ECOLOGY, COGNITION, AND CULTURAL TRANSMISSION OF TZELTAL MAYA MEDICINAL PLANT KNOWLEDGE

by

DAVID GREGORY CASAGRANDE

(Under the direction of Brent Berlin)

ABSTRACT

The goal of this dissertation is to explain patterns in the distribution of medicinal plant knowledge among the Tzeltal; in particular, why some plants are more likely to be known for their medicinal use than other plants. Methods included botanical collection, structured ethnobotanical surveys, landscape vegetation surveys, discourse analysis and participant observation. The explanatory approach was synthetic, drawing on notions from cultural anthropology, ethnopharmacology, ecology, cognitive science, linguistics, and studies of cultural transmission. Explanatory notions were tested by comparing Tzeltal Maya who have lived in the temperate Chiapas Highlands for many generations with other Tzeltal who have migrated from the Highlands to the lowland tropical rainforest within the last 30 years.

Both study populations show patterns in which a few plants are known by everyone, but distribution of knowledge decreases as the diversity of plants increases, and most knowledge is idiosyncratic. The effects of typicality in categorization and discourse account for the few widely known plants. Humoral (hot/cold) classification is highly variable, does not facilitate recall of medicinal uses of plants, and has no significant effect on the distribution of knowledge. Cultural interpretations of plant taste and morphology are very important in individual cognitive models, but lose importance at the scale of shared discursive models where social and pragmatic themes also influence the dissemination of knowledge. While humoral classification and cultural interpretations of taste and morphology may be important for expert curers, they do not significantly affect the dissemination of knowledge among novices. Species that are more accessible tend to be used more often, and frequency of use is weakly correlated with knowledge distribution. Emic perception of efficacy is the variable that most accounts for the distribution of knowledge. But social organization, individual cognition, and random processes in cultural transmission shape and bias the flow of information, and knowledge about many species that fit emic conceptions of efficacy is not distributed throughout the populations.

INDEX WORDS: Chiapas, cognitive anthropology, cultural transmission, cultural models, goal-derived categories, prototypicality, distributed cognition, discourse, efficacy, ecological anthropology, ecology, ethnoecology, ethnopharmacology, ethnopharmacognosy, human ecosystems, humoral classification, indigenous knowledge, information, Maya, medical anthropology, medical ethnobotany, medicinal plants, Mexico, organoleptics, phytosociology, social networks, Tseltal, Tzeltal, variation, migration

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Dedication

To Donna, whose patience and courage made this dissertation possible.

And to my parents, Guido and Dorothy,

for their enduring belief in my ability to do whatever I choose.

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I would like to thank the administration, staff and faculty of El Colegio de la Frontera Sur in San Cristóbal for agreeing to sponsor me as a visiting researcher and for their generous help over the years. In particular, Dr. Mario González-Espinosa, the library staff, and Dr. Mario Ishiki and the staff of the herbarium have all been very helpful.

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I am also grateful to have inherited the ability to build on a long tradition of research of Tzeltal medicine beginning with the work of Duane Metzger and Gerald Williams, and continuing with the work of Elois Ann and Brent Berlin and that of their students: John Brett, who studied the role of organoleptics; Luisa Maffi, who documented Tzeltal illness classification; George Luber, for his work on explanatory models; and Rick Stepp, who studied the effects of vegetation disturbance and habitats. Without the cumulative results of their meticulous work and thoughtful insights I simply would not have had the opportunity to ask the questions that I did in this dissertation

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Some of the ideas in this dissertation, especially the themes of synthesis, the new ecology, and information, can be attributed to my participation in the Human Ecosystems Group at the University of Georgia. I would especially like to acknowledge the inspiration and advice provided by Dr. Charles Peters, who always admonished the need to “take the next step,” and Becky Zarger for her help and advice regarding cultural transmission. Other group members that I have not already thanked above include Eric Jones, Mitch Pavao-Zuckerman, Felice Wyndham, Suzanne Joseph, and Warren Roberts.

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Introduction

The research problem

Living and conducting research in the Highland Maya communities of Chiapas, one quickly becomes intimate with a variety of stomach ailments. My residence in the community of Nabil provided no exception, and as long as I was willing to discuss my abdominal abnormalities, my friends and host family were willing to suggest treatments. On one occasion, 12-year-old Luci [1] suggested that I drink a tea of the very bitter *yakan k'ulub* (*Verbena litoralis*). This was a common suggestion. When I asked why *yakan k'ulub,* she said, "*Spisil ya jnatik ja' mero poxil tza'nel*," 'everyone knows it's a good cure for diarrhea.' I later discreetly asked her seven-year-old sister if she knew of a cure for *tza'nel*, to which she promptly and proudly recommended that I consume boiled leaves of *yakan k'ulub*. Indeed, it is nearly impossible to find a person in the Highlands beginning at age four who does not know that *Verbena litoralis* is an effective cure for common diarrhea. This comes as no surprise. After all, it would be difficult for a researcher to find an American who didn't know that aspirin can be used to treat a headache.

Another personal vignette reveals a different perspective of "common knowledge." While hiking a trail with a middle-aged Tzeltal friend, I came upon a rather odd-looking shrub with fig-shaped leaves that I knew as *Bocconia arborea*. I asked my friend for the Tzeltal name, to which he replied "*max k'il, pero ya spoxta sak obal, xi*," 'I don't know, but they say it cures tuberculosis.' "*Mach'a la yalbet*?" 'who told you?' I asked. He said that everyone knew about it, but he specifically remembered that his mother told him. Subsequent interviews revealed this to be only partially true. His older brother knew about it, and his mother claimed that it was used extensively as an effective treatment for tuberculosis, which was much more common in the past. Despite many interviews with friends and neighbors of this family, however, I never found another person who knew about this treatment.

The Tzeltal Maya, like most people besides modern Americans, have a complex pharmacopoeia involving hundreds of plant species. The degree of consensus among the population about the complex medicinal uses of around 200 of these species is remarkable (Berlin and Berlin 1996). But even more remarkable is the patterned variation of medicinal plant knowledge among the Tzeltal. Throughout the Maya Highlands and within individual communities there are a handful of plant species that are known for their medicinal use by nearly everyone. Then there is a core set of around 40-60 plants that are more or less widely known. And then there are hundreds of species that are known by only a few people. Even more interesting, as I discuss in Chapter 2, is the observation that most ethnopharmacological studies that have quantified variability in knowledge show a strikingly similar pattern.

This dissertation is based on a simple but fundamental question: why are some plants more likely to be known as medicinals than others? Proximate questions can be derived from patterns in the distribution of medicinal plant knowledge. For example, could these patterns represent some optimal system in which enough knowledge is shared to provide benefits to all, but diversity also allows for change and adaptability? Perhaps there are characteristics of the individual plants that make information about them more likely, or less likely, to circulate throughout the population. Or are these patterns primarily the result of social organization and behavior? These questions have broader implications for anthropology, and ecological anthropology in particular.

The processes of experimentation, discovery, and transmission of knowledge about medicinal plants represent complex relationships between pathogens and phytochemicals in the environment, and the biological and cultural constraints on human cognition and communication. In the tradition of cultural ecology (Steward 1949) one could ask how much of the observed patterns in knowledge result from direct interaction with the nonhuman environment? This question can be recast at a finer (and more operational) resolution of analysis by asking how much of these patterns are a function of universal cues presented by organoleptic qualities,[2] pharmacological efficacy, and disease prevalence. Or is medicinal plant knowledge mostly the result of symbolic interpretations of the characters mentioned above, and therefore is completely culturally relative? Yet another possibility is that these patterns are largely the result of social organization and are only tangentially related to environmental information.

The research approach

My approach to the fundamental question of why plants are known by some people and not by other people consisted of documenting and explaining patterned variation of medicinal plant knowledge in several Tzeltal communities. Analytical tools included botanical collection and structured ethnobotanical surveys in order to document which plants were known as medicinals by which people. Much of the study involved reducing the most plausible explanations to quantifiable variables that could be tested for correlation with patterns in knowledge distribution. But I also made extensive use of discourse analyses and participant observation to contextualize statistical analyses, choices in the scales of analysis, and interpretation of data and results. Some of the explanatory notions tested in this dissertation derive from the literature; others represent my attempts to synthesize disparate ideas by carefully applying methodological and theoretical tools from across the intellectual traditions of cultural anthropology, ecology, linguistics, information theory, and the cognitive sciences.

The first, and perhaps most obvious, explanation for the distribution of medicinal plant knowledge is that plants that are more likely to be perceived by people as efficacious treatments are more likely to be known throughout a study population (Adu-Tutu et al. 1979; Ankli et al. 1999b; Browner et al. 1988; Friedman et al. 1986; Heinrich et al. 1992; Johns et al. 1995; Trotter and Logan 1986). I will show that Tzeltal perceptions of efficacy are indeed the most important catalyst for the dissemination of information about medicinal plants, but efficacy alone is inadequate for explaining all of the patterns that I report.

The second explanatory theme, which has rapidly gained attention within the last decade due to a stimulating synthesis between biochemical ecology and anthropology, is the notion that cultural interpretation of organoleptic properties serve as environmental cues for appropriate medicinal uses (Ankli et al. 1999a, 1999b; Brett 1994, 1998; Johns 1990; Rodrigues et al. 1976). While this idea has mostly been applied to models of traditional experimentation and selection by experts, I tested the possibility that it also guides the dissemination of knowledge and acceptance of information about medicinal plants in a population of novices.

Other notions that I considered for their possible influence on the distribution of medicinal plant knowledge include the distribution of plants in the landscape (Alcorn 1984; Caniago and Siebert 1998; Moerman 1998; Moerman et al. 1999; Stepp and Moerman 2001), the doctrine of signatures (Etkin 1988a), and informant agreement about hot versus cold humoral classification (Foster 1994; Kidwell 1991).

The first objective of this study was to systematically test predictions derived from each of the potential explanations presented above to see how well each *individually* might contribute to the patterns of knowledge distribution that I observed. I argue that while some of these notions have more explanatory power than others, none of them alone can adequately explain the patterns observed in this study.

Therefore, the second objective of this dissertation was to explain observed patterns in knowledge by integrating these explanatory notions using a synthetic approach that also accounts for the constraints of human cognition and patterns of cultural transmission that result from social organization and random processes. Surprisingly, the ways that human cognition and cultural transmission might affect the distribution of medicinal plant knowledge have mostly been ignored (see Garro 1986, 2000; Johns 1986, 1990:160-194 for exceptions). Advances in cognitive theory and methods (especially regarding distributed cognition—Hutchins 1995; Nickerson 1993), studies in cultural transmission (Cavalli-Sforza and Feldman 1981; Henrich 2001), and approaches from the "new ecology" (Scoones 1999) can be combined to provide exciting possibilities for a synthetic approach to studying the use of plants as medicinals—a universal cultural feature that represents a fundamental link between human thought and biophysical environments.

The key to this synthesis was to apply analytical tools that specifically allowed for the study of asymmetrical patterns in information (including cognition), biophysical variables, social organization, and behavior *across scales of analysis*. For example, I analyzed both individual cognitive models of plant-based curing and shared discursive models to identify differences in the relative importance of the variables at the scale of individuals versus that of the population. This was crucial for explaining why perceptions of organoleptic qualities appear so important to individuals, but actually have little effect on the distribution of knowledge (Chapter 8). Regarding cultural transmission and the "new ecology" (Scoones 1999), I used non-equilibrium and stochastic evolutionary principles of cultural transmission to strike a middle ground between reductionism and complexity (Joseph 2000; Winterhalder 2002) in order to explain non-optimal, non-adaptive behaviors and forms of informational organization. I describe these and other methodological issues in more detail in individual chapters and in the Conclusion. The point I want to make here is that the potential explanations for the distribution of medicinal plant knowledge that I have gleaned from the literature only achieve explanatory power when integrated using recent developments from a variety of disciplines.

The third objective of this study was to test predictions about knowledge distribution derived from the study of Tzeltal Maya who have lived in the Highlands of Tenejapa for many generations by replicating research with other Tzeltal who have migrated from Tenejapa to the tropical rainforest frontier within the last 30 years. The Highland communities were chosen to represent a temperate flora, and the frontier communities are tropical. The migrants have rapidly assembled a new pharmacopoeia that differs from that of the

Highlands. They have maintained their language, most aspects of their subsistence economy, and conceptualizations of illness, but have abandoned most traditional rituals and cosmology. A comparative study provides an outstanding opportunity to determine which of the patterns observed in the Highlands are replicated in the new cultural, social, and biophysical environments.

Why study novices?

It is important that I clarify the distinction between novice and expert informants that I use throughout this dissertation. Tzeltal Maya who are recognized by their fellow Tzeltal as having some special talent for curing—usually due to supernatural powers—are linguistically labeled as *jpoxiletik* 'curers' (Brett 1994:48; Metzger and Williams 1963), or are labeled according to their specialization (e.g., those who read pulses, prayer specialists, midwives, and bonesetters). Prayer and ritual are usually integrated into the curing practices of these people; they receive some form of compensation for their services (usually not monetary); and they command the authority and respect to proscribe specific behaviors. People fitting this description have been labeled by other authors as "healers" (Ankli et al. 1999b), "curers" (Garro 1986), and "specialists" (Barrett 1995).

There are other specialists who receive monetary payment for their plant-based medicinal knowledge and who generally do not include supernatural, religious, or cosmological references in their practice. These people are considered by other Tzeltal to be medicinal plant experts (Brett 1994:48-60) and are often called *yierberos* 'herbalists.' I will refer to them with the term "expert" to be consistent with the distinction between "experts" and "novices" that has become popular in the cognitive literature (e.g., Johnson 2001; Medin et al. 1997). I make an additional distinction by referring to those experts who have invested financial resources into their practices and derive substantial income by charging for services as "professional herbalists." These include the owners of herbal medicine shops and kiosks in markets, but also an increasing number of Tzeltal living in their own communities who have studied herbal medicine in some formal setting.

I refer to people who do not conform to the criteria above as “novices.” Some novices in this study may command considerably more knowledge about medicinal plants than others, and may be consulted for their advice about medicinal plants. I refer to these people as “more knowledgable novices” because they are not called *jpoxiletik* or *yierberos* by other Tzeltal, nor do they refer to themselves as such, nor do they conform to any of the other criteria presented above.

It has been suggested that the cognitive organization of expert knowledge may be different from novice knowledge of semantic domains in general (Johnson 2001; Medin et al. 1997), as well as for medicinal plants (Barsh 1997; Garro 1986). Because experts and novices may be employing different knowledge systems and forms of cultural transmission, I decided not to include both in my study population. There were no experts (*jpoxiletik, yierberos,* or professional herbalists) living in any of the four communities where I conducted research.

I chose to study only novices for several reasons. 1) Time limits did not allow for a thorough treatment of both types of knowledge and the vast majority of medicinal plant studies have focused on experts. I hoped to broaden the understanding of medicinal plants in social context by contributing to the smaller body of knowledge regarding novices. 2) It was easier to study the role of cultural transmission among novices since they are geographically centralized and were communicating regularly in a highly organized social context, as opposed to the more widely distributed networks and lower numbers of expert healers who meet infrequently. 3) I hoped that explanations of how information is shared among novices may be more informative to readers interested in “everyday” semantic domains other than Tzeltal medicinal plants, whereas results from experts would tend to be much more specialized. 4) I was specifically interested in studying variation across different scales of space and social organization, and I expected to encounter greater variation in knowledge among novices than among experts.

Notes regarding orthography, Tzeltal plant names, and presentation of discursive data

Throughout this dissertation I provide excerpts from interviews that were conducted in Tzeltal. I have provided both direct transcriptions of the Tzeltal text and English translations. Although the Tzeltal text added considerably to the volume of this dissertation, I felt it was important for readers who might desire insights into the English translations and glosses. The discursive data are presented verbatim, including stops, pauses, and incomplete sentences. This is intentional. I feel it gives the interested reader more insight into the thought processes and discursive context.

I conducted all interviews in Tzeltal, but participants occasionally spoke Spanish. These are the only interview excerpts presented in Spanish. Since Spanish is the second language of most participants, it was often poorly spoken. As with the Tzeltal text, all Spanish text is presented as unedited transcriptions. They include mispronunciations, erroneous conjugations, misuse of tense and person, and other errors. I intentionally left these errors in case the reader is interested in the thought processes involved with Tzeltal Maya speaking Spanish.

In the English translations of interview excerpts I give botanical names of plants mentioned in the Tzeltal or Spanish text. These are based on identifications of specimens by the same speakers either during the interviews from which the presented text was excerpted, or during other interviews with the same speaker. If a direct identification by the speaker was not available, the Tzeltal or Spanish name is left in italics in the English translation. If the identification is questionable, then the botanical name is followed by a question mark. The botanical names were determined at the herbarium of El Colegio de la Frontera Sur (see Methods, Chapter 2). Tzeltal names of plants presented in figures, tables, and text other than interview excerpts were derived from consensus analysis of names reported during structured ethnobotanical interviews (Borgatti 1996a; Romney et al. 1986).

I have followed the Tzeltal orthography that will be useful to most English-speaking readers with some experience with Spanish per Berlin and Berlin (1996:xxix). Most consonants and vowels are pronounced as they would be in Spanish, including the pronunciation of "j" as an English "h." Phonemes that deviate from Spanish include the "x," pronounced as an English "sh," glottalized consonants (p', t', k', ch' and tz'), and the glottal stop, which is also indicated by a single apostrophe.

Notes

[1] I use the true names of all geographical features and political units throughout this dissertation, but I use only pseudonyms for people.

[2] Throughout this dissertation I will maintain the distinction between organoleptic and symptomatic properties of plants as expressed by Berlin and Berlin (1996:66): "*Organoleptic* qualities are recognized directly by the sense organs (e.g., taste, smell) and reactions of the skin to the plant. *Symptomolytic* qualities pertain to the removal of symptoms (e.g., reduction of abnormally elevated body temperature." (Italics in original.)

Chapter 1
Ethnographic and Ecological Context

An elder Tzeltal man from Nabil told me that he once went to an herbal shop in San Cristóbal, the nearby city, to inquire about a cure for his sick wife. The shopkeeper showed him a dried plant that he recognized as a plant that grows in Nabil. It has no reputation of being harmful, so he decided to pick it when he arrived back at home and give it a try. Given that the Tzeltal are generally skeptical about such matters, I asked why he believed him. His response was "*Ya spoxta pajal sok penesilina, xi,*" 'it works like penicillin, the man said.' This led me to ask how he knew about penicillin. It turns out that he learned the word from his daughter who sells a few biomedical pharmaceuticals from her small wooden store in Nabil. Although he could not explain what penicillin is, and he remains unsure about the outcome of the plant that he tried, I heard him relate this story to others in the community who often asked his advice about medicinal plants. He always mentioned that it should work like penicillin.

This anecdote shows that it would be difficult to understand the diffusion and variability of plant knowledge among the Tzeltal without understanding social relationships within their communities and with the world outside of their communities. The goal of this chapter is to provide the background for the subsequent analysis of the distribution of medicinal plant knowledge by highlighting some of the ways in which external influences, the biophysical ecosystem, social structure, and local strategies regarding agriculture, economics, and curing affect the distribution of knowledge about medicinal plants.[1]

Tenejapa and Maravilla Tenejapa are two *municipios* 'municipalities' located in the state of Chiapas, Mexico (Figure 1.1). *Municipios* are comparable to counties in the United States regarding their place in the hierarchy of political divisions. They are comprised of

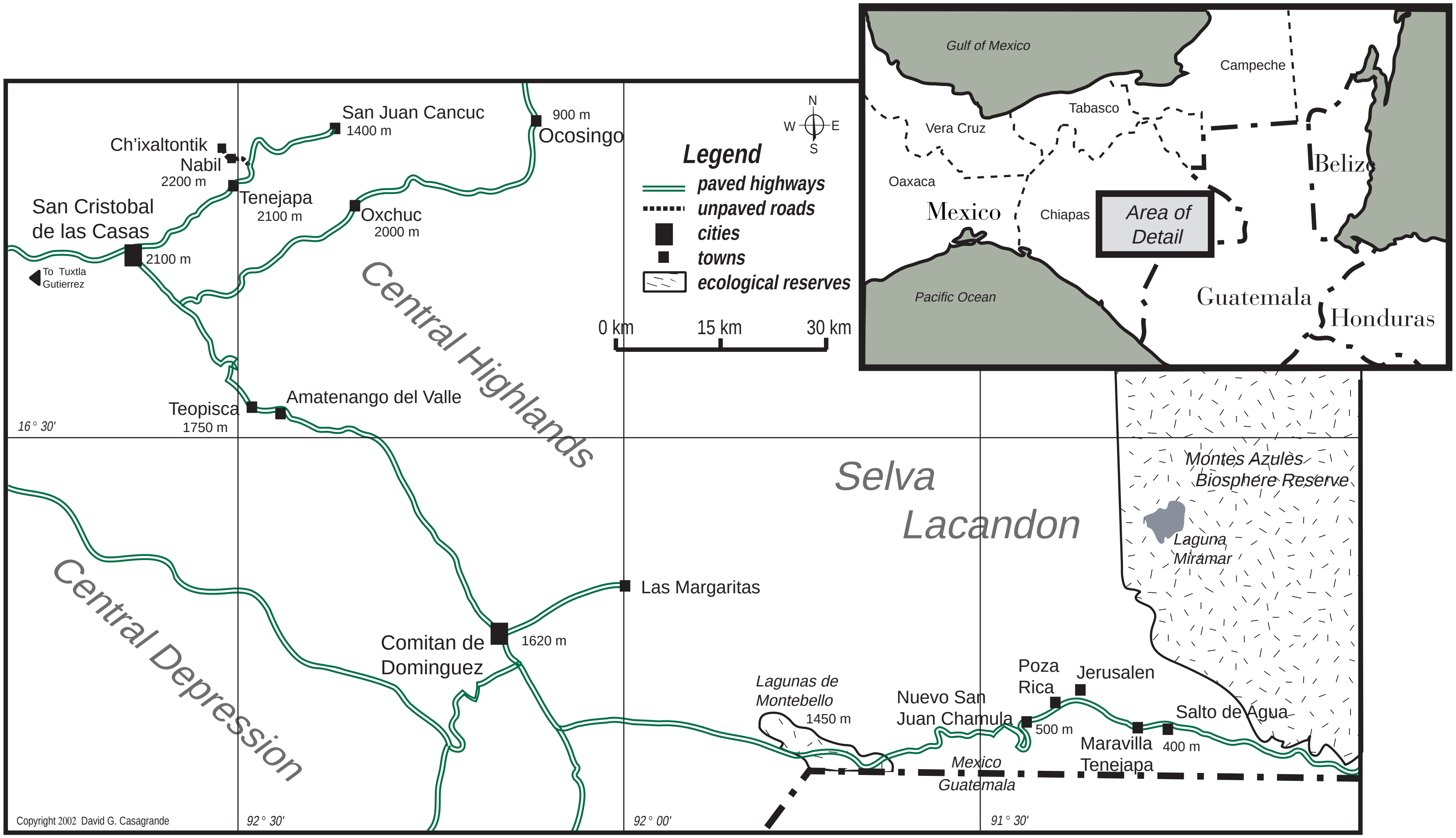

Figure 1.1. The study site in Chiapas, Mexico and geographical features mentioned in this dissertation.

densely populated political, commercial, and ceremonial centers (*cabeceras*), outlying hamlets that are either *parajes* or *ejidos*, and large privately-owned plantations (*fincas*). *Parajes* and *ejidos* are the smallest political divisions in Chiapas, and are recognized as political units by both the Tzeltal and the Mexican Government. *Parajes* in Tenejapa derive primarily from traditional lineage systems (Medina Hernández 1991). Most land within *parajes* is privately owned and inherited patrilinearly. *Ejidos* are agricultural cooperatives formed under the Mexican constitution. Land is owned communally, but rights and obligations to work the land are granted to individuals (usually male heads of households) and also inherited patrilinearly (Stephen 1994).

I conducted most of my dissertation research in Nabil—a *paraje* located within the municipality of Tenejapa in Highland Chiapas, and in Maravilla Tenejapa—an *ejido*-style municipality founded on the Guatemalan border by Tzeltal migrants from Tenejapa. In Maravilla Tenejapa I conducted research in the municipal center and in Salto de Agua—another *ejido* located close to the municipal center. Throughout this dissertation I also refer to some comparative work that I conducted in Ch'ixaltontik—another high-elevation *paraje* adjacent to Nabil within Tenejapa.

In all four communities the primary language is Tzeltal. Men are more likely to know some Spanish than women, because they are more likely to have lived and worked outside of their communities. Primary education in all four communities is now bilingual, and most young girls and boys are learning to speak Spanish, but Tzeltal is spoken in the home.

The habitation of Tenejapa dates back at least to 1611 (Calnek 1961) and the Tzeltal have inhabited the Highlands in general since much earlier (Calnek 1988). This indicates a long history of cultural interaction with the local flora spanning many generations. Maravilla Tenejapa was settled by immigrants from the Highlands only with in the last 30 years.

Regional and global integration of the Highland Maya communities

Ninety-nine percent of the people in the municipality of Tenejapa are subsistence swidden horticulturists (INEGI 2001), but they are also somewhat cosmopolitan. Taxis leave Tenejapa center for San Cristóbal de Las Casas about every 15 minutes. A city with a population of at least 132,000 (INEGI 2001), San Cristóbal is the political and commercial center of the region and offers department stores, as well as a large, primarily indigenous, outdoor market, occasional low-wage employment, legal services, and health services, including hospitals, well-stocked pharmacies, dentists, and a variety of herbal medicinal shops. The cost of the trip by taxi from Tenejapa center to San Cristóbal during 2001 was 12 pesos ($1.33 US). This appears to be affordable given that men and women from Nabil will visit the city about once a week, often on shopping trips with other family members.[2] Occasionally they will stay for more than one day with friends or family who have migrated to San Cristóbal, although overnight visits are limited to occasions like festivals, important protracted legal, commercial, or healthcare transactions, or in some cases long-term stays by young adults attending higher-education schools in San Cristóbal. The 27 km drive from Tenejapa to San Cristóbal takes about 30 minutes on a well-paved road. It is important to note that these excellent travel conditions have existed only since about 1998, meaning that reliable and predictable transportation for residents of Tenejapa, commercial venders, government agencies, and non-governmental service providers, including healthcare workers, is rather recent.

North from Tenejapa, in the opposite direction of San Cristóbal, the paved road continues toward San Juan Cancuc (Figure 1.1). Approximately five kilometers along this route one may turn onto a dirt road to travel another seven winding kilometers to reach the *paraje* of Nabil. Automobile transportation from Tenejapa center to Nabil takes about 30 minutes and is by special arrangement, costing up to 50 pesos ($5.55 US) each way. Most people prefer to walk the more direct trail if they don't have too much cargo. The walk between Nabil and Tenejapa center takes about 45 minutes along a slippery trail that descends steeply down a canyon wall at the northern edge of Tenejapa.

In Nabil, there are about five poorly-stocked stores selling mostly soda pop and sweets that are operated out of the fronts of houses along the dirt road. Three of these sell basic pharmaceuticals like aspirin and other analgesics, alka seltzer, and some antibiotics. There are a few stores (*farmacias*) in Tenejapa center that stock a wider selection of pharmaceuticals, but people from Nabil must travel to San Cristóbal to acquire most important pharmaceuticals. There is an IMSS (Instituto Mexicano del Seguro Social—the Mexican Social Security Institute) health clinic in Tenejapa center with a doctor. The clinic is open two or three days a week to provide limited services free of charge. There is no such facility in Nabil or Ch'ixaltontik.

As the description above indicates, even if one walks from Nabil to Tenejapa and then catches a taxi, they can be confident of arriving in San Cristóbal within one and a half hours spending as little as 12 pesos. This means that potential access to hospitals, clinics, pharmacies, and a wide variety of herbal markets is now easily within the reach of residents of Nabil. Although, their ability to pay for many if these goods and services is another matter.

The people of Nabil are also connected to the world beyond their community by radio, television, and, to a limited extent, print. Electricity arrived in Nabil in 1994 and nearly every family owns at least a small transistor radio. We listened to Tzeltal and Spanish broadcasts about politics, crime, accidents, local obituaries, employment opportunities, social announcements (e.g., birthdays, weddings, illnesses), health issues (including commercial sale of vitamins and herbal remedies), and Indigenous, Latin, and American music. In addition to national, state, and local politics, most members of the community were well informed about international events, such as the controversial 2000 election in the USA and the Gulf War.

Although high quality televisions and direct-TV satellite dishes are prominent in Tenejapa center and other wealthier *parajes*, there are only a few small televisions and makeshift antennas tied to trees in Nabil. This reflects the more limited economic potential at this high altitude. The family I lived with had a small black and white television. They occasionally watched movies in the late evenings, depending on reception.

The nearest telephones are in Tenejapa center. There are no personal computers in Nabil, although I can not make this claim for Tenejapa center. In 2000 I attended a public planning meeting for soliciting computers for the secondary school in Tenejapa center, but when I left in 2001 this had not yet born fruit. Due to the limited telephone service in Tenejapa (only 3 or 4 phone lines), the nearest internet access remains in San Cristóbal, where internet cafes charging between seven and ten pesos per hour are ubiquitous.

Hopefully, this discussion is sufficient to introduce Nabil's interconnectedness with events and ideas that originate outside the political boundaries of their *paraje*. This interconnectedness permeates all aspects of their life and certainly influences knowledge about medicinal plants and healthcare options.

Despite the arrival of modernity, however, some things have not changed.[3] In Nabil—indeed throughout the *parajes* of Tenejapa—life continues to revolve around the *milpa* 'corn swidden,' most people are very poor, they are generally not healthy (see Chapter 3), and they share an extensive knowledge about local medicinal plants.

Biophysical, demographic, and political-ecological influences on medicinal plant knowledge in the Highlands

The most recent IMSS census (conducted in 2000 as part of the vaccination program) estimated the population of Nabil to be 360 (comprised of 105 families) and Ch'ixaltontik to be 173 (comprised of 48 families). Using an altimeter, I estimated the elevation in the center of Nabil to be 2200 meters above sea level. The highest point in Nabil is 2250 meters. The lowest point is 2025 meters. The elevation in the center of

Ch'ixaltontik is 2100 meters. The average annual temperature in the Highlands at these altitudes is between 13˚ and 15˚ C. Between December and March, nighttime temperatures in Nabil commonly dip below freezing, leading to frost and damage to plants. Daytime highs around 25˚ C can be expected any time of the year. Annual rainfall averages between 1500 and 2000 mm, with 80% falling between the months of May and October (González-Espinosa et al. 1991).

Bedrock in the region is limestone with occasional volcanic outcrops (Mülleried 1957:62). The soil is predominantly a dark brown, highly calcareous, clayey-loam weathered from the limestone, and ranges from 30-50 cm deep in some forest stands (González-Espinosa et al. 1995) to being absent in eroded areas with exposed limestone. As is typical of karst topography, very steep slopes dominate the landscape.

Highland Chiapas is located at the juncture of the temperate (Holarctic) floral assemblage to the north and the neotropical to the south (Rzedowski 1993). This, combined with the effects of temperature, rainfall, and topography presented above, result in an exceptionally diverse flora. The area of Tenejapa is only 99.4 km^2, yet it ranges in elevation from 2600 meters to about 1000 meters, and is thought to contain almost 3000 vascular plant species (Stepp and Moerman 2001, based on Berlin, Breedlove and Raven's unpublished inventory). This represents a highly diverse ambient flora of potential medicinal use.

Of course, floral diversity in any particular location is much lower as a result of historical habitat manipulation, endemism, and microclimatic conditions (Breedlove 1981; González-Espinosa et al. 1991; Zuill 1973). The flora in higher-elevation communities like Nabil tends to be more temperate than tropical. Some species from temperate families that are common in Nabil and Ch'ixaltontik, but are not found at lower elevations, include *Liquidambar styraciflua* (Hamamelidaceae), *Carpinus caroliniana* (Betulaceae), and *Alnus acuminata* (Betulaceae). Tzeltal medicinal plants tend to be herbaceous species that grow in disturbed habitats (Stepp and Moerman 2001), and include several botanical families that are not limited to either temperate or tropical climates (Moerman et al. 1999). Nevertheless, some species within these families show elevational affinities. For example, high elevation communities in Tenejapa will include a somewhat higher diversity of Asteraceae, but far fewer species of Piperaceae, Melastomaceae, or Fabaceae as compared to the lower-elevation communities. Also, there are botanical families, like Annonaceae, Myristicaceae, and Chloranthaceae, that are exclusively tropical and are not represented by any species in the high-elevation communities. Finally, some species commonly used as medicinals, like *Verbena litoralis* and *Borreria laevis*, are common in disturbed areas at all elevations.

This regional diversity of potential medicinal plants is best kept in the perspective of individual experience. For example, *Salvia lavanduloides, Erigeron karwinskianus* and *Baccharis vaccinioides* are some of the best known medicinal plants in Nabil, but they are rarely found below 1600 m elevation. On the other hand, *Byrsonima crassifolia* and *Neurolaena lobata* grow only below about 1600 m and are widely known as medicinals in lower-elevation communities. Elevations vary greatly over short distances, and several *parajes* that are within a three-hour walk from Nabil include elevations as low as 1500 m. Many people from Nabil own land or otherwise visit or work in these communities, and are thus exposed to a greater diversity of medicinal flora than occurs within their own community. But their firsthand experiences in Nabil and these other communities still involve only a portion of the highly diverse flora.

Edaphic and climatic conditions are also the primary determinants of subsistence agriculture, and therefore health and economic potential. The Tzeltal of Nabil and Ch'ixaltontik are subsistence swidden horticulturists. Their primary crops are corn, beans, and squash, but greens (esp. *Brassica* spp.) and temperate fruits like apples, plums and peaches are also cultivated. All of these are grown primarily for household consumption, but are occasionally sold at the markets in Tenejapa center or San Cristóbal. Many wild berries and greens are also consumed. Livestock include chickens, turkeys, pigs, and very few horses. Some residents of Nabil own one or two cattle, which are strictly for market.

Wild animals, including rabbit, squirrel, raccoon, opossum, birds, and other small rodents are enthusiastically hunted for household consumption. Larger forest animals like deer and peccary are very rare.

Forest or grassland in Nabil are burned to create new swidden corn fields at the end of the dry season in February and March. Corn, beans, and squash are planted at the onset of the rainy season in April. Harvesting is completed by the end of November. After the initial burning, a plot will be used to grow corn for one or two years before being left fallow. The fallow period averages about eight years, but varies from four to 15, based on elevation, slope, and soils. Larger tracts of secondary forest belong to wealthier owners who can afford to leave land for harvesting firewood or pine for market. The swidden system results in a patchwork of agricultural plots (Figure 1.2) in various stages of succession. Each of these stages has unique plant communities that are easily distinguishable and linguistically labeled (Table 1.1). The structure and species composition of the more mature stands of forest in Nabil and Ch'ixaltontik generally conform to Breedlove's (1981) description of a pine-oak-sweetgum community. Medicinal plants are acquired from all of the habitats, although disturbed habitats tend to be favored (Stepp and Moerman 2001; and see Chapter 7).

Figure 1.2. Intensive swidden horticulture results in a patchy mosaic landscape in Tenejapa.

Table 1.1. Highland Tzeltal habitat classifications[1] and their characteristics. [2]

Tzeltal lexeme	Swidden stage	General ecological characteristics
pat na	houseyards	Highly disturbed areas around houses with many weedy species, occasionally forest or *milpa* edge, and some planted species
ak'il	pasture	Dominated by grass. Mostly for cattle grazing
k'altik	swidden (1-3 years)	Fields that currently have corn growing in them
k'ajbenal	1st year fallow	Dead corn stalks evident amongst early successional herbs and saplings
wank'altik	2nd year fallow	Dominated by early successional herbs and small saplings up to 1.5 m
unin k'inal	3-7 year secondary growth	Dense early successional forest with a closed canopy up to 10 m
k'inal	6-12 year secondary growth	Dense early successional forest up to 15 m with a well–developed understory layer
te'tikil	secondary forest, woodlot	Stands of oak and/or pine with a closed canopy up to 20 m and thinned understory
ja'mal	old growth forest	Oak, pine and *Persea* sp. forming canopies up to 35 m tall, a closed mid-story and humid herbaceous floor

[1] Determined from interviews while visiting the various habitats with three principle informants on separate occasions.
[2] Based on my field observations.

It is important to note that the cold weather in Nabil allows for only one crop of corn per year, and also precludes cultivation of coffee and tropical fruits like bananas, avocados, lemons, oranges, or mangos. Tzeltal who live at lower elevations in Tenejapa can grow coffee, many tropical products, and two corn crops per year. The fact that crops that can be grown in Nabil (corn, beans, and squash) can also be produced in greater volume at lower elevations, as well as the greater diversity of products that can be grown below (some of them for the international market), largely explains why Nabil is one of the poorest communities in the Highlands. Some families have managed to purchase, rent, or otherwise acquire rights to agricultural land at lower elevations. Nevertheless, residents of Nabil struggle to produce sufficient food for household consumption, and are even less likely to produce for the market. They are constantly at risk of malnutrition and disease, and they have little financial resources to deal with illnesses. Although all children are vaccinated by the government, and some basic treatments are offered free of charge at the government health clinic in Tenejapa center and government hospitals in San Cristóbal, comprehensive biomedical care and pharmaceuticals are, for the most part, unaffordable to residents of Nabil.

Much of the inability to produce sufficient food, and the subsequent undernutrition and disease (see Chapter 3), have resulted from a rapidly increasing population. Rapid population growth appears to have two antithetical effects on medicinal plant knowledge. On the one hand, people are poorer, have more disease, and have more of each other to share medicinal information with—all of which might enhance medicinal plant knowledge. On the other hand, both Tzeltal and government strategies for coping with the population explosion have resulted in a somewhat mixed integration into the market economy and a greater reliance on biomedical care and pharmaceuticals—which may diminish knowledge about medicinal plants. But as the following discussion shows, the situation is more complex and, perhaps, contradicts these superficial assumptions.

Population density in the Central Highlands was estimated to be 56 per km^2 in 1974 (Berlin et al. 1974). Collier (1975) argued then, that population densities could not be supported by the traditional corn-swidden system. By 1989 population density in the Central Highlands was estimated to be 273 per km^2 and shortened fallow times had reduced soil productivity to unsustainable levels (Alemán Santillán 1989). Census data for 2000 indicate a population density of 334 per km^2 for Tenejapa (INEGI 2001). As a result of this pressure, the Highland Maya have intensified land use by shortening fallow times, using commercial herbicides, pesticides, and fertilizers, and renting additional lowland fields. They have also sought income from wage labor, logging pine, and manufacturing and marketing crafts and textiles (Collier 1975; Hunn 1977; Parra Vásquez and Mera Ovando 1989).

Many men from Nabil and Ch'ixaltontik have also worked at construction in San Cristóbal and points farther away, especially during the 1980s when the government was investing heavily in large infrastructure projects in Chiapas.

One important strategy, mostly for men, has been to work in the large, privately-owned coffee and sugar plantations (*fincas*) during periods of high labor demand; usually for no more than two or three weeks. Most older men I interviewed have worked at *fincas* at some point in their lives, and they describe very poor living conditions and wages. They also describe severe outbreaks of illnesses, especially dysentery, as a result of unsanitary, crowded living conditions, inadequate food, and a complete lack of healthcare. As a result, the *fincas* have also served as "clearinghouses" for medicinal plant knowledge because people from other states, and even Guatemala, share knowledge about the illnesses they are experiencing. Many of the low-elevation plants that are known as medicinals in Nabil were learned at the *fincas*.

Another very important source of household income is weaving and embroidering of clothing and carpets using traditional Tenejapa patterns. Weaving is done exclusively by women, and women in every household I visited were involved. Recently, regional indigenous cooperatives and philanthropic patrons have begun supplying materials and credit, and offering fair prices for finished products. As a result, textile production by women has become a critical enterprise for some of the better-connected families in Nabil and Ch'ixaltontik.

Another important strategy is logging of pine for the construction industry. The area where the road ends (it is still under construction in Ch'ixaltontik) is mostly privately-owned pine forest. Owners supply men from Nabil and Ch'ixaltontik with chain saws and credit for gasoline to cut pine, which can easily be trucked to market since the road arrived around 1993. One young man from my host family earned a substantial income due to his skill for cutting boards with a chain saw.

Perhaps the most important strategy for dealing with unsustainable population densities has been emigration. In Nabil, there is presently only enough land to pass on to the oldest of sons. Many of the other sons have moved to San Cristóbal, the Selva Lacandon and other parts of Mexico, or even the United States. In some of the cases in which men have married in Nabil before leaving, their families have relocated with them, but in many cases the family has remained behind to live with other relatives and receive remittance payments from the men. Some men who had land left anyway because of the poor agricultural potential at the high altitudes.

I was told that at least part of the income from logging, textile production, and remittance payments is used to pay for pharmaceuticals and better biomedical healthcare than that which is provided free of charge. Interestingly, some of the families that were "buying in" to the biomedical system were also the most knowledgeable about medicinal plants. In some cases they have used their income to attend courses and buy books about herbal remedies. Thus, the effects of population pressure and economic integration on medicinal plant knowledge may not necessarily lead to a decrease in medicinal plant knowledge.

As the vignette about penicillin at the beginning of this chapter suggests, current Tzeltal medical beliefs and practices are pluralistic (see also Brett 1994:48-58 and Maffi 1994:105-115). Whether talking about illness and cures or making behavioral decisions, the Tzeltal draw upon a blend of traditional Maya cures and ideologies, Ladino herbal lore, and biomedical concepts. For common illnesses like diarrhea, headaches, toothaches, and coughs and fevers from colds or flu, the general pattern in Nabil is to apply home-based remedies prepared from the local flora soon after symptoms begin. If symptoms persist, the family will initiate discussion among themselves and with friends and neighbors, which usually results in a trip to a biomedical clinic. Or, the next step may be limited to additional plant-based remedies, or it may be a combination of both. Some people will visit a traditional curer (*jpoxil*) who will make a diagnosis based on the ill person's pulse (Brett 1994: 53-55; Metzger and

Williams 1963), but this is becoming rare in Tenejapa. It is limited mostly to cases in which biomedical options do not yield positive results. It should be noted that no curers (*jpoxiletik*) live in Nabil or Ch'ixaltontik, so this option requires a trip to another community.

People in Nabil are more likely to begin treatment of dermatological conditions (e.g., scabies, lice, infected wounds) by purchasing pharmaceuticals or visiting a clinic in attempts to secure a treatment free of charge. For example, when the woman living next door to me realized her small boy had head lice, she went directly to a store in Tenejapa and bought medicated shampoo. In some cases, plant-based dermatological remedies will be applied in the home first, but this is rare in Nabil.

Strategies are different for emotional and mental illnesses, and those thought to derive from problems with social relations or witchcraft. After considerable family discussion in attempts to arrive at a diagnosis, plant-based remedies will in some cases be applied, but usually a *jpoxil* is consulted first. *Xiwel* 'fright' is an exception to this pattern in that families will usually try plant-based treatments in the home before consulting a *jpoxil.* Biomedical clinics are generally not thought of as a viable option for treatment of these illnesses.

Yet another class of illnesses includes those thought to be of natural origin, but for which most biomedical practitioners do not know a corresponding disease. Two examples are *cha'lam tsots* 'second hair' (Luber 2002) and *me'winik* 'mother of man' (Berlin et al. 1993). Although many people will claim that plants can be used in the home to treat these illnesses, consultation with a *jpoxil* is generally considered the best option.

Although I was told that people may on occasion seek biomedical treatment for illnesses lacking clear biomedical correspondences, like *me'winik*, *cha'lam tsots*, or *xiwel*, this is generally not considered to be an option, because past attempts to communicate with biomedical practitioners have proven frustrating or in some cases humiliating.

Of course, strategies and diagnoses will vary considerably from case to case and between families. Some families claim they never visit clinics, others deny the legitimacy of the *jpoxiletik* . Sometimes the original diagnoses come from *jpoxiletik* or clinics.

But, the basic pattern for the Tzeltal of Nabil is that family and/or friends will first attempt to diagnose the symptoms and apply a linguistic illness label. This is usually as simple as noticing a case of diarrhea (*tza'nel*) or cough (*obal*). In general, they appear to consider biomedical treatment a viable option for those illnesses that they perceive to have clear biomedical correspondences (e.g., *ja' ch'ujt* 'diarrhea,' *obal* 'common cough,' *sak obal* 'tuberculosis'). It is important to note that in the course of illness treatment families may often switch between home-based cures, *jpoxiletik*, and biomedical practitioners, and that diagnoses will change often.

There are also an increasing number of amateur and professional herbalists. This is probably a result of a general trend away from supernatural ideologies, distrust or fear of witchcraft and traditional curers, Catholic and Protestant evangelism denouncing Maya supernaturalism, increasing pluralization of medical options and beliefs, and a flood of external concepts about curing—ranging from "snake oil" salesmen hawking the latest cure-all herbal remedy in the Tenejapa market, to television and radio shows portraying the miracle of modern medicine and commercials about products from pregnancy testing kits to Rogaine and vitamins.

The Tzeltal integrate these new ideas with traditional values and shared cultural models in a constant process of reinventing meaningful concepts of health and illness. Plant-based curing appears to be a very important mechanism in this process, probably because it draws on themes shared by the Tzeltal, Ladino and biomedical systems.[4] Whether a plant is believed to cure because it is imbued with power by God, or because it is thought to contain a bioactive phytochemical (not mutually exclusive ideas), all three systems recognize that plants have the power to alter illness symptoms. Many Tenejapans are actively educating themselves about medicinal plants. Some claim this is only to benefit friends and family, others freely admit it is for profit. The incentives in both cases may be economic, but also include a desire to exercise more control over the curing process and increase treatment options in case biomedical or other traditional options fail. These people have attended courses and workshops, purchased books, and in some cases served as apprentices with Ladino herbalists. The result is an influx of new information about how to use the local flora to treat illnesses. But as I will discuss in Chapter 9, this information does not necessarily circulate throughout the community.

There is one other reason that herbalism has come to serve as a mechanism for negotiating external and traditional ideologies that is worth mentioning. In Chapter 3, I argue that my data from the Tzeltal support Foster's (1976) notion that most Latin Americans tend to distinguish between illnesses of natural and personalistic origin—a notion also supported by Berlin and Berlin (1996:52-56), Maffi (1994:151-152), and Brett (1994:63-66) for the Tzeltal. All of these authors have argued that although plants serve as integral parts of ritualistic curing, they are much more strongly affiliated with curing of illnesses believed to result from natural causes. It is personalistic Tzeltal ideologies that appear to conflict with Protestant evangelism, biomedical science, and Ladino Catholicism. On the other hand, naturalistic Tzeltal illnesses tend to show the most direct correspondence with biomedical and Spanish disease classifications. Thus, it is probably much easier to reconcile the naturalistic, plant-based aspect of Tzeltal curing with the flood of new ideas about illnesses and curing coming from the media and experiences outside of the community.

Here is an example. I worked closely with one of the new Protestant "professional" herbalists in Tenejapa center during the summer of 1998. He appeared to have replaced supernatural explanations and techniques traditionally used to secure the confidence of patients (Metzger and Williams 1963) with biomedical concepts. For example, he made pills out of herbal remedies using purchased capsules and claimed that a particular plant cured because it is bitter like aspirin or chloroquine. For such analogies, he carefully chose pharmaceuticals with a widespread reputation for successful treatment. He did not claim to have received a calling to his profession in a dream, as is typical of traditional curers. Instead he emphasized his training at an herbal institute in San Cristóbal.

It appears as though population pressure, market integration, and the demise of Tzeltal supernatural beliefs may not be diminishing knowledge about the medicinal use of the local flora. What remains of utmost importance for this dissertation is to understand if, how, and/or why information becomes distributed throughout the population. Next, I briefly present some of the patterns of social organization within the communities that affect the distribution of medicinal plant knowledge.

Social organization and medicinal plant knowledge

The average number of inhabitants per household in Nabil is about 3.4. But household size is highly variable, ranging from as many as ten people to as few as two. Residence is patrilocal and it is common for as many as four generations to live in the same household. Sleeping quarters are generally in one-room buildings (Figure 1.3). Usually a husband and wife will have their own building, which they will share with young children. New buildings or one-room additions to buildings are commonly built for teenagers. Unmarried and widowed women will often share a building, sometimes divided into two or more rooms.

Figure 1.3. A family from Nabil outside of typical one-room sleeping buildings, most commonly constructed of cement block or wood, with aluminum or asbestos roofing.

Figure 1.4. A kitchen building with traditional pine-plank walls and thatched roof. Thatched roofs have mostly been replaced by aluminum or asbestos in the Highlands, but most kitchen floors are still dirt.

Sleeping quarters have no heating. Every household also has a separate building used specifically for preparation and consumption of meals where a fire is always kept burning (Figure 1.4). It is in this building that people spend almost all of the time that they are at home and not sleeping.

Most discussions about illnesses and plant-based treatments take place among family members and visiting friends around the fire. It is common to overhear four generations of householders talking about diagnoses, etiology, and possible curing strategies. This is the primary mechanism by which children learn medicinal plants and by which knowledge acquired outside of the household is shared. When I asked people during structured ethnobotanical interviews how they learned about specific plants, the most common response, by far, was that they learned from their parents or other household members.

But knowledge within households is not uniformly distributed. Obviously, the youngest children know the least. But there are also differences among adults that appear to correlate with gendered patterns in division of labor.

I conducted a very brief time allocation survey. For one week, I followed adults from three households during their daily routines, or asked them at dinner-time to recall how they had spent their time while I was following another group. I chose a week that was typical of the year (e.g., not during a festival or planting). I recognize that this is a very small temporal and demographic sample. Nevertheless, the results presented in Table 1.2, combined with observations I made while living with a family, as well as visits and conversations I had with other families, allow for some general observations. For example, men never participate in the weaving of textiles, preparation of food, washing dishes, cleaning house, mending clothes, or other household chores, with the exception of making infrastructure repairs. While some men seek daily wage labor nearby, and men occasionally hunt wild animals, women rarely participate in these activities (although two women from the household I lived with had migrated to San Cristóbal to work). Men spend far more time serving in political posts.[5]

Community meetings are held nearly every evening, but are mostly attended by men, unless the topic is specifically a women's issue. Both men and women spend about equal time in agricultural chores such as weeding cornfields and harvesting—the one exception being that women are largely responsible for collecting firewood. Note that shared agricultural duties include trips to work in land owned or rented at lower elevations. Also, it is not included in Table 1.2, but women are the exclusive caregivers of infants.

My observations indicated that women spend more time in households than men, spend more time with other women than with men, and are more likely to discuss children's health amongst themselves. Not surprisingly, structured ethnobotanical surveys showed that women tend to know more about local plants that grow near households, and men are more likely to have learned plants that grow in other communities (see Chapter 9). Also, women within a household tend to agree more amongst themselves about which plants have medicinal uses, while men in the same household will have a tendency to know different plants.

Table 1.2. Time allocation in hours during a typical week from three households in Nabil.

	Political duties	Wage labor	Cooking and house chores	Relaxing indoors	Taking meals	Meetings and sports	House maintenance	Hunting	Harvesting food and firewood	Trips to town	Weaving	Sleep
Male 1	4	8	3	10	12	15	3	0	42	14	0	57
Male 2	21	32	0	3	11	24	4	6	12	8	0	47
Male 3	0	41	0	3	12	16	14	4	29	4	0	45
Male 4	23	18	0	5	10	29	2	0	21	15	0	45
Male 5	0	38	0	8	11	22	5	0	28	13	0	43
Female 1	4	0	62	0	7	4	0	0	32	6	7	46
Female 2	0	0	42	0	8	2	0	0	42	6	24	44
Female 3	0	0	41	0	8	3	0	0	42	6	21	47
Female 4	0	0	67	0	7	3	0	0	31	8	8	44
Female 5	0	0	40	0	9	5	0	0	33	7	30	44
Female 6	0	0	58	0	7	2	0	0	20	11	25	45
Female 7	0	0	41	0	7	2	0	0	32	13	27	46

Nevertheless, at a wider scale of analysis it becomes evident that people within households, including men, are more likely to agree with each other than with different households. In other words, although friends neighbors and health specialists may be consulted for advice, most information is passed on within households.

In sum, the Tzeltal of Nabil and Ch'ixaltontik continue to be poor, while at the same time experiencing greater integration into the regional economy and exposure to radically new concepts about illness and curing. These processes may be widening the potential scope of new information about medicinal plants. But informational networks within the communities are actually quite limited. This high potential for external information combined with a constrained pattern of distribution within the communities suggests that there should be a great deal of idiosyncratic knowledge about medicinal plants within the communities. In the following chapter, I show that this is indeed the case.

The tropical frontier communities

In order to test the resilience of some of the explanations for the acquisition and dissemination of medicinal plant knowledge that I tested in the Highlands, I also conducted comparative research in tropical frontier communities settled by people from Tenejapa. Here, I briefly highlight those ecological and ethnographic similarities and differences that most impact medicinal plant knowledge.

During the late 1950s, the Mexican government began a program to build a road through the uninhabited area of the Selva Lacandon (the Lacandon Rain Forest) along the Guatemalan border (Figure 1.1) in order to extract resources and encourage settlement of the area (Calvo Sánchez et al. 1989; Collier 1994). In 1973 the government announced that there was still federal land available for settlement along the border beyond Lagos de Montebello. That year, 35 families from various *parajes* in Tenejapa, including Nabil, formed a group who petitioned the government for a land grant, and Maravilla Tenejapa was founded as an *ejido* in 1974. In 1987, 34 families from Tenejapa and Maravilla Tenejapa founded another *ejido* approximately 7 km to the east called Salto de Agua. Both ejidos were part of the very large municipality, Las Margaritas, until 1999, when a new municipality was created out of 47 *ejidos*, including Maravilla Tenejapa and Salto de Agua. Maravilla Tenejapa was designated as the *cabecera*, and the new municipality bears its name.

My ethnohistorical interviews and the work of Calvo Sánchez et al. (1989) indicate that the most common reason cited by migrants for leaving the Highlands was that there was no longer enough land to support the population. Men were increasingly being exploited as laborers in the *fincas* in order to obtain enough food to survive. Eventually, the risk associated with abandoning what resources they had in the Highlands and moving to an unknown area, as well as the emotional consequences of abandoning friends, families, and traditional institutions, was offset by the perception that the worsening living conditions in the Highlands could no longer be tolerated.

The process of establishing Maravilla Tenejapa was similar to that for other frontier communities. The federal government granted the 35 families permission to start an *ejido*, and the leaders (elected by the families) went to Tuxtla Gutiérrez (the state capital) to select a potential site based on a map. Then, accompanied by a government surveyor, the *ejido* leaders went to the Selva Lacandon to establish the boundaries of the new settlement. At that time, there was no road beyond Lagos de Montebello, so the men had to walk several days to reach the site. After establishing the site, they returned to Tenejapa, gathered the other men, and all of them returned to the new settlement to begin cutting and burning parts of the forest to plant corn and build temporary housing. After planting the corn they returned to Tenejapa. In a few months they came back to the new settlement with their families and were overwhelmed with the amount of corn that had grown. Unfortunately, because there was no road, there was no way to bring the surplus corn to market and most of it rotted. But a gravel road was constructed through Maravilla Tenejapa in 1981 and was paved in 1996. Today, most residents of the frontier communities near the highway are not only able to grow sufficient food for household consumption, but also generate a modest income from truck farming of corn, beans, coffee, cattle, bananas, pineapples, and other tropical fruits.

Housing in both the municipal center and Salto de Agua is very centralized. Indeed, the municipal center is laid out in a 1 km^2 grid and all houses are located within the grid. The current population of the municipality is 11,147 (INEGI 2001) of which 780 live in the municipal center[6] and 170 live in Salto de Agua. Both the municipal center and Salto de Agua have water piped in from natural springs, and both communities received electricity by 1993. There is no sewer system, but due to an education and financial assistance program all houses have latrines (see Chapter 3).

Although the majority of residents are of Tzeltal origin, there are a few Ladino households that operate stores and small restaurants in the municipal center. Both Maravilla Tenejapa and Salto de Agua hosted Guatemalan refugee communities as a result of the Guatemalan civil war during the mid-1980s, but no Guatemalans live in these communities now, although Guatemalans often arrive by foot looking for temporary work in *milpas* and coffee groves or selling manufactured products, herbal remedies, and pharmaceuticals from Guatemala.

Tzeltal remains the primary language in both communities. It is the language spoken at all community meetings and in nearly all households.[7] Illness nomenclature is for the most part the same as in Nabil, but personalistic illnesses are almost never mentioned, probably because of a heavy Protestant evangelical influence in both communities. Habitat classification is also the same, except that primary forest is generally referred to using the Spanish *montaña* and not the Tzeltal *ja'mal*.

Women continue to wear the traditional Tenejapa skirt, but Tenejapan blouses have been replaced by western style t-shirts or blouses. No women I observed or spoke with were involved in textile weaving (as all of the women in Nabil are). Traditional Tenejapan men's clothing have been completely abandoned.

Although there is a small Catholic population with a church in the municipal center, the center does not serve the traditional ceremonial function as in Tenejapa (Medina Hernández 1991). There is no affiliation with saints along kinship lines, nor are there any civil or religious *cargos* in Maravilla Tenejapa. I never heard traditional Highland music being played on stereos in the frontier communities, although this was common in Nabil and Ch'ixaltontik. No one in the frontier communities plays the traditional harp, drum, or flute that accompany all festivals in Tenejapa (Figure 1.5). Evangelical revival meetings occur almost every day in Maravilla Tenejapa. Singing is occasionally accompanied by a guitar player, but participants most commonly sing along with evangelical tapes played on stereos. As Collier (1994:15) has described the reconstruction of identity by the Highland Tzeltal who have migrated to the frontier: ". . . new religions, new organizations, and even new corporative production enterprises replaced ethnicity as the basis for building community."

It is obvious from this discussion that most Highland traditions and institutions have been abandoned in the frontier, along with many supernatural and cosmological beliefs

Figure 1.5. Musicians lead the annual pilgrimage to bless community water sources during the Fiesta de Santa Cruz in Nabil. These traditions have been abandoned in the tropical frontier communities.

(Figure 1.6). But some things remain the same as in Tenejapa: life still revolves around the *milpa*; although better off, people remain relatively poor and suffer from typical diseases of poverty; and they know how to use much of the local flora as medicines.

Figure 1.6. A *rezador* 'prayer man' incanting blessings during a Maya-Catholic ceremony in Nabil. These rituals and their associated cosmology are shunned in the mostly evangelical frontier communities.

Both Salto de Agua and Maravilla Tenejapa are 400 m above sea level. The geology and topography are similar to the Highlands (Mülleried 1957). The typical forest community is evergreen lower montane tropical rainforest (Breedlove 1981). Average annual rainfall is between 1800-2200 mm, with most occurring between June and October (slightly later than in the Highlands). The Tzeltal of Maravilla Tenejapa and Salto de Agua cut and burn secondary forest growing on fallow cornfields to restart the agricultural process in April and May. As in the Highlands, corn, beans, and squash are planted to coincide with the beginning of the rains, but in this case about a month later than in the Highlands. There are several differences that contribute to the enhanced well-being of the frontier Tzeltal as compared to their colleagues in the Highlands.

First, the population density in Maravilla Tenejapa is 27 per km^2 (INEGI 2001). Compared to 334 per km^2 in Tenejapa, it is obvious that the frontier Tzeltal have much more land per capita to put into production.[8] Furthermore, the land is more productive than in the Highlands.

Second, the tropical climate allows for at least two corn harvests per year. The corn planted in May is harvested in October. A second crop is planted in November and harvested in February. Nearly every household is able to sell surplus corn.

A third benefit appears to be the shorter time required to leave a field fallow between plantings. I was told by Tzeltal men that woody tropical pioneer species of genera like *Albizia*, *Cassia*, (Leguminosae) and *Cecropia* rapidly colonize and regenerate the soil. Indeed it is not uncommon to see secondary forests with 10–15 m tall canopies of legumes and *Cecropia* on corn fields that have been fallow only five years. Rapid decomposition of leaf matter in the heat and humidity and nitrogen fixation by pioneer species evidently result in fallow times as short as six years compared to the eight to 15 years required to leave a field fallow before cutting in Nabil.

Fourth, and perhaps most important, is the potential for agricultural diversification. In addition to subsistence production of corn, beans, and squash, households in both frontier communities have an average of about 2 ha of shade-grown coffee, mostly produced for organic cooperatives. Some families have opted to put as much as 10 ha into coffee production. These stands are maintained as highly diverse production systems, and include such additional food items as nance (*Byrsonima crassifolia*), cacao, *Pouteria mammosa*, *Inga* sp., avocado, mango, edible wild *Solanum*, *Piper*, and *Ficus* spp., and most importantly, various types of bananas. Houseyards will also commonly contain mango, avocado, orange, lemon, lime, sugar cane, coconut palm, guava, *Artocarpus altilis*, and more bananas. These are only a few of the edible species found throughout the community, but the important point is that an abundance of nutritious fruits are available for domestic consumption on a year-round basis. In addition, sugar cane and peanuts are planted for domestic and market consumption, and each household maintains about 4 ha for cattle grazing. Corn, beans, coffee, bananas, cattle, and peanuts are the most important items produced for the market. If the price or yield of any of these products falls (as has been the case for the price of coffee), farmers can still generate income from the other products.

Another difference from the Highlands relates to benefits that have come from the Mexican government and international aid agencies, both as a result of the Guatemalan refugee crisis during the 1980s and the Zapatista uprising of 1994. Maravilla Tenejapa was a solid supporter of the (until recently) ruling PRI party. Most interviewees agreed that immediately following the Zapatista uprising in 1994 the PRI party increased assistance to loyal frontier communities. After 1994 the highway was quickly paved (although this was primarily to facilitate troop mobility) and agricultural extension services were increased. Also, since 1994 the health clinic in Maravilla Tenejapa has been fully staffed, well supplied, and able to conduct effective education programs, as well as provide regular, reliable healthcare free of charge.

Residents of the frontier communities are also very cosmopolitan. The nearest large city, Comitán de Domínguez, can be reached in three hours. Buses and vans leave the Maravilla Tenejapa center for Comitán in the morning and return in the afternoon. Comitán has a population of 105,000. Similar to San Cristóbal, it is the commercial hub of the area, including a large outdoor market, and is the major destination for those seeking biomedical healthcare. Despite the length of the trip, it is very common for residents of Maravilla Tenejapa and Salto de Agua to shop, conduct business, and visit clinics, hospitals, and private doctors in Comitán as often as once a week.

The Tzeltal of Maravilla Tenejapa are not only more integrated into the market economy than those of Nabil, but they are also more inundated with non-indigenous ideas from evangelism to science fiction television. One of the most noticeable features of the municipal center is that nearly every household has direct-TV (Figure 1.7). Tzeltal language radio broadcasts are not available in the area, and more people are likely to speak Spanish than in Nabil. Some even speak English, having worked in the United States.

Figure 1.7. Most Tzeltal households in Maravilla Tenejapa have consumer amenities like direct-TV.

Again, the effects of these social processes on medicinal plant knowledge are difficult to ascertain. In some cases the greater availability of biomedical healthcare and financial resources available to purchase pharmaceuticals, and new ideas about illness and curing, appear to have lessened the importance of medicinal plant knowledge. Several of the families I attempted to interview did not know more than three medicinal plants, and claimed to have never used a local plant as a medicinal since migrating to the area. I never encountered anybody in the Highlands, including most 12-year-olds, who didn't know at least a dozen medicinal plants.

On the other hand, most of the other families in the frontier that I interviewed knew many local medicinal plants. Also, the amateur and professional herbalist movement appears to be even stronger in the tropical frontier. I found more men and women there who had studied herbalism as apprentices, taken classes and workshops, and purchased books on the subject. There are several powerful herbalist organizations operating politically and professionally in the area (most notably in Jerusalén and Poza Rica) who sell herbs, charge for consultations, establish medicinal plant gardens in communities, and offer workshops and courses. When comparing the Highlands with the frontier, it is possible that what I was seeing is that while medicinal plant knowledge is not necessarily lost with economic and ideological integration, it may become more concentrated among fewer individuals. As with most capitalist economies, the trend is toward specialization.

Strategies for dealing with illness also show similarities and differences compared to the Highlands. All families attempt to diagnose illnesses first, the same as in Nabil. But in Maravilla Tenejapa and Salto de Agua, there is more of a tendency to go to the clinic to treat illnesses like children's diarrhea and respiratory infections before trying medicinal plant remedies. Also, consistent with the abandonment of Highland traditions and institutions, there are no *jpoxiletik* in any of the frontier communities I visited. Therefore, diagnosis by pulsing is not an option. And, personalistic illnesses are generally dismissed by the frontier population as antiquated superstitions. It is possible that the role of the traditional curer is being filled by biomedical clinicians and professional herbalists. Also, in the case of personalistic illnesses, treatment may be pursued more in the evangelical context of a personal relationship with God, as opposed to the traditional Tzeltal model in which a *jpoxil* intervened with the appropriate saint on behalf of the victim (Metzger and Williams 1963).

Conclusion

The Tzeltal of the communities that I studied live in a world centered around family, community, and subsistence agriculture. In both the Highland communities and the tropical frontier people have access to basic government healthcare and large commercial centers. Tzeltal remains the primary language, although Spanish is more likely to be spoken in the frontier. In both cases, primary diagnoses of illnesses occur in the home. Families in all the communities have also had some experience working and learning tropical medicinal plants at the *fincas*.

In both the Highland and frontier communities, conceptualizations of illness and healing result from the negotiation of traditional knowledge with nontraditional ideas and values in the form of interaction with non-Tzeltal speakers, mass media, integration into the national biomedical system, and Protestant evangelism. This process is much more pronounced in the frontier, where the Tzeltal have largely abandoned traditional clothing, music, Maya supernaturalism, and institutions like civil-religious *cargos*. The frontier communities are also more integrated into the global market, and there appears to be more professional herbalism in response to the aforementioned processes. It appears that integration into the global markets has not reduced overall medicinal plant knowledge. The effects of market integration and the commodification of medicinal plants on the distribution of knowledge within communities remains to be seen.

Throughout this dissertation I will be attempting to answer the question of why the Tzeltal know some plants as medicinals and not other plants by attempting to correlate patterns in the distribution of knowledge with emic perceptions of efficacy, cultural interpretations of plant characteristics, the distribution of plants in the landscape, principles of category inclusion, shared cultural models, and structured and stochastic patterns of cultural transmission. Comparisons between the Highland and frontier communities will be important for understanding these relationships. For example, the abandonment of traditional Maya ideologies in the frontier does not tend to alter emic perceptions of efficacy, probably because there has always been an emic distinction between naturalistic and personalistic illness. As a result, emic perceptions of efficacy have a similar effect on knowledge distribution in the frontier as in the Highlands.

On the other hand, there is significantly more primary forest in the frontier. But the tendency to rely on more accessible plants from disturbed habitats in the Highlands is so strong that the same pattern is replicated in the frontier, and the effects on knowledge distribution are similar.

In the next chapter I discuss the basic patterns in knowledge distribution that I sought to explain and the basic methods that I used to document the patterns.

Notes

[1] Unless I have cited a reference, all of the information presented here derives from observations, interviews, censuses, and other ethnographic research that I conducted while living or working in the various communities.

[2] My inquiries indicated that the average daily wage one could expect to earn in the immediate geographical area ranged from 50 pesos/day ($5.55 US) for picking coffee in the lowlands, to as high as 100 ($11.11 US) for logging with one's own power saw.

[3] See Medina Hernández (1991) for a comprehensive ethnography, including kinship, household economics and social structure, based on research conducted in 1961.

[4] Biomedical practitioners in Mexico (indeed those in most of the world) do not discriminate against herbal remedies as American practitioners have come to do since the post-WWII chemical revolution. For example, it is very common to find medicinal plant gardens in the yards of government clinics in Chiapas, the doctor in Maravilla Tenejapa told me he regularly conducts experiments using herbals, and when I attempted to purchase cortisone in a pharmacy to treat an allergen-induced skin rash, the university-trained pharmacist suggested that I use an infusion of chamomile instead.

[5] In Table1.2, Male #4 was the elected town leader (*comité de educación*), Male #2 was the elected supervisor of electric utilities (*agente de electricidad*), and Female #1 was the elected food-aid representative (*comité de PROCAMPO*). To my knowledge her post is the only one of the 12 political posts in Nabil that can be held by a woman.

[6] This population figure does not include the military base, with about 300 personnel, located just on the edge of town, which has a considerable impact on the economy. The base is largely closed-off and self-sufficient, but soldiers frequent stores and restaurants in town and attend social events like fairs and dances. Some higher ranking personnel rent houses in town. Several soldiers have married Tzeltal women.

[7] Unlike the parajes of Tenejapa in which I worked, and where there were no instances of linguistic intermarriage, I interviewed several mixed Ladino, Tzeltal, Tzotzil, and Tojolobal married couples in Salto de Agua and Maravilla Tenejapa. Spanish was spoken in these households, although the children appeared to be bilingual.

[8] I was told in all seven frontier communities that I visited that they have placed between 40 and 60% of their *ejido* territory in ecological reserve in order to control soil erosion, protect drinking water quality, and avoid altering rainfall patterns on the advice of government surveyors and agricultural extensionists. This land is held in common, and logging is prohibited. Only hunting is allowed. I see this as a strategy tenable only at low population densities.

Chapter 2
Basic Methods and Fundamental Patterns of Knowledge Distribution

The main goal of this dissertation is to explain variability of knowledge about medicinal plants among residents of several Tzeltal communities; in particular, to explain why some plants are known by many people, while knowledge about other plants is idiosyncratic. I begin this chapter by describing the basic methods that I used to approach the research problem, including ethnobotanical interviews, discursive data collection, and participant observation. I also present the general patterns of knowledge distribution that emerge from the ethnobotanical surveys. These patterns formed the basis for the subsequent data collection and analysis. The following chapters represent my attempts to explain these general patterns in knowledge distribution by examining several variables that have either been proposed by other researchers or developed by myself to explain medicinal plant knowledge acquisition and dissemination. Because these variables are somewhat eclectic, I have chosen to describe the methods and techniques that are particular to the analysis of each variable within the appropriate chapters.

The research presented in this dissertation results from 18 months of field work conducted during three field-stays between 1998 and 2001. During the summer of 1998 (May through August) I lived in the municipal center of Tenejapa studying the Tzeltal language and conducting ethnobiological research in the municipal center and in the nearby *paraje* Matsab. Upon returning to the United States in the Fall of 1998, I was fortunate to be able to continue Tzeltal language studies when Dr. Brent Berlin offered a class in conversational Tzeltal. Again, during the summer of 1999 (May through August) I lived in the municipal center of Tenejapa, during which time I began medical ethnobotany research and took Tzeltal language lessons at the Jovel language institute in San Cristóbal de las Casas.

The longest field stay was from September 2000 to September 2001. During the first month I lived in San Cristóbal while conducting research in Ch'ixaltontik and studying Tzeltal language at Jovel. In October I moved in with my host family in Nabil, where I lived and conducted research until May 2002. Most weekends I returned to San Cristóbal to transcribe interviews with the help of Tzeltal assistants and continued language studies at Jovel. From May 2002 until September 2002 I lived with another host family in the municipal center of Maravilla Tenejapa, conducting research there and in the neighboring community Salto de Agua.

Ethnobotanical survey methods and "consensus within diversity"

I began ethnobotanical surveys by developing a list of all the plants that might be considered medicinal by residents of Nabil—a high-elevation community of approximately 150 households. This list was based on research conducted in the Highlands by my predecessors (Berlin et al. 1990) and my freelists, trail interviews, and interviews with herbal shopkeepers.

Drs. Brent and Elois Ann Berlin, along with several colleagues, began an extensive ethnobotanical and ethnomedical survey of 10 Highland Tzeltal and Tzotzil Maya municipalities in 1987 through their PROCOMITH project (Berlin et al. 1990; Berlin and Berlin 1996). Based on collections with 351 informants that yielded 1,650 botanical species of potential medicinal use, they developed a subset of 204 of the most widely known medicinal plants used by the Highland Tzeltal and Tzotzil. Herbarium specimens of these 204 species were laminated and inserted into loose-leaf binders, which became known as the "traveling herbarium." They used the traveling herbarium to conduct in-depth interviews with 126 knowledgeable informants throughout the Highlands.

I used the traveling herbarium for interviews to determine whether residents of Nabil knew about the medicinal uses of the 204 plants. Throughout this dissertation I also make reference to the PROCOMITH database when making comparisons between knowledge within the communities I studied and the broader distribution of knowledge throughout the Highlands as documented by the Berlins and their colleagues.

To the traveling herbarium, I added 53 botanical species based on freelists, trail interviews, and herbal shop interviews. I elicited freelists from 42 adult residents of Nabil by asking for the names of all the medicinal plants that they knew (*Binti sbil jujuten poxil wamaletik ya a'na?*). Working with the interviewees and four Tzeltal assistants, I identified all of the plants that were mentioned during freelists that were included in the traveling herbarium. With the same assistants, I collected and prepared herbarium specimens of those plants mentioned during freelists that were not already included in the traveling herbarium.

I conducted 10 four-hour trail surveys with five assistants—both alone and in groups of two. While walking trails and visiting all of the major habitat types, we collected and prepared additional specimens that these assistants knew as medicinals that were not already included in the freelist or traveling herbarium collections.

Accompanied by members of two different families from Nabil, I conducted brief interviews with two non-indigenous herbal shopkeepers in San Cristóbal. The Nabil families said they frequented these shops to obtain advice and medicinal material. I asked the shopkeepers which plants they often sold to Tzeltal customers. I purchased samples of these plants from the shopkeepers to use for interviews.

The combination of these four sources yielded a collection of 257 potential medicinal species. With the help of my primary assistant, I conducted structured interviews with ten (4 male, 6 female) randomly selected residents of Nabil who were over the age of 20. The questions that I asked for each specimen are presented in Appendix A. Based on these interviews, the freelists, and trail interviews, I eliminated all species said to be medicinal by less than two people. For example, many of the species in the traveling herbarium grow only at lower elevations or are better known in Tzotzil communities as medicinals. They were completely unfamiliar to the Tzeltal residents of Nabil. Many other species were known by only one person. This resulted in a set of 130 specimens (Appendix B) thought to be medicinal by at least two members of the sample population. I used these 130 specimens to conduct interviews with 18 additional adults (10 male, 8 female). As a result, I interviewed 28 adults (50% male, 50% female) asking the questions in Appendix A for all 130 botanical species in Appendix B. This resulted in 1,535 reported medicinal uses for the various plants.

Botanical determinations of the collected specimens were conducted at the herbarium of El Colegio de la Frontera Sur (ECOSUR) in San Cristóbal de las Casas. All specimens are deposited at that herbarium.

One of the questions I asked for each plant was: "Is there an illness that this cures?" (*Ay bal chamelil ya spoxta mene?*). In order to visualize the distribution of knowledge about the medicinal use of each plant, I arranged the plants according to the percent of informants who answered this question in the affirmative along an *x*-axis from most-reported to least-reported, with the percent of affirmative answers as the *y*-axis (Figure 2.1). This yields a clear pattern in which the percent of people who know each plant as a medicinal decreases steadily as the diversity of plants increases. The shape of this knowledge distribution curve leads to three observations: 1) there are three plants that are known by almost everyone in the community; 2) there are about 60 plants for which knowledge is shared throughout the community to a variable degree; and 3) knowledge about the remainder of the plants is limited to very few people. Note that I excluded plants from interviews that were known by only one person. Thus, the asymptotic tail of this curve, which represents idiosyncratic knowledge, probably extends much further than shown in Figure 2.1. In other words, while some plants are known as medicinals by many people in the community, most plants are known by very few people—a situation described by Barrett (1995) as "consensus within diversity." Stepp (1998) and Berlin et al. (1990:4) found that although hundreds of species were identified as medicinals by the Highland Maya, most agreement tended to focus on between 40-50 species—what they have referred to as a "cuadro basico" or "basic medical kit."

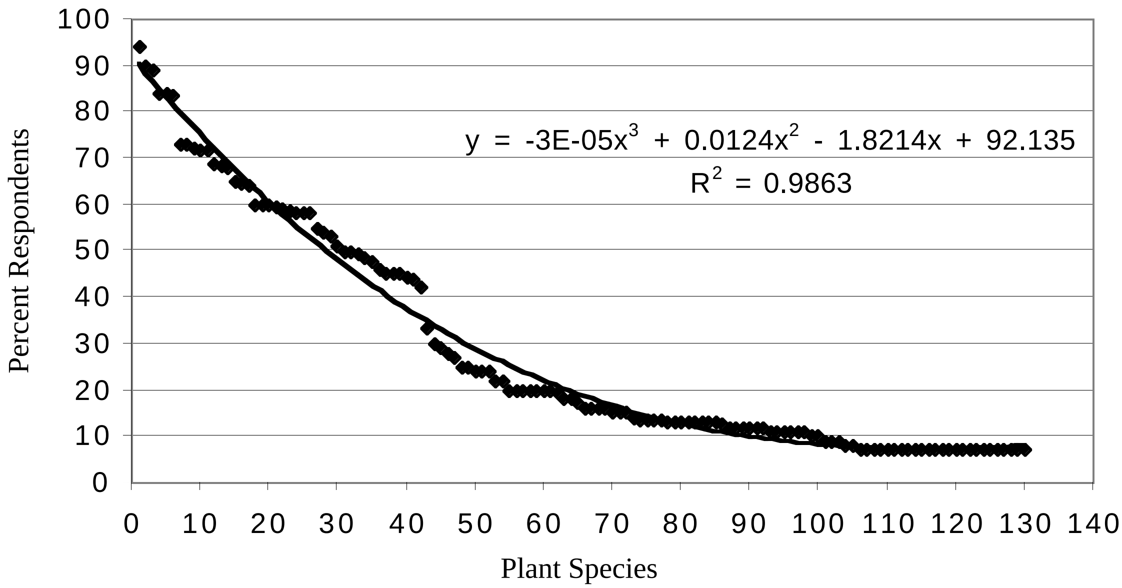

Figure 2.1. Distribution of knowledge among residents of Nabil as a function of increasing plant species diversity.

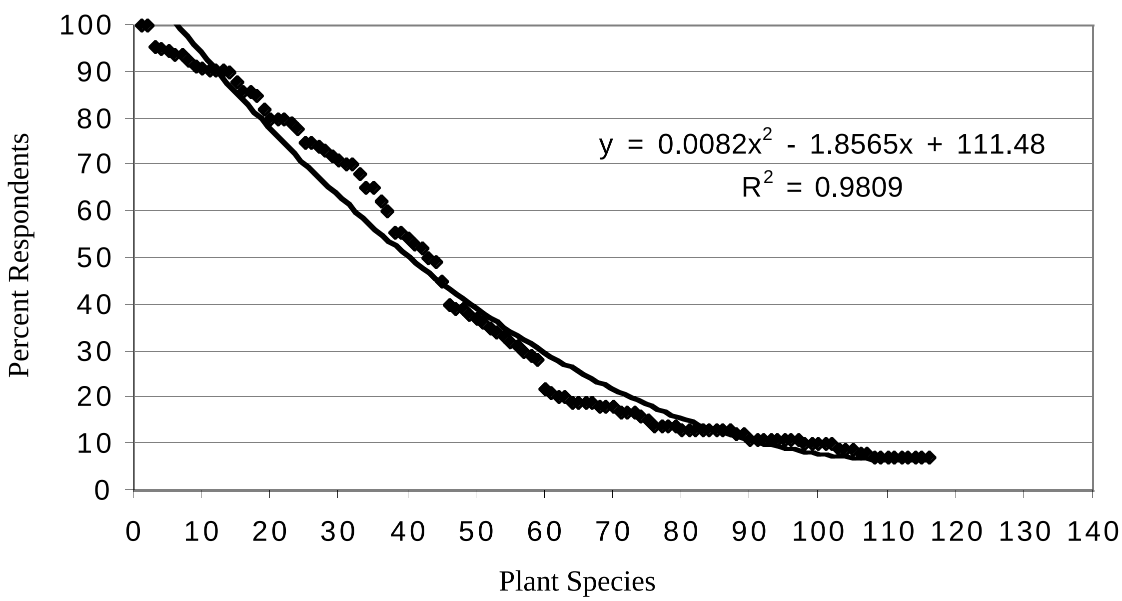

Figure 2.2. Distribution of knowledge among residents of Maravilla Tenejapa and Salto de Agua as a function of increasing plant species diversity.

A review of studies conducted with other linguistic groups suggests that this pattern, including the numbers of plants involved, may be widespread in pre-literate medicinal-plant knowledge systems. Barrett's (1995) study of home remedies in Nicaragua indicated that of the 162 plants reported, 77 of the plants were reported only once, 53 were reported by 2-10 people, 24 by 11-50 people, and 8 were reported by 50 or more people. Three of these plants were known by almost everyone he interviewed. Friedman et al. (1986) found that of the 81 medicinal plant species named by Bedouin informants, only 41 were named or recognized by more than 3 informants. Johns et al. (1990) found that of the 330 species mentioned by the Luo, 162 were mentioned only once, 168 were known by two or more people, and only 66 were confirmed by three or more people. Alexiades (1999:339) found that 40% of medicinal plant knowledge among the Amazonian Ese Eja was idiosyncratic. Much of the remainder of this dissertation is devoted to explaining why more plants are not widely known throughout the Tzeltal communities in which I worked.

Some aspects of the subsequent research required a larger interview population in Nabil. For example, in Chapter 9 I estimate which plants children learn first, how well households within communities agree with each other about medicinal plants, and how knowledge within households is distributed by division of labor. Time limits did not allow for a sufficient number of interviews using the full set of 130 species. Therefore, I extracted the 45 best known species for these additional interviews.

Another important pattern identified from the ethnobotanical data is that there appear to be whole classes of illnesses for which medicinal plant knowledge is either missing or known by very few people. Furthermore, the illnesses that are involved differ between communities. I am not referring to illnesses traditionally thought to be the province of expert curers or shamans. The information to which I am referring is "common knowledge" among novices in other communities. In Nabil, for example, there are very few people who know about treatments for dermatological illnesses like boils, scabies, rashes, various sized pustules, acne, or boils (Appendix B). Also, knowledge about female reproductive treatments is poorly represented.

To further illustrate these points I turn now to the comparative research I conducted in the neighboring Tzeltal community of Ch'ixaltontik. I elicited freelists from 21 adults and conducted ethnobotanical interviews using the traveling herbarium and questions in Appendix A with 15 (8 male, 7 female) randomly-selected adults of Ch'ixaltontik. I also conducted four four-hour trail surveys with four assistants from that community. These techniques yielded a list of 97 plants known by two or more adults.

A comparison of results between Nabil and Ch'ixaltontik indicates that even though the vegetation of these two communities is nearly identical, intermarriage between the two communities is frequent, and some men from the two communities work together as day laborers, medicinal plant knowledge was surprisingly different. At the same time, some aspects of medicinal plant knowledge were quite similar—further illustrating Barrett's "consensus within diversity."

I analyzed freelists from both communities using ANTHROPAC (Borgatti 1996b:21) to determine the saliency of freelisted items. Saliency is computed in ANTHROPAC as an average of how often and how soon items are mentioned in freelists. In this case it represents those medicinal plants that are more readily recalled by subjects. It provides a preliminary glimpse of what items are most likely to be shared as acceptable members of a category, as well as what items best represent the category amongst the sampled population (see Chapter 8).

Comparison of rankings of freelist saliency from Nabil and Ch'ixaltontik (Table 2.1) show that the three most salient medicinal plants in Nabil are among the four most salient in Ch'ixaltontik. A few other species like *Prunus persica* and *Foeniculum vulgare* also share similar ranks between communities. But the rankings are otherwise quite different. For example, *Gaultheria odorata* was the fifth most salient plant in Nabil, but it was never mentioned during freelists in Ch'ixaltontik. On the other hand *Smallanthus maculatus*, which ranked ninth in Ch'ixaltontik, was never mentioned in Nabil.

Table 2.1. Comparison of Nabil and Ch’ixaltontik ranked freelist saliency for the 20 most salient medicinal plants from each community.

		Rank of saliency	
Species	Tzeltal names	Nabil	Ch'ixaltontik
Verbena litoralis	*yakan k'ulub*	1	1
Salvia lavanduloides	*ch'a bakal*	2	2
Baccharis vaccinioides	*mes te'*	3	4
Erigeron karwinskianus	*sakil nich wamal*	4	20
Gaultheria odorata	*ajate'es*	5	--
Foeniculum vulgare	*inojo*	6	10
Myrica cerifera	*sera te'*	7	--
Cupressus lusitanica	*nujkupat*	8	--
Litsea glaucescens	*tziltzil ujch'*	9	--
Prunus persica	*turezna*	10	7
Solanum lanceifolium	*tujkulum ch'ix*	11	--
Ageratina ligustrina	*ch'aj te'*	12	6
Sedum praealtum	*poxil majben*	13	--
Borreria laevis	*we'el buluk' sit*	14	3
Cornus disciflora	*sak ji*	15	--
Eryngium sp.	*yak' tz'i' wamal*	16	--
Mentha citrata	*wena*	17	5
Chenopodium ambrosioides	*k’ajk’an*	18	11
Sambucus mexicana	*chijil te'*	19	8
Pinus spp.	*taj*	20	27
Smallanthus maculatus	*ch'ajkil*	--	9
Peperomia sp.	*pimil wamal*	--	12
Nicotiana tabacum	*may*	--	13
Psidium guineense	*pajchak*	63	14
Aloe vulgaris	*savila*	--	15
Musa sp.	*lobal*	--	16
Apium leptophyllum	*kulantu chitam*	--	17
Rumex crispus	*yak' tz'i' wamal*	--	18
Annona cherimola	*k'ewex*	--	19

Results from the ethnobotanical interviews using mounted specimens support this pattern. The three species that share the highest freelist salience between communities (*Verbena litoralis*, *Salvia lavanduloides*, and *Baccharis vaccinioides*) were described as medicinals during interviews by almost everyone in both communities. On the other hand, *Gaultheria odorata* was cited by 65% of interviewees in Nabil as a medicinal compared to only one person in Ch'ixaltontik.

This pattern becomes even clearer when looking at how individual plants are used. Once again, there is nearly complete agreement between the two communities about the use of the three most salient plants—*Verbena litoralis*, *Salvia lavanduloides*, and *Baccharis vaccinioides*, as well as many other plants (Table 2.2). But there are also important differences. For example, nearly all of the people in Nabil who cited *Ageratina ligustrina* as a medicinal claimed that it was used to treat cough. In Ch'ixaltontik, *Ageratina ligustrina* is almost exclusively considered a cure for diarrhea.

Table 2.2. Comparison of Nabil and Ch'ixaltontik medicinal reports from ethnobotanical interviews for selected species (principle uses only).

	Nabil		Ch'ixaltontik	
Species	No. responses	Medicinal use	No. responses	Medicinal use
Verbena litoralis	26	diarrhea	15	diarrhea
Salvia lavanduloides	23	common cough	13	common cough
Baccharis vaccinioides	19	common cough	14	common cough
Rumex crispus	1	dermatological	6	dermatological
Oreopanax xalapensis	0	-------	5	dermatological
Apium leptophyllum	2	diarrhea	4	dermatological
Saurauia scabrida	0	-------	5	birth inducement
Myrica cerifera	10	dental caries	2	diarrhea
Solanum lanceifolium	13	dental caries	5	aches and pains
Ageratina ligustrina	7	common cough	11	diarrhea
Total interviewed	28		15	

Most important of all is the problem of the “missing illness treatments” described above. Although there appears to be very little knowledge about treatments for dermatological conditions in Nabil (Appendix B), around a third of interviewees in Ch’ixaltontik reported dermatological applications for *Rumex crispus, Oreopanax xalapensis* and *Apium leptophyllum* (Table 2.2). Also, I elicited very little information about female reproductive treatments in Nabil, but about one third of interviewees in Ch’ixaltontik (including male and female) knew how to use *Saurauia scabrida* to induce birth. In all of these cases, these plants grow in Nabil, but information about their use appears to be missing.

Conversely, *Myrica cerifera* and *Solanum lanceifolium* are widely known as home-remedies for toothaches in Nabil. But almost no one in Ch’ixaltontik was able to provide me with any potential treatments for toothaches.

The obvious pattern is that both within and between communities information about some plants and treatments is widely shared, but not for others. Next, I describe research conducted in tropical frontier communities where many Tenejapans have relocated, and provide further support for these patterns.

Further comparative research was conducted in Maravilla Tenejapa and Salto de Agua. These are two neighboring low-elevation communities that were established when Tzeltal from Tenejapa migrated into the tropical rainforest on the Guatemala border. I began ethnobotanical surveys by developing a list of all the plants that might be considered medicinal by residents of both communities. The list was compiled from the traveling herbarium, freelists from 28 adults, 19 four-hour trail interviews with nine assistants, and interviews with two herbal shop owners in Comitán de Domínguez—the nearest large city where the Tzeltal can buy medicinal herbs. These sources resulted in a list of 245 botanical species, which I used for interviews (Appendix A) with ten adults (5 male, 5 female) over the age of 20 who were randomly selected from the two communities. All collections were determined and eventually deposited at the ECOSUR herbarium.

Using the freelists, trail interviews, and interviews with prepared specimens, I eliminated all species known as a medicinal by less than two informants. The remaining 116 botanical species (Appendix C) were used to interview 13 more adults in Maravilla, for a total of 18 adults (9 male, 9 female) from that community, and 19 more adults in Salto de Agua, for a total of 24 (12 male, 12 female). This resulted in 1,227 reported medicinal uses for the various plants.

Plotting the percentages of interviewees reporting medicinal uses for each plant as described above for Nabil resulted in a strikingly similar pattern (Figures 2.1 and 2.2). A few plants are known by everyone, knowledge of about 60 plants is shared to a variable degree, and medicinal uses of between 60 and 116 plants are known by only a few individuals.

Comparison of freelists between the two frontier communities also shows the same pattern as the Highlands. Rankings of freelist saliency from Maravilla Tenejapa and Salto de Agua (Table 2.3) show that the three most salient medicinal plants in Maravilla Tenejapa are the same in Salto de Agua. But saliency is otherwise quite variable between the two communities.

Differences between Maravilla Tenejapa and Salto de Agua regarding medicinal uses reported for plants are also similar to the Highlands. For example, in both communities *Verbena litoralis* and *Neurolaena lobata* are primarily used for diarrhea, *Byrsonima crassifolia* is used for dysentery, and *Vernonia patens* is used to stop bleeding. But medical uses for other plants are quite different between the two communities. Although *Mentha citrata* is primarily used to reduce fever in Maravilla Tenejapa, this was never mentioned in Salto de Agua. Conversely, *Lantana trifolia* was widely known as a treatment for diarrhea in Salto de Agua, but not in Maravilla Tenejapa. Again, this replicates the pattern of consensus within diversity that other researchers have documented and that I found in the Highlands.

A few other observations are important to mention. First, *Verbena litoralis* is the most salient plant in freelists from all four communities—both Highland and tropical frontier. It is known, specifically, as a cure for diarrhea by almost every man, woman, and child

Table 2.3. Comparison of Maravilla Tenejapa and Salto de Agua ranked freelist saliency for the 20 most salient medicinal plants from each community.

		Rank of saliency	
Species	Tzeltal names	M. Tenejapa	Salto de Agua
Verbena litoralis	*yakan k'ulub*	1	1
Neurolaena lobata	*chikin buro*	2	2
Byrsonima crassifolia	*nantzin*	3	3
Vernonia patens	*sitit*	4	14
Aspidosperma cruentum	*ch'ich' te'*	5	20
Citrus sinensis	*alchax*	6	17
Chaptalia nutans	*kulix pimil*	7	33
Solanum lanceifolium	*tujkulum ch'ix*	8	9
Begonia heracleifolia	*poxil majben*	9	54
Mentha citrata	*wena*	10	55
Cissampelos sp.	*curarina*	11	11
Sida sp.	*tzatzames*	12	8
Chenopodium ambrosioides	*k'ajk'an*	13	52
Foeniculum vulgare	*inojo*	14	31
Ruta chalapensis	*ruda*	15	46
Sambucus mexicana	*chijil te'*	16	37
Musa sp.	*lobal*	17	--
Psidium guajava	*pata*	18	4
Citrus limon	*lima*	19	16
Cecropia peltata	*warum*	20	--
Baccharis vaccinioides	*mes te'*	--	5
Mangifera indica	*mango*	30	6
Matricaria sp.	*manzanilla*	--	7
Cornus disciflora	*sak ji*	--	10
Smallanthus maculatus	*ch'ajkil*	38	12
Psidium guineense	*pajchak*	--	13
Hyptis verticillata	*san martin*	23	15
Piper sp.	*mumun*	--	18
Gossypium hirsutum	*kaxlan tunim*	--	19

in all four communities. It is important to also note that this plant grows as a weed in houseyards in all four communities. *Baccharis vaccinioides*, however, is known as a treatment for cough in both the Highlands and tropical frontier even though it only grows at high elevations. Conversely, *Byrsonima crassifolia* is known as a treatment for dysentery in all four communities even though it is a tropical species. This pattern is very similar to that described by Barrett, in which some plants are known for specific uses throughout wide geographical areas, while others are only known very locally.

Finally, as in the Highlands, there are illnesses in the frontier for which treatments are missing (Appendix C). Most notably, there appears to be very little knowledge about treatments for toothache or 'fright' in both Maravilla Tenejapa and Salto de Agua. Also, knowledge about respiratory treatments is lower than in Nabil. On the other hand, almost every adult I interviewed in the frontier told me about the use of *Zingiber officinale* for female infertility and *Hyptis verticillata* to induce birth, which far outweighed the distribution of knowledge about female reproductive treatments in either Nabil or Ch'ixaltontik.

Summary and implications of knowledge distribution patterns

In summary, these are the basic patterns that I seek to explain through the remainder of this dissertation:

1. The number of people who know medicinal uses of plants decreases steadily and predictably as the number of plants increases.
2. There is a basic pattern of consensus within diversity. For example, both within and between Nabil and Ch'ixaltontik most people know about the medicinal use of three very salient plants; then there is a core set of about 45-60 plants which show less agreement; and between 60 to 100+ plants for which knowledge is quite idiosyncratic. An identical pattern is found in the tropical frontier communities. At least one plant, *Verbena litoralis*, is known by almost everyone in all four communities.

3. Within each of the communities knowledge about plant-based medicinal treatments appears to be absent or narrowly distributed for a few culturally-recognized (linguistically labeled) illnesses.

I will address several questions that derive from these patterns. The most fundamental is: why are some plants more widely known than others? In particular, what is so special about the few plants that are known everywhere and by almost everyone? Why are there only 45-60 plants that are known as medicinals by more than a few individuals? And why are there so many plants that are known by only one or two people?

A potential initial explanation is that only about 60 plants are needed to treat the various illnesses. But this is unlikely, because comparisons of knowledge from the different communities show that there are many treatments for some illnesses like diarrhea, but knowledge is lacking for others. In Chapter 3 I show that the epidemiological conditions in the communities are similar enough that one would expect the distribution of knowledge within illness categories to be similar.

Another explanation might be that people know all of the plants that are available in their environment for treating the various illnesses, but that there aren't very many plants available that are effective. In other words, the most effective plants are widely known, and the negative slope of the curve in Figure 2.1 is a function of the decreasing pharmacological efficacy of the ambient flora. I show in Chapter 4 that perceptions of plant efficacy are a major factor contributing to the acquisition and dissemination of knowledge. Nevertheless, there are many effective plants that are known by only a few people as treatments for several important illnesses, and these illnesses largely go untreated as a result of the poor distribution of this information. In other words, the true pharmacological potential of the ambient flora is not realized.

The implication is that either some processes are constraining the distribution of knowledge about most species, or greatly enhancing the distribution of knowledge about a “privileged” few plants. In the following chapters I investigate how knowledge distribution is influenced by cultural perceptions of organoleptic and morphological characteristics of plants (Chapter 5), ‘hot’ and ‘cold’ humoral classification (Chapter 6), the distribution of plants in the landscape and the frequency of their use (Chapter 7), and patterns and processes of individual and shared cognition (Chapter 8). My conclusion is that emic perceptions of efficacy, the frequency with which plants are used, and cognitive prototyping are the factors that most influence knowledge distribution, but these variables still only partially explain the patterns described above. In Chapter 9 I offer the possibility that social organization and other constraints on information exchange also contribute significantly to the patterns described here. In short, there are limits to the amount of knowledge that can circulate in any community that are a result of the structure of informational networks and random processes.

As I hope will be evident from this and the following discussion, attempts to explain knowledge distribution that rely on one or only a few of these variables or methodological approaches are inadequate. Instead, I have taken a synthetic, or holistic, approach to the problem. The overall method was to see how the variables discussed in each of the chapters statistically correlate with each other and with the pattern of knowledge distribution shown in Figures 2.1 and 2.2. I also contextualized the correlational analyses using discursive and ethnographic data.

Qualitative and ethnographic methods

I felt it was important to contextualize the quantitative data using discursive data, participant observation, and estimates of time allocation. Analyses of discourses were particularly useful. In some cases discursive data played an important supplementary role for explaining the effects of quantitative variables. For example, in Chapter 4 I use subjects’ rankings of plant efficacy to show that perceptions of efficacy are correlated with knowledge distribution. But it was also important to understand why subjects considered some plants to be more effective treatments. My analysis of how people talked about medicinal plants showed that they were focusing on observable illness symptoms when making judgements about efficacy. This becomes important for understanding why some characteristics of plants, like their taste, play a minor role in the dissemination of information. Basically, if observations that are in conflict with individual explanatory models based on humoral or organoleptic concepts are convincing, such information will supercede or alter those models.

In other cases, I used discursive data in and of itself to test explanatory notions. For example, I analyzed verbal reasoning data from taped conversations to show that humoral classification does not serve as a mnemonic device for recalling a plant's medicinal use. Here I briefly describe my techniques for acquiring and analyzing these data.

The first source of discursive data was tape-recordings of unstructured interviews conducted with family groups in their homes in Nabil, Maravilla Tenejapa, and Salto de Agua. All interviews were conducted in Tzeltal, although a few interviewees occasionally slipped in and out of Spanish. Along with my Tzeltal assistant, I asked questions that were intended to stimulate conversation among family members without biasing the topics discussed. In many cases people simply started talking about illnesses and plant-based treatments as soon as my assistant and I explained the purpose of our visit. In other cases I had to stimulate discussion by asking for the names of some illnesses (*Binti spil te chameletik*), or if there are illnesses that people have had (*Ay bal chamelil la stsak?*). Only if conversation did not naturally follow did I ask questions about the illnesses mentioned, such as how each of the illnesses begins (*Bit'il ya xlijk ____?*) or what actions people took (*Binti la a'tuntes?*). Once conversations among interviewees began I did not interrupt or attempt to steer the conversation. I limited my participation to occasionally asking for clarifications, expressing agreement or surprise, or offering general gestures of assurance and comprehension. Only when discussions ended or strayed to a topic clearly unrelated to illnesses did I ask another of the topical questions. This was very effective for initiating conversation, and for the most part I simply let the conversation flow from topic to topic while the cassette tape recorder ran. There were many polite debates regarding illness etiology, when particular illness events occurred and who was involved, clarifications about how to prepare remedies, and many other topics. I conducted the unstructured interviews before I conducted structured interviews using the plant specimens so that discourses would not be biased by the themes I was asking about during structured interviews.

I also opportunistically tape-recorded spontaneous conversations that occurred during illness and curing events, around households (especially at mealtimes), and during encounters between friends and neighbors on trails, in markets, or other locations.

I tape-recorded 21 hours of discourse from 32 different subjects ranging in age from four to 77. The material was comprised of approximately 85% unstructured interviews and 15% natural conversations. A total of 29 different illnesses represented by distinct linguistic labels were discussed. The Tzeltal language tape-recordings were transcribed in Tzeltal by two Tzeltal assistants on Macintosh computers using Microsoft Word 98 software. The assistants, who were bilingual (Spanish and Tzeltal) later translated the texts into Spanish using the same software. The original Tzeltal transcriptions were then imported into the Macintosh-based text analysis software HyperResearch. All text analysis was performed on the Tzeltal texts. I used the Spanish translations only to clarify my understanding of some Tzeltal passages. I produced English translations only for the excerpts presented in this dissertation.

I coded items or topics in HyperResearch in order to determine the relationships between codes, such as the frequency with which passages co-occurred and hierarchical relationships between coded passages, depending on the analytical goals described in the subsequent chapters.

I gave each interview (structured and unstructured) a unique identification number. Interview excerpts presented in this dissertation are identified by the interview number and the geographical location where it was conducted. For example “Nabil Interview 35” was the 35th interview conducted in that town. Both Maravilla Tenejapa and Salto de Agua interviews are identified simply as “Frontera,” indicating interviews from the frontier towns.

I also participated in seven home-based illness curing events in order to better understand the process of diagnosis and decisions about treatments. This was particularly useful for understanding how information about medicinal plant treatments is shared and how children learn. All of these events were related to cases of common diarrhea and respiratory infections.

The results from the qualitative data collection and analysis are discussed in the appropriate chapters.

Chapter 3
Epidemiological Context and Tzeltal Illness Classification

The overall goal of this dissertation is to explain the patterns in the distribution of medicinal plant knowledge that I presented in the previous chapter. In the following chapters I analyze the effects of different processes on the distribution of medicinal plant knowledge. In this chapter I provide the background necessary for these analyses by outlining the epidemiological context from a biomedical perspective and discussing how the Tzeltal recognize and classify illnesses.

The rationale for this discussion is in part obvious. If some Tzeltal illnesses are experienced more frequently, and plants that are known to treat these illnesses are used more often, then perhaps these plants will be better known throughout the population. But as I hope to illustrate in the following chapters, processes and patterns of knowledge acquisition and dissemination are much more complex. Although the exchange of information may be constrained by illness prevalence, it is also a function of cognition, social structure, information networks, and perceptions of each plant's efficacy. For example, information flow is only possible because of a shared semantic category "medicinal plants," shared explanatory models of curing, and above all, shared illness nomenclature and symptomatology.

I argue in Chapter 8 that plants are classified by the Tzeltal as "medicinal" according to their ability to treat illness symptoms and this requires the *a priori* classification of illnesses. Also, information about plants that are perceived as more effective for curing illness symptoms is more likely to spread throughout communities. Again, these perceptions rely on the symptomatic aspects of illness classification. In the second part of this chapter I draw on the research of my predecessors to show that *a priori* illness classification is based primarily on cultural interpretations and semantic contrasts of anatomical affiliations and symptoms. This anatomical-symptomatic system permeates all semantic processes from individual cognition to cultural transmission and behavior.

Epidemiological context of Nabil

There were 27,928 registered live births throughout the municipality of Tenejapa during 2000 (INEGI 2001). Of these, 4,087 infants died within the first year, yielding an infant mortality of 146 per 1,000 live births. In other words, one out of every seven children dies before the age of one. When compared to the Mexican national rate of 28 per 1,000 live births, and seven per 1,000 live births in the United States, the severity of health problems in Tenejapa becomes obvious.

The situation has improved somewhat in the past decades. The current (2000) infant mortality rate of 0.46 per woman has decreased from 0.64 in 1990 (INEGI 2001). This is probably due to government sponsored programs like PROGRESA (Programa de Educación, Salud y Alimentación) administered by the Secrataría de Desarrollo Social (SEDESOL—Department of Social Development), which provides nutritional supplements and education regarding water sterilization and rehydration of children with diarrhea. Family planning, sanitary practices, and rehydration techniques are also taught via the "Solidaridad" program of the Instituto Mexicano del Seguro Social (IMSS—the Mexican Social Security Institute) through their clinics and outreach programs. Also, the immunization programs for polio, measles, whooping cough, diphtheria, and neonatal tetanus under the direction of the Secretaría de Salubridad y Asistencia (SSA—the Secretariat of Health) have led to near eradication of these diseases (PAHO 1998:358-359). Currently, 2.67 children per woman are surviving into their second year in Tenejapa (INEGI 2001).

These statistics are probably highly variable among the 54 communities within the municipality of Tenejapa. I suspect infant mortality is higher in Nabil, which is one of the most economically marginalized communities, and which also has a poor sanitation infrastructure. Two of the six children of my host family died before their first year despite the family's relative wealth and access to Lowland resources. Anecdotes related to me by various people in Nabil point to infant mortality as a major cause of depression, alcoholism, and loss of productivity.

During 1999 most infant mortality in Chiapas resulted from perinatal conditions (48%), congenital malformations, deformities, and chromosomal anomalies (18%), respiratory problems, including influenza, pneumonias, acute respiratory infections, bronchitis, emphysema, and asthma (11%), gastrointestinal infections (5%), accidents (4%), and malnutrition (3%)(SSA 2000). Leading causes of death for children age 1-4 were accidents (24%), respiratory problems (14%), deformities (12%), gastrointestinal infections (10%), malignant tumors (6%), and malnutrition (6%).

These are composite data for the state of Chiapas, but comparison to data from the IMSS clinic in Tenejapa Center for 1999 and 2000 (Table 3.1) suggests a similar pattern. Considering that deformities and accidents are not treatable in the Tenejapa clinic (care is sought at the hospital in San Cristóbal if the family has sufficient resources), respiratory and gastrointestinal conditions are the most commonly treated problems. Also, malnutrition is probably much worse in Tenejapa than would be represented in the state-wide data (Luber 2002:103).

The leading causes of death for all ages in Chiapas are heart disease (16%), malignant tumors (12%), diabetes (10%), accidents (8%), liver disease (6%), cerebrovascular disease (6%), perinatal conditions (4%), influenza and pneumonia (3%), homicide (3%), and gastrointestinal infection (1%)(SSA 2000). The most important illnesses in this group are not treated at the Tenejapa clinic. Indeed, an interesting pattern emerging from these data is that treatment at the Tenejapa clinic, and most plant-based treatments administered in the home (see Chapter 7), focus on pathogenic illnesses most likely to kill children.

Other illnesses treated in the Tenejapa clinic, or otherwise frequently reported in patient discharge data throughout Chiapas (PAHO 1998; SSA 2000), include scabies, Hepatitis A, genital herpes, epilepsy and seizures of other origins, hypertension, gonorrhea, onchocerciasis, otitis, urogenital trichomoniasis, tuberculosis, leukemia, nonfatal breaks of bones, sprains and other trauma. Diseases that are reported rarely (some of which were more common in the past) include dengue, measles, polio, rubella, tetanus, rabies, pertussis, leishmaniasis, leprosy, syphilis, cholera, taeniasis, trypanosomiasis (Chagas disease), and chicken pox.

Table 3.1. Cases of visits to the IMSS health clinic in Tenejapa Center during 1999 and 2000 by diagnosis. (Source: Instituto Mexicano del Seguro Social [IMSS] annual summaries of daily register of consultations.)

Diagnosis	No. cases
respiratory infections	283
whooping cough	0
pneumonia	0
tuberculosis	0
total respiratory	283
intestinal amoebae	36
ascaris	6
gastritis	15
acute diarrheas	55
total gastrointestinal	112
urinary infections	28
malnutrition	17
conjunctivitis	9
scabies	7
ear inflammations	7
diabetes	6
vaginal infection	2
neurological shock	2
dog bites	1
cervical displasia	1
chronic alcoholism	1
measles	0
tetanus	0
Total cases	476

There are also many illnesses not included in these data. For example, I observed, or otherwise heard of, illnesses that the Tzeltal don't seek treatment for at clinics or hospitals. These include infertility, impotency, dental caries, depression and other psychiatric conditions (some of which fall into the realm of personalistic illnesses treatable only through ritual), chronic fatigue, sprains, acute or chronic headache, heat stroke, migraine, sunburn, contact dermatitis, snakebites, and aches and pains from rheumatisms and muscle strain. Head lice are common, especially among children. Parents usually purchase treatments like medicated shampoos directly from drug stores in Tenejapa center after home-diagnosis or consultation with store owners. Alcoholism is rampant and largely untreated in Tenejapa.

So far, this discussion has reflected the general epidemiological context. Next, I focus in more detail on the pathogenesis of respiratory and gastrointestinal illnesses for four major reasons: 1) these represent the most prevalent infectious diseases that continue to pose the most serious threats to children (PAHO 1998:358); 2) they represent the conditions for which both biomedical and traditional herbal treatment is sought; 3) to point out that most of these pathogenic infections result in classifiable symptoms for both the biomedical and Tzeltal empirical systems; and 4) to show the diversity of pathogens involved. This final point is important because different pathogens may cause similar symptoms leading to a divergence of biomedical and Tzeltal etiologies and the tendency for high variability in the success of different plant species to treat similar symptoms.

Acute respiratory infections are mostly viral, including influenzas and the common cold. Often, these infections lead to more serious conditions. Pneumonia is characterized by cough and fast, difficult breathing. *Streptococcus pneumoniae* and *Haemophilus influenzae* are the bacterial pathogens most commonly leading to pneumonia (CDC 2002). Other bacteria (*Staphylococcus aureus*, and gram-negative pathogens) most often affect newborns and malnourished children. Respiratory viruses (RSV, influenza, parainfluenza, and adenovirus) can be identified in children with pneumonia, but are much less likely to cause fatal infection than are the bacterial pathogens. Nearly 75% of pneumonia deaths occur among infants under 1 year old (CDC 2002).

Tuberculosis of the lungs (caused by the bacteria *Mycobacterium tuberculosis*) is indicated by a persistent cough, pain in the chest, and coughing up blood or sputum (CDC 2002). Although the Tenejapa clinic reported no cases of Tuberculosis for 1999 and 2000, it is still widespread throughout Chiapas and is known to occur in the nearby community of Yochib (Menegoni 1996).

Pertussis (whooping cough), caused by the bacteria *Bordetella pertussis*, causes spasms of severe coughing, followed by a whooping sound and often vomiting (CDC 2002). This disease has been largely eradicated from Chiapas by the SSA vaccination program (PAHO 1998:358). I include it here because it is generally believed to correspond with the Tzeltal illness *jik'jik' obal* ('sudden choking cough;' Berlin et al. 1990:61; Brett 1994:304; Maffi 1994:335), and people that I interviewed referred to it often.

Coughing can also be caused by nematode worms like *Ascaris lumbricoides* and *Strongyloides stercoralis* migrating into the lungs (Berlin and Berlin 1996:108,408). Both may be diagnosed by biomedical practitioners and lay Tzeltal by the presence of worms in the stool. But ascaris worms may also be coughed up and expelled through the mouth.

Finally, I include the bacteria *Streptococcus* spp. here because it occasionally infects the lungs, but also because infections of the throat often co-occur with influenzas, colds and other illnesses that produce coughs (CDC 2002). The characteristic sore and red throat, pain on swallowing, and possible tonsillitis, high fever, headache, nausea, and vomiting are often considered by the Tzeltal to be associated with cough.

Prevalence and mortality rates for respiratory illnesses in Chiapas probably result from suppressed immunity due to malnutrition and high parasite loads, but also poor sanitation conditions (SSA 2000). Transmission of bacteria and viruses is mostly airborne or from contact with contaminated surfaces. *Strongyloides stercoralis* can penetrate the skin from soil. Ascarid eggs are also found in the soil. Infection occurs when a person accidentally ingests ascarid eggs (CDC 2002).

Agents of gastrointestinal infection are also highly diverse and include bacteria, worms, viruses, amoebae and other protozoa (Table 3.2). The most important of these, based on prevalence and threats to infants, are amoebas, *Giardia lamblia*, *Shigella* spp., *Salmonella* spp., and *Ascaris lumbricoides* (SSA 2000).

Some of these pathogens like *Isospora belli*, rotaviruses, *Cyclospora cayetanensis*, and *Salmonella* spp. are self-limiting, except in immunodeficient hosts (CDC 2002; USFDA 1992). In most healthy adults, these parasites go away without treatment. In these cases both biomedical and Tzeltal treatment may be directed more toward the temporary relief of symptoms.

Most of these viral, bacterial and protozoan pathogens are transmitted by the fecal-oral route, and their prevalence can mostly be attributed to the lack of sanitary infrastructure and practice (CDC 2002; USFDA 1992). I conducted a house-to-house survey in Nabil, and although most residents acknowledged the need for latrines, less than 50% of households had them. Most residents defecate on the ground within 500 feet of households. Domestic animals such as dogs, chickens, and pigs, as well as wild rats, mice and other animals, will often consume the feces and later defecate in houseyards.

These pathogens also spread directly from person to person. For example, direct contact of contaminated hands and persons with contaminated hands preparing food are probably the most important means by which rotaviruses and some bacteria are transmitted (USFDA 1992). People in Nabil rarely wash their hands with water after defecating; and even more rarely use soap. Once I observed a woman change the diaper of an infant who had diarrhea, barely rinse her hands in a bowl of water, and then return to preparing food.

Also, it is customary in many households to rinse one's hands before eating meals. Unfortunately, in some households several people may rinse in the same bowl (although in other households the water is poured over hands by another person).

Animals are also often found in dirt-floor buildings where food is prepared and consumed; most commonly chickens, which consume pest insects, and cats, which hunt mice and rats. Dogs, pigs, and turkeys are found roaming free in dirt houseyards in close

Table 3.2. Gastrointestinal parasites of Tzeltal communities in Chiapas.[1]

Agent	Type of agent	Potential symptoms[2]
Entamoeba histolytica	amoeba	fever, diarrhea
Campylobacter jejuni	bacteria	watery diarrhea, fever, bloody stool, fecal leukocytes, abdominal pain, nausea, headache and muscle pain
Clostridium botulinum	bacteria	lassitude, weakness and vertigo, double vision, difficulty in speaking and swallowing
Clostridium difficile	bacteria	mucoid diarrhea
Clostridium perfringens	bacteria	watery diarrhea, fever
Escherichia coli	bacteria	watery diarrhea, abdominal pain, low-grade fever, nausea, malaise, bloody stool
Salmonella spp.	bacteria	watery diarrhea, fever, nausea, vomiting, abdominal pain and headache
Shigella spp.	bacteria	watery diarrhea, possibly extreme fever, cramps
Staphylococcus aureus	bacteria	watery diarrhea, nausea, vomiting, retching, abdominal cramping, and prostration
Vibrio cholerae	bacteria	watery diarrhea, abdominal cramps, nausea, vomiting, dehydration, and shock
Balantidium coli	protozoan	mucoid diarrhea, bloody stool
Blastocystis hominis	protozoan	diarrhea, abdominal pain, anal itching, weight loss
Cryptosporidium parvum	protozoan	severe watery diarrhea
Cyclospora cayetanensis	protozoan	watery diarrhea, frequent, sometimes explosive, bowel movements
Giardia lamblia	protozoan	(highly variable) abdominal cramps, bloating, fever, wasting, diarrhea at initial infection
Isospora belli	protozoan	nausea, pain, and chronic diarrhea
Ascaris lumbricoides	nematode worm	visible in stool or mouth
Necator americanus	nematode worm	anemia, wasting, epigastric pain, visible in stool
Strongyloides stercoralis	nematode worm	itch at point of entry, wheezing, cough, fever, visible in stool
Trichuris trichiura	nematode worm	bloating, flatulence, wasting, dry skin and diarrhea (usually mucoid)
Enterobius vermicularis	pinworm	usually none
Taenia solium	tapeworm	visible in stool
Rotavirus	virus	vomiting, watery diarrhea, and low-grade fever

[1] Sources: Berlin and Berlin 1996; CDC 2002; SSA 2000; USFDA 1992.
[2] Infection with any of the pathogens may or may not lead to the symptoms listed here.

proximity to houses and kitchens. They usually scavenge in outdoor food-production or washing areas.

Ascaris infections are spread by human contact with infected feces and soil (USFDA 1992). People usually become infected after touching their mouth with their hands contaminated by contact with eggs from soil or other surfaces. Pigs can be infected with ascaris, and infection can be spread to humans through soil. Also, all houseyards are bare dirt and many women and children go barefoot. Hookworms (*Strongyloides stercoralis*) can directly penetrate skin that contacts contaminated soil, generally while walking barefoot (CDC 2002).

Infection by *Giardia lamblia* is most frequently associated with the consumption of contaminated water (CDC 2002; USFDA 1992). Nabil has a potable water system in which water is fed by gravity through metal or plastic pipes from a spring several kilometers away at a higher elevation. The source spring is enclosed by a fence, but is largely exposed to small animals. The water is also temporarily stored in several distribution tanks that are covered, but these tanks have venting windows that allow animals to enter. *Giardia lamblia* is a zoonotic pathogen (USFDA 1992). Contamination of drinking water very commonly results from infected animals defecating in drinking water. Most, although not all, households in Nabil boil the water from the potable water system.

In sum, dirt floors and yards, bare feet, lack of latrines, contaminated water, unwashed hands, close contact with domesticated animals, and exposure to human and animal feces are primary sources of gastrointestinal infection. During the 16 months that I lived in the Tzeltal communities I exercised extreme caution in attempts to avoid these parasites. My practices included accepting food only when I knew it was prepared with boiled water, drinking only sterilized water, and disinfecting my hands regularly (always before meals). Nevertheless, I experienced repeated gastrointestinal illnesses and on different occasions was biomedically diagnosed with *Cyclospora cayetanensis* and *Entamoeba histolytica*. I was probably also periodically infected with various pathogenic bacteria. My personal experience indicates that there are high levels of pathogens circulating in these communities and that it is nearly impossible to avoid infection.

As with the respiratory diseases, I want to emphasize the diversity of gastrointestinal pathogenic agents that may lead to similar symptoms. *Cyclospora cayetanensis* (a protozoan), *Escherichia coli* (a bacteria), and rotavirus are all very different types of pathogens that can all cause watery diarrhea (CDC 2002; USFDA 1992). But a protozoan, a bacteria, and a virus will differ significantly in their response to biomedical drugs and, most likely, to Tzeltal phytochemicals. To make matters more complicated, accompanying symptoms for most of the pathogens are quite variable from case to case (Table 3.2). For example, *Escherichia coli* infection may or may not also result in fever or vomiting (USFDA 1992). Prescribing an appropriate biomedical treatment for eliminating the pathogen requires identification of the specific pathogen and relies less on symptomatology.

Tzeltal medicinal plant treatment relies much more on symptomatology. My interviews indicated that people begin treatment of gastrointestinal and respiratory illnesses in the home with a core set of plants and seek advice from more knowledgeable people if symptoms do not respond to home remedies. The ability to make very fine symptomatic distinctions and apply the appropriate phytochemicals requires extensive experience with many cases over time. The knowledge of any given individual within a population is likely to include the plants applicable to general categories like *ja' ch'ujt* 'watery diarrhea' and a limited set of more detailed treatments particular to that person's experiences.

Epidemiological context of the tropical frontier communities

The epidemiological context in Maravilla Tenejapa is nearly identical to Nabil, but infant mortality and survivorship reflect a slightly healthier situation. There were 9,048 live births in Maravilla Tenejapa in 2000. Of these infants, 916 died within their first year, yielding an infant mortality rate of 101 per 1,000 live births, as compared to

146 in Tenejapa (INEGI 2001). There were 3.0 births per woman, and the infant mortality rate was 0.3 per woman, with 2.69 infants per woman surviving into their second year. In comparison to Tenejapa, the frontier women are having fewer babies, but those babies have a better rate of survival.

Monthly report data and interviews I conducted with the staff of the IMSS clinic in Maravilla Tenejapa indicated that the relative prevalences of pathogenic infections are similar to Tenejapa (Table 3.3). Respiratory infections are the most commonly treated conditions, followed by cases of diarrhea. The most common infectious gastrointestinal agents are amoebae and bacteria.

Table 3.3. Cases of visits to the IMSS health clinic in Maravilla Tenejapa during 2000 by diagnosis. (Source: Instituto Mexicano del Seguro Social [IMSS] monthly compilations of daily registries of clinic consultations.)

Diagnosis	No. cases
acute respiratory infections	469
tuberculosis	30
total respiratory	499
unspecified gastroenteritis	290
intestinal amoebiasis	125
total gastrointestinal	415
scabies	106
various wounds	82
unspecified abscesses	77
gastritis	73
urinary infections	66
impetigo	65
traumas	63
malnutrition	61
skin fungi	42
ear inflamations	38
malaria	21
dengue	7
leishmaniasis	2
Total cases	1617

There are some minor differences between the Highland and tropical epidemiological contexts. There appears to be a slightly higher prevalence of tuberculosis in the frontier communities, although tuberculosis may have been under-reported at the Tenejapa clinic due to differences in record keeping.

Other differences result from tropical disease vectors present in Maravilla Tenejapa that are absent from the colder locations like Nabil. In Maravilla Tenejapa, infections of botfly larvae (*Dermatobia hominis*) and bacterial or viral infection from other insect bites (especially *mosque chiclero*, which is probably the new world screwworm—*Cochliomyia hominivorax;* CDC 2002) were problematic in the past, but have become rarer as a result of extreme habitat alterations in residential and agricultural areas and government eradication programs, including the release of sterilized conspecifics. Skin fungi (e.g., *Tinea* spp.) and bacterial skin infections like impetigo (*Streptococcus pyogenes*) are more common in the hot and humid climate of Maravilla Tenejapa (SSA 2000). Also, cases of dengue are occasionally reported from Maravilla Tenejapa (Table 3.3).

The biggest difference that I anticipated was in rates of malaria infection. In Nabil, the steep karst topography allows for little standing water. This, combined with cold temperatures provides poor habitat for mosquitoes, which I rarely encountered during my work there. Maravilla Tenejapa, however, is hot all year and has some surrounding, flat, occasionally-flooded, areas. Mosquitoes were abundant.

But malaria has been mostly eradicated in the frontier migrant communities as a result of an aggressive government anti-malaria campaign (Campaña de Eradicación del Paludismo—CNEP), which consists of spraying insecticides in residential areas (including inside houses), educational campaigns, drainage projects to discourage standing water, and liberal distribution of antimalarial drugs like chloroquine (Aralen)(SSA 2000). Most malaria treatment at the Maravilla Tenejapa clinic (Table 3.3) was for recurring cases as opposed to new diagnoses.

Thus, the pathogenic context in Maravilla Tenejapa is not that different from Tenejapa. If there is any difference at all, it is a higher potential for tropical diseases in Maravilla Tenejapa. Why then are infant mortality rates lower in Maravilla Tenejapa? Unfortunately, the clinical data are neither consistent nor precise enough to allow for a direct comparison of infection rates. But socio-economic conditions, sanitary infrastructure, sanitary practices, and access to clinics are notably better in Maravilla Tenejapa.

Regarding socio-economic differences, there is a longer growing season in Maravilla Tenejapa that allows for two corn crops per year (and in some cases three). Most families I spoke with derived a small income from selling excess corn every year. Families in Nabil can grow only one crop between frosts, and must occasionally buy corn. Families in Maravilla Tenejapa can also grow cash crops like coffee, bananas, and mangos that do not tolerate the cold in Nabil. Maravilla Tenejapa is also well situated on a paved highway, which greatly facilitates cash cropping. As a result, many Tzeltal households in Maravilla Tenejapa have amenities like refrigerators and direct-TV; some have gas-powered corn and coffee grinders. Owning such appliances is unthinkable for most families in Nabil.

I hasten to point out that while people in Maravilla Tenejapa may be better off than those in Nabil, it is still a very poor community. Malnutrition, alcoholism and other diseases of poverty remain tenacious problems in the frontier (Table 3.3).

Another major difference from Nabil is that every house in Maravilla Tenejapa has a latrine. Indeed, most houses have raised "dry" latrine systems encased in cement foundations. This extends the life of the latrine (holes in the ground tend to fill quickly during the rainy season) and precludes entry of rats and mice. Most latrines were constructed in 1999 when the latrine design and construction materials (including blocks, cement and aluminum roofing) were provided through a peasant cooperative program.

People in most households I visited in Maravilla Tenejapa and Salto de Agua washed their hands at outside spigots or by pouring water over hands before eating and preparing food. The clinic staff claim that most, if not all, residents boil their water, which is piped in from an exposed spring like that of Nabil. Pigs are very rare in Maravilla Tenejapa and Salto de Agua due to the local perception that they spread disease

Finally, the health clinic in Maravilla Tenejapa appears to be better staffed and equipped, and operates more hours than the clinic in Tenejapa, especially since the Zapatista uprising.

In sum, although the health situation is somewhat better in Maravilla Tenejapa, the major health problems are similar to those in Nabil. In particular, the major threats posed to infants are from respiratory and gastrointestinal infections, most likely as a result of impaired immune systems. Given the epidemiological similarities, one might expect the distribution of knowledge about medicinal plants that treat the various types of illnesses to be similar. As I will show in Chapters 5 and 8, they are not. Particularly puzzling is the much lower knowledge about dental and respiratory treatments and much higher knowledge about female reproductive treatments in the frontier communities Maravilla Tenejapa and Salto de Agua.

Tzeltal illness classification

After having presented an overview of the diseases that the Tzeltal must cope with from a biomedical perspective, I turn now to outline the structure of Tzeltal illness classification by drawing on the work of previous researchers of Tzeltal medicine. The fundamental concepts fall into the category of things that are simply too salient not to be noticed and named by people everywhere in the world. These include the various body parts and deviation from normal states, including pain and visible manifestations like bleeding, diarrhea, or rashes. Following Young (1982), I will refer to such linguistically recognized aberrant states as “illnesses.”

As I will argue in Chapter 8, another concept “discovered” by all humans, and many nonhuman animals, is that ingesting or topically applying certain plants can help correct aberrant states. In other words, plants can be used to treat illnesses. From a logical standpoint, this is simply not possible without noticing *a priori* that something is wrong. Furthermore, developing a sense of which plants are appropriate for treating which illnesses is not possible without some *a priori* semantic categorization of illness (Young 1978), and sharing this information relies on linguistic classification of illnesses (Maffi 1994:2).

This discussion of illness classification follows the line of reasoning outlined by Frake (1961:115), who stated that for the Subanun "diagnosis is the procedure of judging similarities and differences among instances of 'being sick'" and then placing those events into "linguistically labeled categories." The linguistic and semantic research of Maffi (1994), Berlin and Berlin (1996), Berlin et al. (1990), and Brett (1994) suggest that Tzeltal illness classification relies on contrastive features within three general semantic dimensions—affected anatomical region of the body, overt symptoms, and attributed etiology.

The first dimension very likely results from the universal linguistic recognition of anatomical parts, which appears to form one of the fundamental bases for human thought. Every language includes labels for human anatomical parts, and Tzeltal is no exception (Stross 1976). Examples from Tzeltal include *jolol* 'head,' *nuk'il* 'neck,' *k'abil* 'hand,' *eil* 'mouth,' *k'inel* 'kidney,' and *ti'il* 'lip.' Labels for body parts serve as fundamental sources of metaphorical extension in human thought through which concepts associated with the human body are mapped onto nonhuman concepts (Lehrer 1974; Levinson 1994; Vogt 1976). Some examples from Tzeltal include *ti'nel* 'door' (from *na* 'house' and *ti'il* 'lips') and *jolna* 'roof' (from *na* 'house' and *jolol* 'head'). Although metaphorical extension from human anatomy is ubiquitous in languages, metaphorical extension in the other direction is unheard of. For example, one would never hear a human head referred to as a 'roof of a person.' The point is that because semantic and linguistic recognition of anatomical parts is universal and fundamental to human thought, it comes as no surprise that it forms one of the bases of Tzeltal illness classification.

Maffi (1994:154), Brett (1994:38-39), and Berlin and Berlin (1996:56) all found that when they asked their informants to sort illnesses, the informants tended first to sort them according to affected anatomical region. Although each of the studies varied somewhat in the particular categories that resulted, the general categories that emerged indicated that informants differentiated between illnesses affecting the abdominal area (i.e., gastrointestinal), respiratory illnesses, reproductive problems, dermatological conditions, eye, ear and mouth illnesses, broken bones and sprains, mental conditions, pain or swelling unaffiliated with any particular anatomical area, dental problems, emotional conditions, wounds, and bites. Both Maffi and Brett provide strong evidence that these distinctions are important in conversations and decisions about treatment.

This pattern is not unique to the Tzeltal. Young's (1978) cluster analysis of frame elicitations with Tarascans showed a primary distinction between gastrointestinal, respiratory, and "other" illnesses. Gollin's (2001) study of classification by the Kenyah of Borneo also showed primary distinctions between gastrointestinal, respiratory, dermatological, and febrile conditions. Indeed, Frake's (1961) groundbreaking analysis relied on the distinction made by his Subanun friends between dermatological conditions and all other conditions.

An example of contrast along this dimension is the distinction made by all of the subjects I interviewed between *k'ux jolol* 'headache' (from *k'uxul* 'pain' and *jolol* 'head') and *k'ux ch'ujtil* 'stomach ache' (from *k'uxul* 'pain' and *ch'ujtil* 'belly').

Another important semantic dimension for the Tzeltal involves the relationships drawn between tactile sensations (e.g., pain, itching, heat, cold), visual phenomena (e.g., irregular stool, appearance of skin and hair, visible worms), and auditory signs (e.g., gurgling stomach, wheezing)—all considered to be abnormal and deleterious for obvious reasons. Researchers commonly call these observable phenomena "illness symptoms" (Berlin and Berlin 1996:53; Maffi 1994:6). Again, studies with other linguistic groups (that have avoided fetishizing supernatural beliefs) have also found symptomatology to be fundamental to illness classification and behavior regarding treatment (e.g., Foster 1994:75; Frake 1961; Messer 1991; Weiss 1998).

A simple example of symptomatic differentiation within an anatomical class is *k'ux jolol* 'headache' versus *sulil jol* 'dandruff' (from *sulil* 'fish scale-like, flakey' and *jolol* 'head'). Note that these multidimensional contrasts are not perfectly paradigmatic (D'Andrade 1995:33). Symptoms affiliated with one anatomical part need not be affiliated with another. There is no equivalent 'flakey stomach.'

Neither does Tzeltal illness classification appear to be taxonomic. Symptoms sometimes occur alone and are therefore considered illnesses onto themselves (e.g., *k'ux jolol* 'headache'). But these symptoms may also tend to occur with other symptoms in groups that form linguistically labeled illnesses. For example, *k'ux jolol* 'headache' tends to occur along with *obal* 'cough' and *k'ajk* 'fever' within the labeled illness *simal* 'flu' (Maffi 1994:339). Any one of these individual symptoms can stand alone as illnesses, but as Berlin and Berlin (1996:70) observe they are not linguistically marked in those situations. Therefore, unlike taxonomic classification of plants or animals (Berlin 1992), primary and complex lexemes tend to occur at the same level of contrast (Maffi 1994:176).

Attempts to form taxonomic relationships with illness data are further complicated by the dynamic nature of illnesses (Maffi 1994:175,186). For example *ja' ch'ujt* 'diarrhea' can become *ch'ich' tza'nel* 'dysentery.'

Yet another issue is that not every symptom affiliated with an illness needs to be present during every illness occasion. For example, Tzeltal informants may still consider an illness to be *simal* 'flu' even though episodes of the flu may not always include 'headache' or 'fever' as symptoms.

Thus, Tzeltal illness classification can best be described as graded "fuzzy sets" of attributes clustered around prototypical features (Kempton 1981; Kronenfeld et al. 1985). As proposed by Rosch et al. (1976) prototypes emerge from clusters of item attributes. Attributes which tend to occur more often with others are focal, but need not necessarily occur with every item, although subjects might expect that prototypical attributes should occur with every item (Wierzbicka 1990).

This description applies very well to Tzeltal illness classification, and likely explains Berlin and Berlin's (1996:69) classification scheme in which illnesses that affect the gastrointestinal system form clusters of condition classes whose affiliation is based primarily on clusters of signs and symptoms. Symptoms such as *tza'nel* 'diarrhea' or *lukum* 'worms' form focal cores within the clusters because they are salient, they can occur alone, and they tend to be present most often in conjunction with other symptoms. Other illnesses like *ch'ich' tza'nel* 'bloody diarrhea, dysentery' form an "extended core," and still other illnesses like *xiwel* 'fright,' which are loosely associated with diarrhea, form groups of outlying "affiliated conditions" (pp. 69-70).

A similar scheme could be applied to respiratory illnesses. The prototypical symptom is the linguistically unmarked *obal* 'cough.' Widely known illnesses that form an extended core include *sak obal* 'white cough' (probably tuberculosis) and *jik'jik' obal* 'grabbing, choking cough' (probably pertussis). An affiliated condition might be *simal* 'flu,' which sometimes includes cough, but also shares attributes like fever and vomiting with other core clusters.

Rather than a taxonomy, the overall system, which includes gastrointestinal, respiratory, dermatological, and other types of conditions, including psychological and personalistic illnesses, more likely resembles a network of affiliations (Maffi 1994:188) with links that are "weighted" by varying semantic importance of classificational criteria.

The important point is that medicinal plants are located by the Tzeltal within this illness network based primarily on linguistically labeled clusters of affected anatomical regions and symptoms, but these distinctions can at times be fuzzy. For example, a plant that cures *obal* 'cough' can be used for a variety of other conditions that include cough as one of many symptoms. Or, in the case of linguistically marked conditions like *sak obal* 'white cough,' only a specific, different plant is used. It is important to note that one never finds a "cure all" plant that is used for everything, as suggested by Laughlin (Breedlove and Laughlin 1993:43) for the Tzotzil of Zinacantan.

To develop this example a little further, interviewees in Nabil told me that *Salvia lavanduloides* was used to treat *bats'il obal* 'true cough' on 53 different occasions. Three informants told me it could also be used for *sak obal,* three for *k'ux nujk'ul* 'sore throat,' and ten for *simal* 'flu.' The latter two cases probably represent the tendency for cough to co-occur with sore throat and flu. On the other hand *sak obal* 'white cough' is a persistent cough that appears to be linguistically marked by a characteristic accompanying white phlegm (Maffi 1994:329), and is generally thought to correspond with tuberculosis (Menegoni 1996). *Salvia lavanduloides* is generally not accepted as a treatment for *sak obal*. Instead most interviewees claimed that *Cornus disciflora* is the appropriate treatment. Furthermore, the use of *Cornus disciflora* in Nabil is almost exclusively limited to treating *sak obal*.

As I will show in Chapters 4 and 8, the affiliation of plants with particular illnesses is almost entirely with the intent to alter characteristic, linguistically-labeled symptoms. But as this discussion points out, strategies can change when particular symptoms are re-conceptualized as co-occurring with other symptoms, or when illnesses (including clusters of symptoms) are thought to have changed into other illnesses.

The third important dimension of contrast is etiology. Following Foster's (1976) definition as adopted by Berlin and Berlin (1996:52), the Tzeltal appear to distinguish between naturalistic and personalistic illnesses. A few examples of naturalistic Tzeltal etiologies include worms that enter a tooth (*ya x'och chanul*) to cause toothache (*k'ux eal*) and getting sick from contaminated food or food that is metaphorically either too 'hot' or 'cold.' Examples of personalistic illnesses are those sent by other living people (*ak'bil chamel*) or dead ancestors (*jme'tik jtatik*). Berlin and Berlin (1996:52-56), Maffi (1994:151-152), and Brett (1994:63-66) have used pile sorts and/or linguistic analysis to show that naturalistic illnesses tend to be symptom-based and curable with herbal remedies by most anyone in the population (as suggested by Foster 1976). Personalistic illnesses focus more on cause (usually social), and are perceived to be curable only by an expert (*jpoxil*). These cures focus more on ritual than herbal treatments, although plants are often included in ceremonies.

Diagnosis by an individual or family as to whether the illness is naturalistic or personalistic influences what strategies will be pursued first to address the illness (Brett 1994:63-66; Maffi 1994:25-30). In general no etiological considerations are required to treat illnesses like diarrhea, headache, or dandruff when symptoms first appear and if they occur alone. They are considered to have arisen from some natural cause, and home-based plant treatments directed at the particular symptom are the first line of defense. Only when symptoms persist or are reconceptualized to be part of another illness do etiological considerations become more important. Young (1978) found a similar pattern among the Tarascans of Pichátaro.

But classification of illness experience into personalistic or naturalistic categories is not clear cut. As expressed by Foster (1976:776): "*the two etiologies are rarely if ever mutually exclusive*" (emphasis in original). For example, my interviews indicated that diagnosis of *xiwel* 'fright' (Spanish *susto*) is largely symptom-based. Diarrhea, lack of appetite, malaise, and wasting represent a linguistically labeled cluster of symptoms said to result when a person's soul has become dislodged from its proper location as a result of some traumatic event like a hard fall, seeing a snake, or being startled by another person. The etiology is a mix of natural (falling down) and supernatural (soul loss) events—interestingly, so are perceptions of appropriate cures. Many interviewees claimed that *xiwel* can be cured by bathing in infusions from three plants: *ijk'al ok' tzib* (*Adiantum andicola*), *poxil xiwel* 'medicine for fright' (*Phyllanthus niruri*), and a third plant that I promised to keep a secret. But they also said that this often doesn't work, in which case one must visit an expert healer who will perform rituals to relocate the soul. The healer usually also uses the plants mentioned above and may make use of additional plants as well.

It is important to point out that diagnosis of xiwel may start with a diagnosis of simple diarrhea. When the diarrhea doesn't respond to home-based remedies (usually *Verbena litoralis*), and other symptoms become apparent, the diagnosis may be changed to *xiwel* as a result of discussion within the family or consultation with friends or experts. As the case of *xiwel* indicates, the distinction between personalistic and naturalistic classification, as well as symptomatological versus etiological classification, can be fuzzy.

Etiology can also play an important role in illnesses that are clearly perceived as naturalistic. A good example is the Tzeltal construction of infertility, which is sometimes referred to as *ochem sik ta sch'ujt antz* 'cold has entered a woman's belly.' In this case the linguistic label reflects etiology, although the illness is diagnosed by the symptom of not becoming pregnant. A popular treatment is to ingest the pungent extract of *san sibre* (ginger—*Zingiber officinale*), which is believed to 'heat-up' a woman's belly. The important point is that even for some naturalistic illnesses, etiology can be combined with symptomatology to arrive at a diagnosis. But note also that the efficacy of the treatment is based on correction of the symptom—whether the woman becomes pregnant—rather than whether the woman's belly gets hot.

In summary, Tzeltal illness classification is somewhat hierarchical, but not taxonomic, and is better described as a network of interrelated anatomical and symptomatic observations, some of which form focal cores. The overall network is represented by the Tzeltal lexeme *chamel* 'illness' (Berlin and Berlin 1996:55; Maffi 1994:213). Types of illnesses are broadly divided by the Tzeltal into personalistic and naturalistic categories, although membership in either category is graded with fuzzy boundaries. Within the naturalistic illnesses, the Tzeltal generally distinguish between gastrointestinal, respiratory, dermatological, and other types of illness based on the affected anatomical region. Crosscutting these designations are symptomatic distinctions, to which linguistic labels are applied. Most importantly, plant-based treatments are matched to illnesses based on these linguistically labeled symptomatic and anatomical distinctions.

Conclusion

The epidemiological context of Highland Tenejapa is sadly typical of impoverished people. Rates of pathogenic infections are high, mostly as a result of reduced immunities from malnutrition and poor sanitation. Gastrointestinal and respiratory infection pose a very high risk to infants. The situation in the tropical frontier communities is similar, but with two exceptions. There is a greater potential for tropical infections and infant survival rates are slightly higher.

The Tzeltal have a rigorous and widely-shared illness classification system that in some cases corresponds with biomedical classification. Some examples include *ch'ich' tza'nel* 'dysentery' (Berlin and Berlin 1996:197-199), *lukum* 'parasitic worms' (Berlin and Berlin 1996:408), and *sak obal* 'tuberculosis' (Menegoni 1996). In other cases, there may not be a biomedical correspondence (e.g., *xiwel*). Cases of correspondence likely result from the fact that both systems are (at least partially) based on anatomical and symptomatic empiricism.

The epidemiological data for Tzeltal illnesses that correspond with biomedical diseases suggest that some illnesses are experienced more frequently and pose more of a threat to newborns. Plans of action depend on how observations are fit into illness classifications based primarily on symptoms. As I will show in Chapter 7, plants used to treat these common and threatening illnesses are more likely to be known throughout the population because they are used more often. But what appears to influence the distribution of knowledge among novices most is the perceived efficacy of each plant.

Chapter 4
Knowledge Distribution and Emic Perceptions of Efficacy

In this chapter I begin presenting a systematic analysis of the possible explanations for the patterns of medicinal plant knowledge distribution that I documented in the Tzeltal communities and presented in Chapter 2. This will also be the subject of the next five chapters, in which I test notions about how the distribution of knowledge may be influenced by organoleptic and morphological characteristics of plants, the humoral classification system, the distribution of plants in the landscape, human cognition, and patterns of cultural transmission. In particular, I am trying to determine why some plants are very well known throughout communities (i.e., those at the top of the curves in Figures 2.1 and 2.2), why the distribution of knowledge falls rapidly for the first 50-60 plants, and then many plants that are known by only a few people form a tail to the curve (i.e., the curves are asymptotic).

In this chapter I focus on what might at first appear to be the most obvious possible explanation—some plants are known by more people because they are more effective than other plants for correcting illness symptoms. I say “at first” because there are two problems involved with operationalizing this statement. The first problem is how to define “effective,” and second is how to measure efficacy to test its influence on knowledge.

I begin this chapter with a discussion to show that interviewees focus on the treatment of symptoms when thinking and talking about the effectiveness of medicinal plants. Then I briefly compare emic and etic approaches to efficacy. Then I move on to the main goals of the research presented in this chapter: to develop an emic-based ranking of efficacy and to determine whether plants that were ranked as more efficacious by interviewees were more likely to be known as medicinals by people in the community of Nabil.

Deriving emic efficacy

In the previous chapter I presented the argument that Tzeltal illness classification is based primarily on symptoms. Conclusions of other researchers of Tzeltal medicine (Berlin and Berlin 1996; Brett 1998; Maffi 1994) and the discourses and narratives that I collected during this study clearly indicate that the overall goal of using plants when treating naturalistic illnesses (as opposed to personalistic) is to correct linguistically recognized deleterious symptoms. Most of these symptoms can be sensed directly. Obvious examples include coughing, heat associated with fever, physical pain associated with diarrhea, injuries, or headache, and conditions that can be seen, such as watery stool, skin rashes, or boils. In the 21 hours of discourse collected from 32 different study participants (Chapter 2) the topic of whether a plant was an effective treatment was discussed 112 times. There were a variety of linguistic terms (all verbs) denoting efficacy (Table 4.1). The terms used most frequently were *ya sutsub* 'it cures it,' *ya xpoxta* 'it cures,' *ya xtuun* 'it works,' and *ya skejchaj* 'it calms it.' During 93% of the occasions that the terms in Table 4.1 were used, they were used in

Table 4.1. Linguistic terms used to denote efficacy and curing.

Tzeltal term	English gloss
utsub	to heal, get well
poxta	to cure
jelaw	to go away
ju'	to achieve, be able
k'axix	to pass
kejchaj	to calm, end
kol	to go away
lamaj	to calm
mil	to kill
pok	to wash away, wipe away
sikubtes	to cool (someone)
tejk'aj	to survive, live
kujch' yu'un	to result well
tuun	to be of use, to function effectively

reference to the alteration of some linguistically recognized symptom. Here are a few brief examples:

Excerpt 4.1 (from Nabil Interview 124)

Casagrande: . . . sakil nich wamal, ch'a bakal, mes te', chikle wamal. Bi yu'un ya spoxta obal. Bi yu'un ay yip?

> *Erigeron karwinskianus*, *Salvia lavanduloides*, *Baccharis vaccinioides*, *Satureja brownei*. Why do all these plants cure the common cough, what gives them power?

Subject: Yu'un ja'jich ya sk'an ya spoxta ek'a te obale. Melel ya skejcha yu'un ek. Ay solel k'ajk'otik ta yalel ma sts'ikix yalel te sik'ak'e pero yu'un k'ajk'otik teme la kuch'tike ja'ya s'utsubotik yu'un ya xkejcha te k'ajk'e. Ya xkejcha te ya xti'wan joltike ya xti'wan bakeltik yu'un wa'i ya xkejcha.

> Because they all just want to cure the cough. The truth is that they calm it. It burns when one talks, one can't endure talking or the fever. But because one drinks these, it is cured, because it calms the fever, it calms the pounding headache and the body aches, it calms it.

Excerpt 4.2 (from Nabil Interview 102)

Subject: Tame tulan te tsa'nele ya xlajotik ta sik k'ajk', ya stijoltik, ya stij kok'abtik spisil ya stij kok'abtik yu'un te tsa'nele. Ja' primero ya pay kuch' te yakan k'ulube. Wa'i ya xkejchaj yu'un te tsa'nele. Ay yip. Ja' te yakan k'ulube. Ya xpoxta te ch'ujtike. Ya smak. Ya xkejchantes te tsa'nele. Yak. Ya sutsub.

> If the diarrhea is very strong it's as though we are dying of fever and chills. Our heads hurt, our whole bodies hurt because of the diarrhea. So, first we boil and drink *Verbena litoralis* because it's understood that this calms the diarrhea. It's strong. It's *Verbena litoralis*. It cures the stomach. It closes it up. It calms the diarrhea. Yes, it cures it.

It was also clear from the discursive data that some plants are considered stronger cures than others, as this example shows:

Excerpt 4.3 (from Nabil Interview 122)

Casagrande: Spisil ya spoxtaik ja'ch'ujt, pero bi yu'un ma ba pajal yakan k'ulub sok tulezna?

> All of these cure diarrhea, but why is *Verbena litoralis* different than *Prunus persica*?

Subject: Osea te diferenciae . . . ja' diferencia te mero uts te tsa'nele me k'axel ma xkejcha ja' ya yich' ak'el te yakan k'ulube ta me ay yutsilnax tsa'nel ma ba lom yip te tsa'nele ya stak' ya yuch'i ja'ni ja' sok te ala buluk' sit wamale. Ta me menos ala tsa'nel osea ala sim nak'al tsa'nel a yalike ya stak' ja' ya pay kuch'tik ja'ni ja'te yabenal sak jie

> The difference . . . If there's really a lot of diarrhea, if it pours out, and if it doesn't abate you use *Verbena litoralis*. If the diarrhea is just not very strong you can drink this one here with *Borreria laevis*. If there's even less, or if it's diarrhea with mucous, I've heard you boil and drink the leaf of this one, *Cornus disciflora*.

It is intuitive to assume that if a plant works well for achieving a culturally defined goal, as this excerpt suggests, than people will be more likely to use it again. They will also be more likely to share this information with family and friends. What's more, if using the plant achieves shared goals, consensus about it's use should result. Thus, knowledge about efficacious plants should be more widely shared and there should be more consensus about how to use efficacious plants.

This process of sharing information has rarely been explicated in the literature, even to this brief level of detail (for exceptions see Johns et al. 1990 and Trotter and Logan 1986). Nevertheless, this is the fundamental implicit assumption underlying studies that seek to correlate pharmacological efficacy with indigenous conceptions of efficacy that use percentages of informants reporting medicinal uses, informant consensus, or frequency of use as surrogate measures of efficacy (Adu-Tutu et al. 1979; Ankli et al. 1999b; Friedman et al. 1986; Heinrich et al. 1992; Johns et al. 1995; Trotter and Logan 1986). In such studies it is assumed *a priori* that the frequency of use, distribution of knowledge, and/or consensus about medicinal uses of plants are the result of, correlate with, or perhaps even are identical to, shared perceptions of efficacy among the indigenous population. To my knowledge this fundamental assumption has never been tested. What's more, it may rely on spurious assumptions.

The first problematic assumption is that "information flow is unrestricted" (Friedman et al. 1986: 277). Data from this study (Chapter 9) show that information networks may be quite constrained—limited mostly to within households. Although some medicinal plants are widely known for specific uses throughout the Highlands (Berlin and Berlin 1996), Figures 2.1 and 2.2 show that shared knowledge decreases rapidly and most medicinal plant knowledge is idiosyncratic. In Chapters 8 and 9 I will argue that this pattern is mostly the result of constraints placed on information flow by individual and shared cognition, the structure and size of information networks, perceptions of speaker legitimacy, and the variable frequency with which different illnesses are experienced. In short, information flow is restricted and biased by variables that may be independent of indigenous perceptions of efficacy.

Another issue involves the conflation of frequency of plant use, consensus, and knowledge distribution. Most learning by the population in this study appears to occur through active participation in illness-curing events, especially for children (see Chapter 9). Furthermore, frequency of use is correlated with knowledge (see Chapter 7), but frequency of use need not be a function of efficacy. As I show in Chapter 7, plants were more likely to be used by participants in this study because they were accessible than because they were considered the most effective treatments (see also Adu-Tutu et al. 1979). Thus, it may be that some plants become better known because they are accessible, not necessarily because they are perceived as the most effective treatments. By using consensus or knowledge distribution as surrogate variables for efficacy, studies like that of Trotter and Logan (1986), Heinrich et al. (1992), and Johns et al. (1995) may be mistakenly testing the correlation between pharmacological activity and plant accessibility rather than between pharmacological activity and indigenous perceptions of efficacy.

Another issue arises from my observation that in the communities I studied there are a variety of illnesses for which there is very little knowledge of medicinal treatments (Chapter 2). As I will show below, this knowledge is lacking despite the fact that cures for these illnesses are widely known in neighboring communities. Again, this points out problems in information flow. But it also points out problems in scale of analysis, and more importantly, the problem of assuming that knowledge about effective treatments will be well disseminated among community members.

The major goal of this dissertation research was to determine which variables might influence the distribution of knowledge about medicinal plants. Therefore, I could not assume that cultural perceptions of efficacy were correlated, or synonymous, with the distribution of knowledge. I needed to isolate efficacy as a variable in order to test that correlation. This raised the problem of how to derive estimates (or rankings) of efficacy for medicinal plants in a community.

My first inclination was to use pharmacological data, especially screenings for bio-activity, to determine the relative efficacies of the medicinal plants in the pharmacopoeia. Such an approach assumes that indigenous use of plants as medicinals is for the most part a result of people using phytochemicals found in those plants to treat symptom-based illnesses (Brett 1998; Johns 1986). If proper correspondence between indigenous and bio-medical understandings of illnesses and medicinal uses can be identified, the plants could be pharmacologically analyzed to determine their efficacy.

The main problem that arises from this approach is how to know what is being tested in the laboratory truly reflects the intentions of the indigenous users. Etkin (1988a) and Browner et al. (1988) have provided a helpful foundation for addressing this problem by outlining the distinction between emic and etic perspectives of efficacy. As defined by Etkin (p. 300):

> The emic (local) perspective is a culture-specific one that is consistent with the ideology of the society under study and presents health-related (and other) phenomena through reference to indigenous understandings of the universe and the intended outcomes of plant use and related practices. On the other hand the etic (outside) perspective uses concepts and theories that are grounded in some other ideology in order to create a framework on which to project and interpret medical beliefs and behaviors.

I am interested in how Tzeltal perceptions of efficacy influence distribution of knowledge throughout the study population. Clearly, then, I am interested in the emic perspective of efficacy. The important methodological question becomes whether I can use pharmacologically derived measures of efficacy that are based on biomedical correspondences to estimate emic perceptions of efficacy.

There are a variety of possible approaches to ethnopharmacological research. Here, I focus on two that might be used to estimate emic efficacy. The first, which most closely reflects Etkin's idea of an emic approach, requires detailed ethnographic and epidemiological data to determine the likely biomedical correspondence with indigenous intentions. In these types of studies, ethnoepidemiological results inform phytochemical and pharmacological work to determine the chemical constituent responsible for achieving the emic-defined goal. A simple example is that of *Chenopodium ambrosioides*, a plant that is used throughout Mexico (including the participants of this study) to kill intestinal worms (Berlin and Berlin 1996:415-417; Heinrich et al. 1998). Ethnoepidemiological reports show that *Chenopodium ambrosioides* is being used mostly to eradicate worms of the genus *Ascaris* (Heinrich et al. 1992). An essential oil, subsequently named ascaridol, has been isolated as the constituent that kills *Ascaris* worms (Gallego et al. 1965). Ideally, if pharmacologically-derived evaluations for emic-defined efficacy (e.g., kill rates of *Ascaris*) were available for every plant in the Nabil pharmacopoeia, one could compare these results to determine the relative efficacy of the various plants.

But there are very few studies that have focused on individual plants in the Tzeltal pharmacopoeia to this level of detail. In many cases biomedical correspondences are often difficult, if not impossible, to determine (Browner et al. 1988; Etkin 1988a). The Tzeltal illness *me'winik* 'mother of man' provides an example. The emic explanatory model focuses on an ethnoanatomical organ said by the Tzeltal to be located in the epigastrium (Berlin and Berlin 1996:353). Extreme pain and other debilitating symptoms result when this organ becomes dislocated. The general treatment focuses on massage, but also includes administration of *Lobelia laxiflora* and *Fuchsia splendens*. Berlin et al. (1993) have proposed that the corresponding biomedical condition is gall stones. It is unclear how the efficacy of the two plant species might be tested either for their ability to relieve the pain associated with this condition or help to dissolve the stones.

Luber's (2002) study of the Tzeltal illness *cha'lam tsots* 'second hair' provides an even more vexing problem for using pharmacological analysis to test the efficacy of plant-based treatments. The Tzeltal explanatory model focuses mostly on the appearance of short spiny hairs on the scalp (Luber 2002:70-74). After extensive dietary and medical analysis, Luber determined the 'second hairs' to be a symptom associated with protein energy malnutrition (p. 107). Both his and my data show that the Tzeltal use a variety of plant-based treatments that are applied to the scalp with the intention of stopping the growth of the hairs. It is unclear how this might remedy malnutrition. Thus, it is not possible to test the emic efficacy of these plants.

Furthermore, as Browner et al. (1988) note, in some cases it may not be possible to derive a biomedical correspondence for the illness in question. This is likely the case for the Tzeltal illness *xiwel* 'fright.' Tzeltal descriptions of this condition show a close correspondence to the mestizo illness *susto* (Berlin and Berlin 1996:60), for which there does not appear to be a biomedical correspondence (Browner et al. 1988).

The Tzeltal that I interviewed cited plants to cure a variety of illnesses that lack clear biomedical correspondences. As a result, this emically-guided pharmacological approach to testing efficacy was not applicable to this study.

In another approach, pharmacological screenings are performed on entire pharmacopoeia or subsets of plant species specific to illness categories. For example, Navarro et al. (1996) screened plant extracts from 12 botanical species used in traditional medicine in Morelos, Mexico to cure infectious diseases by determining potential antimicrobial activity against *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans*—all of which are potential pathogens for the people using the plants. Caceres et al. (1990) screened 84 of the plants most commonly used to treat gastrointestinal illnesses in the Guatemalan Highlands against five enterobacteria that are pathogenic to humans (*Escherichia coli*, *Salmonella enteritidis*, *Salmonella typhi*, *Shigella dysenteriae* and *Shigella flexneri*). Likewise Berlin and Berlin (1996:84-88) determined the botanical species that were most important to the Highland Maya for treating gastrointestinal illnesses and screened extracts of those species for activity against *Escherichia coli, Staphylococcus aureus,* and *Candida albicans*, and for spasmolytic effects on guinea pig ileum. (Spasmolytic effects were tested in case some of the species were being used to slow peristalsis, thus reducing diarrhea and the associated abdominal pain.)

This approach recognizes the need to adhere to ethnographic relevance by screening for activity regarding pathogens or physiological effects that are likely to reflect some of the effects being pursued from an emic perspective. But the screening methods used in these studies represent only a small subset of a highly diverse set of potential effects that may be desired by indigenous users. As Etkin (1988a) points out, the reasons plants are considered efficacious are complex and may not have direct biomedical correlations. Some plants that are used for gastrointestinal illnesses, for example, may not be intended to kill microorganisms or reduce peristalsis, but achieve some other effects associated with aspects of the etiological model that deviate from the biomedical model. As Browner et al. (1988) have shown with their analysis of uteroactive Chinantec medicinals, the emic and etic models followed separate reasoning processes to arrive at the same conclusion.

There is also the possibility that at such large scales of analysis remedies may not always be prepared in exactly the way they would be by the indigenous users (Barsh 1997); in particular, some plants must be combined with others in order to achieve emic-defined goals (Berlin and Berlin 1996:448; Etkin 1988b; Holmstedt and Bruhn 1995). This approach represents a trade-off between the desire for ethnographic relevance and the level of ethnographic and laboratory effort that would be required to achieve a high level of empirical specificity for each plant similar to that represented by the case of *Chenopodium ambrosioides*.

These types of studies have been valuable for supporting the notion that many, if not most, indigenous therapies may have biomedical correspondences, and that indigenous pharmacopoeia are efficacious (Berlin and Berlin 1994). For example, of the 12 plants screened by Navarro et al. (1996), all 12 showed antimicrobial activity against *Staphylococcus aureus,* ten against

Escherichia coli, eight against *Pseudomonas aeruginosa*, and nine against *Candida albicans*. These studies are also important for prioritizing extracts for further pharmacological study.

But other studies that have attempted to screen for ethnographically determined bioactivities have found plants to perform poorly (Domínguez and Alcorn 1985; Johns et al. 1995; Ugarte 1997). Each of these authors have pointed out that this does not necessarily indicate that the pharmacopoeia is ineffective from an etic perspective, but more likely that the screening protocol did not adequately reflect the diversity of pathogens being targeted by indigenous use—a problem that led Barsh (1997) to predict that most studies have probably grossly underestimated efficacy. As indicated in Chapter 3, there are at least 23 pathogens, including bacteria, protozoans, viruses, and worms found in Tzeltal communities that may cause diarrhea (Table 3.2). Such diversity, combined with the possibility that perceptions of efficacy need not even be a function of anti-pathogenic activity, led me to conclude that the effort required to obtain sufficient ethnographic and pharmacological data in order to judge the relative efficacy of the plants in a local pharmacopoeia (perhaps to the level of that obtained for *Chenopodium ambrosioides* above) would clearly be beyond the scope of a doctoral dissertation.

Other studies have used chemical literature databases like NAPRALERT to acquire pharmacological data (Ankli et al. 1999b; Berlin and Berlin 1996; Gollin 2001; Weiss 1998). Unfortunately, NAPRALERT does not contain records for most of the species in my study, and nearly all of the studies that have been conducted on species of interest to me did not include tests relevant to the way the Tzeltal were using these species. For example, a search in NAPRALERT identified one study which described the potential for *Rhus terebinthifolia* to induce labor and another that tested for spasmolytic effects related to gastrointestinal or respiratory conditions. But no studies were identified that evaluated *Rhus terebinthifolia* for inhibition of fungi like *Candida* sp.—the use known by many Tzeltal participants of this study (i.e., *chin yej alal* 'oral thrush').

While it may be true that etic pharmacological constructions of efficacy closely match emic constructions for the Tzeltal because most of the Tzeltal etiologies for naturalistic illnesses are symptom-based (Maffi 1994:172), the potential for bias and problems acquiring data were too great for me to consider pharmacological data as a reliable surrogate metric of emic efficacy. Since I am interested in how Tzeltal perceptions of efficacy affect knowledge distribution, mostly irrelevant of biomedical correspondences, it appeared prudent to derive a direct method for ranking emic perceptions of efficacy.

To develop an emic ranking of efficacy I elicited brief descriptions of the 19 most common illnesses from 11 adults (six women and five men) in Nabil by asking if they knew about the illness (*Ya bal a'na* ____?) and how the illness begins (*Bit'il ya xlijk* ____?). These questions proved reliable for producing brief descriptions of the illnesses. After each brief description I asked interviewees to tell me what was the best plant for treating the illness (*Binti lek slekilal wamal swenta poxil* _____?). Then, I asked them what was the most powerful plant (*Binti wamalil lom tulan yip ya xutsub yu'un*?). If interviewees cited a different plant, I asked which of the two was the best for treating the illness (*Bit'il ja' mero poxil swenta* ___?). I ranked each plant species according to the number of times it was cited as the most effective treatment for any of the illness categories.

Efficacy and knowledge distribution

Results of this exercise showed that some plants were more likely to be considered efficacious (Table 4.2). For example, 11 interviewees claimed that *Verbena litoralis* was the most effective cure for common diarrhea (*ja' ch'ujt*) and one claimed it was best for epigastric pain (*koliko*). Seven interviewees claimed that *Rhus terebinthifolia* was the best plant for treating oral thrush (*chin yej alal*). Therefore, *Verbena litoralis* was ranked first and *Rhus terebinthifolia* second. At the opposite extreme, *Mentha citrata* was never mentioned as the most effective treatment for any illness.

I derived rankings for the distribution of knowledge from interviews with 28 adults (14 men and 14 women) from Nabil using mounted specimens of the 130 species that were known by at least two people as medicinal plants (see Chapter 2, Methods). I divided the

Table 4.2. Rankings of efficacy and distribution of knowledge of medicinal use for the 34 most commonly known medicinal plants in Nabil.

Tzeltal name	Botanical species	Emic rank of efficacy	Rank of knowledge about use
yakan k'ulub	*Verbena litoralis*	1	1
paj 'ul 'ul	*Rhus terebinthifolia*	2	10
sera te'	*Myrica cerifera*	3	16
tujkulum ch'ix	*Solanum lanceifolium*	4	12
pajchak	*Psidium guineense*	5	22
ch'a bakal	*Salvia lavanduloides*	6	5
tujt	*Equisetum myriochaetum*	7	17
ijk' al ok tzib	*Adiantum andicola*	8	20
mes te'	*Baccharis vaccinioides*	9	3
bankilal	*Nicotiana tabacum*	10	13
ajate'es	*Gaultheria odorata*	11	15
k'ajk'an	*Chenopodium ambrosioides*	12	27
jijte'	*Quercus* sp.	13	24
kampana nichim	*Brugmansia candida*	14	9
tzajal nich wamal	*Oenothera rosea*	15	23
inojo	*Foeniculum vulgare*	16	2
poxil majben	*Sedum praealtum*	17	6
sávila	*Aloe vulgaris*	18	11
we'el buluk' sit	*Borreria laevis*	19	29
sakil nich wamal	*Erigeron karwinskianus*	20	4
ch'aj kojtom	*Pinaropappus spathulatus*	21	32
chijil te'	*Sambucus mexicana*	22	8
chicle wamal	*Satureja brownei*	23	7
sak ji	*Cornus disciflora*	24	28
taj	*Pinus* sp.	25	25
yak' tz'i' wamal	*Rumex obtusifolius*	26	26
manzanilla	*Matricaria recutita*	27	14
ch'aj te'	*Ageratina ligustrina*	28	33
nuk balil jonon	*Prunella vulgaris*	29	30
tziltzil 'ujch'	*Litsea glaucescens*	30	21
nujkupat	*Cupressus lusitanica*	31	31
turezna	*Prunus persica*	32	18
tzemen	*Epidendrum radicans*	33	34
wena	*Mentha citrata*	34	19

number of people who cited a medicinal use for each species (regardless of which illness) by the number of interviewees who were shown the specimen to obtain a proportion of interviewees who knew the plant as a medicinal. The plants were then ranked according to these proportions (Table 4.2).

I used Spearman ranked correlation analysis (Zar 1996:389) to determine that rankings of perceptions of efficacy were correlated with knowledge distribution ($r_s = 0.49$, n = 34, $P = 0.003$). In other words, a plant is more likely to be known throughout the community if it is believed to be a very effective treatment for one or more illnesses. Although there were some plants that only a few people knew about, but those few people strongly agreed about the efficacy of these plants (e.g., *Psidium guineense* in Table 4.2), it was *more* likely that plants that are considered highly efficacious will be well known throughout the population (e.g., *Salvia lavanduloides*).

As I will show in the following chapters, the process by which a plant becomes widely known as a medicinal is very complex, and is influenced by plant qualities (such as taste, morphology, and perceived 'hot' versus 'cold' properties), individual cognition (including processes of categorization and shared models of curing), social factors (such as communication networks and the perceptions of speaker legitimacy), and factors that constrain cultural transmission (such as time and illness prevalence). Amidst this complexity it becomes apparent that no other variable is as important for recall, acquisition, and dissemination of knowledge as the perception that the plant in question is effective at altering a culturally-recognized deleterious symptom. This, I believe, is why it is strongly correlated with knowledge distribution.

But the importance of perceived efficacy in knowledge distribution raises another critical issue. If people are acquiring and disseminating information about the most effective treatments, why are there culturally recognized illnesses, some of which are quite serious, for which there are no known treatments in Nabil and the Frontier communities (see Chapter 2)?

Once, while I was conducting an illness census in Nabil, a father brought his eight year old son to the front gate and showed me a ruptured boil behind the boy's ear. He asked me if I knew of a treatment for *chakal* 'boils.' It occurred to me that I had not heard of many treatments for dermatological illnesses during interviews. A review of my data confirmed that during freelists, plant interviews, and trail interviews very few people had reported any treatments for boils (*chakal*), rashes or blisters (*chin*), warts (*ch'ojk*), scabies (*sakal chin, sal*), or acne (*wajba*)(Appendix B). This is remarkable given that other researchers have documented extensive knowledge about dermatological treatments in Tenejapa (Berlin et al. 1990; Stepp 1998; Maffi 1994). My observations indicated that all of these illnesses were prevalent in Nabil. Acne is very common (and as much of a source of anxiety for Tzeltal youth as Americans). And the boil behind the boy's ear would have soon been infected if untreated. Why would these people not know about potential treatments for these illnesses given that such treatments are known by other Tzeltal outside of their community?

I found a similar pattern while replicating research among Tzeltal who have migrated to frontier communities in the tropical Lowlands. Almost no one in the frontier communities was able to cite a treatment for toothaches or *xiwel* 'fright.' Also, there were considerably fewer reports of treatments for respiratory illnesses, such as influenzas (*simal*), common colds, and respiratory infections (*obal*) in Maravilla Tenejapa and Salto de Agua (Appendix C). Both clinical data (Chapter 3) and my illness censuses (Chapter 7) showed that dental and respiratory illnesses were as important in the tropical Lowlands as in the Highlands where I (and others) found extensive respiratory and dental pharmacopoeia.

In another example, almost every woman I interviewed in Maravilla Tenejapa and Salto de Agua was familiar with the use of *Zingiber officinale* for treating infertility and *Hyptis verticillata* for inducing labor, and almost everyone knew several treatments for topical wounds. Information regarding treatments of these illnesses was poorly distributed in Nabil.

People in all of these communities are interested in learning these “missing” treatments. Indeed, they asked me for information, consulted with friends and neighbors, inquired at markets and health clinics, and even participated in herbal courses and workshops in attempts to acquire such information. So how might this “missing” knowledge be explained? There are at least five potential explanations: 1) plants that might be emically-defined as efficacious treatments for these illnesses don’t occur in the communities; 2) information about these treatments never enters the community; 3) information does enter, but shared explanatory models of curing function to bias knowledge acquisition away from new information that doesn’t fit preconceived models; 4) there is a limit to the quantity of information that can exist in any pre-literate population, and in these cases the limit is less than that which is needed to include treatments for all illnesses; and 5) various social and epidemiological patterns and processes constrain the cultural transmission of some types of information (e.g., some illnesses occur infrequently and/or people who know the appropriate treatments are not “well connected”). I deal with these last three potential explanations in later chapters. Here, I briefly show why the first two explanations are unlikely. This is crucial because it shows that although perception of efficacy is important in the acquisition and distribution of knowledge, it can not explain all of the patterns I have documented in this study.

To begin with, I am suggesting that plants that could be emically defined as efficacious for these untreated illnesses *do* exist in Nabil and Maravilla Tenejapa, and that in some cases a few people know about them. The basic assumption for this argument is that people in neighboring communities share emic definitions of efficacy. In particular, they share the notion that some plant-based treatment alters illness symptoms to which the same linguistic labels are applied. If a plant is well known as a treatment for a specific illness in the other communities, then it would probably fit cultural definitions of efficacy in Nabil. I draw on data published by Stepp (1998), Berlin et al. (1990), Berlin and Berlin (1996), as well as unpublished data of the Berlin and Berlin PROCOMITH study, and my own plant interview data from the communities of Ch'ixaltontik and Tenejapa Center, which border Nabil to the north and south, to make the point that there are several plants that grow in Nabil that are known in the surrounding communities as effective treatments, but this information is "missing" from Nabil. In some cases a few people in Nabil know these treatments (i.e., the information does exist within the community), but this information has not been disseminated.

Some treatments for dermatological conditions like scabies, rashes and various sized pustules (*sakal chin, muk'ul chin, ch'ujch'ul chin*) that are known throughout Tenejapa, including the communities that border Nabil, are *Tagetes lucida* (*tzitz ak'*), *Lopezia racemosa* (*tzajal nich wamal*), *Rapanea juergensenii* (*tzajal atz'am te'*), *Oreopanax xalapensis* (*wajtan chuch*), *Conyza canadensis* (*chi'ub*), which is also known as a treatment for acne (*wajba*), and *Rumex crispus* (*yak' tz'i' wamal*), which is also known to cure mange (*sal*). Widely known treatments for boils (*chakal*) include *Oreopanax xalapensis*, *Prunella vulgaris* (*nuk'balil jonon wamal*), and *Rumex obtusifolius* (*yak' tz'i' wamal*).

Vegetation surveys that I conducted (Chapter 7) indicated that all of these species were very common in Nabil, with the exception of *Tagetes lucida*, which was present, but not common. Most adult interviewees in Nabil (>70%) were able to name these plants, describe their habitats, and some cited medicinal uses for them. For example, *Prunella vulgaris* was known as a medicinal treatment for headache (*k'ux jolol*), fever (*k'ajk*) and 'second hair' (*cha'lam tsots*). *Tagetes lucida* was known by several interviewees as a pleasant tasting condiment that is added to coffee. One person used it for treating headaches and another for depression. But these plants were never cited by interviewees for treating dermatological conditions. *Rapanea juergensenii* and *Oreopanax xalapensis* were never cited by interviewees in Nabil for any medicinal use.

On the other hand, *Lopezia racemosa* was known by one interviewee in Nabil for treating boils. *Rumex crispus*, *Rumex obtusifolius* and *Conyza canadensis* were known by one interviewee each for treating scabies. Two interviewees told me that *Conyza canadensis* could be used to treat acne, including one older man who claimed that this knowledge dated back at least as far as his youth. This shows that at least a few people in Nabil knew about some plants that are considered to be efficacious dermatological treatments outside of the community, but this information is not widely distributed. In other words, even though 1) some plants in Nabil probably conform to emic perceptions of efficacy, 2) people are interested in learning about these treatments, and 3) the information exists on a limited basis in the community, knowledge about these plants has not become widely disseminated.

In Chapters 8 and 9 I will elucidate some of the cognitive, epidemiological, social, and cultural transmission patterns that help explain this finding. The main point I want to make here is that plants that are perceived from an emic standpoint as more efficacious are more likely to be known throughout the community, but that this pattern only applies to a subset of all the potential plants that could be known to treat the various illnesses. In other words, the fact that more efficacious plants are more likely to be known does not ensure that *all* plants that grow in the local environment that might conform well to emically-defined notions of efficacy will be known.

Conclusion

The correlation between emic perceptions of efficacy and knowledge about medicinal plants in Nabil suggests that emic perceptions of efficacy are contributing to the distribution of knowledge. In Chapter 8 I will show that efficacy supersedes all other concepts during recall, categorization, and discourse. Whether or not a plant alters a linguistically-recognized symptom is the primary criterion for inclusion in the semantic category "medicinal plants." Furthermore, how well a plant performs for altering symptoms is a major theme in discourse and shared cognitive models. By explicating the role of efficacy in cognition and cultural transmission, I hope to provide the necessary concepts for explaining the processes responsible for the correlation between perceptions of efficacy and knowledge distribution. In other words, I will explain the processes through which perception of efficacy comes to account for much of the shape of the curves in Figures 2.1 and 2.2.

But efficacy alone does not provide a complete explanation. There are pronounced exceptions to the overall pattern of correlation. In particular, some plants are poorly known (i.e., they are located in the asymptotic tail of the curve) even though they probably fit perceptions of efficacy. Most notable are the lack of knowledge about dermatological and reproductive treatments in Nabil and the poor distribution of knowledge about dental and respiratory medicinals in Maravilla Tenejapa.

My two observations that there are plants in these communities that are known to be efficacious by people outside the communities and that a few people inside Nabil know about these plants rule out the two possible explanations that either there are no efficacious plants or that knowledge has failed to enter the communities. Other possible explanations that I mention above and will address in following chapters are that there is a limit to the quantity of information that can be maintained in a pre-literate population that lacks specialists, widely shared explanatory models bias knowledge acquisition away from new information that doesn't fit the models, and various social and epidemiological patterns and processes constrain the cultural transmission of information in both structured and random ways.

In the next chapter I deal with cultural perceptions of plant characteristics, in particular taste and morphology. These concepts clearly influence Tzeltal thought about medicinal plants, but they do not appear to be as important in the acquisition and dissemination of knowledge as perceptions of efficacy.

Chapter 5
Salient Plant Characteristics and Medicinal Plant Knowledge

Introduction

While I was accompanying a family from the tropical frontier on a visit to their former Highland community, we went for a walk to look at the cold-country plants. I picked a small herb that I thought I recognized from the tropical Lowlands—an Euphorbiaceae with copious milky sap—and showed it to the group. They responded: "*Ma ba ja. Ma xch'i ta k'ixin kinal*," 'that's not it, that doesn't grow in hot country.' But the teenage boy, who had never seen it before, was quick to point out: "*Niwan ya xpoxta ejchin. Ay bayel spojowil*," 'perhaps it cures cuts and wounds since it has lot's of white sap.' There are many plants with white latex in the tropics and some are used by migrant Tzeltal of the frontier to treat cuts and topical infections. As the boy's statement illustrates, people appear to associate this salient characteristic with treating wounds, even when dealing with unfamiliar plants.

Even more pronounced is the effect of some plant tastes—in particular bitterness and astringency. When I asked interviewees why a particular plant cures diarrhea, a common response was: "*yu'un sbutz' lom ch'a*," 'because it's very bitter.' Don Augustin, who migrated from Nabil to Maravilla Tenejapa, told me this story:

<u>Excerpt 5.1 (from Frontera Interview 34)</u>

> <u>Subject:</u> Estaba muy enfermo mi hermano mayor, alla en Tenejapa. Tiene tuberculosis dicen. Va morirse dicen. Pero, empezó tomar todo amargo. Ch'a. Antes de medecina de los doctores. Hace mucho tiempo. Tuvimos puru plantas para curar. Puru plantas. Tomó mi hermano todo las plantas amarga que sabia. Casacara de manzana, raiz de mayil, sera te'. Tomó todo cada dia. Poco a poco se calmó la toz. Despues de un año no hubo toz. Mayuk obal. Despues de tres años se sanó completamente. Dicen mucha gente que hubo brujo. Pero no hubo, porque lo curan las plantas. Nunca fue a brujo. Dicen la gente que las plantas amargas tienen mucha fuerza.

> My older brother was very sick. Back in Tenejapa. He had tuberculosis, they say. They said he was going to die. But he decided to drink anything bitter as medicine. This was before there was medicine from doctors, back when there were only plants for curing. All plants. My brother drank a mixture of all the bitter plants he knew. Apple bark, squash roots, *Myrica cerifera* . . . He drank it every day. Slowly the cough began to abate. By the end of a year the cough was gone. No cough. By the end of the third year he was totally cured. Some people said it was witchcraft. But it wasn't, because the plants cured it. He never went to a shaman. Bitter plants have a lot of power, they say.

This narrative illustrates the potential importance of taste for thinking about medicinal plants and transmitting knowledge. And, while bitterness is often associated with gastrointestinal illnesses, its "power" can be used to treat other types of illnesses as well.

In this chapter I focus on how characteristics of plants, in particular flavors and salient visual stimuli, influence the way the Tzeltal think about medicinal plants, and whether this can explain why the Tzeltal of Nabil and Maravilla Tenejapa know the plants that they do as medicinals. The fundamental assumption is that if cultural interpretations of observations of illness symptoms and plant characteristics contribute to the empirical system (Brett 1994), then these interpretations should be reflected in the resulting patterns of knowledge about plants. In particular, plants that have characteristics that conform to shared explanatory models should be more widely accepted and therefore known by more people (Figures 2.1 and 2.2).

Salient morphological characteristics

People often interpret morphological plant characteristics as possible suggestions for medicinal utility—a process commonly referred to as the "doctrine of signatures" (Johns 1990:280). Examples from a variety of language groups include using yellow extracts to treat jaundice, phallic shaped plants as aphrodisiacs, plants with red sap for blood disorders, navel-shaped flowers for navel pain, spiny plants for "sharp" pains, pink leaves for "pink eye," and plants with watery latex for watery diarrhea (Ankli et al. 1999a; Etkin 1988a;

Shepard 1999). Brett (1994:162) reported a minor influence of the doctrine of signatures in medicinal plant selection by more knowledgable Tzeltal in Cancuc. I never found any evidence of it among the novice population in Nabil, even though I made intensive efforts to elicit such explanatory concepts during interviews, surveys in the field, and participation in curing events.

Tzeltal who have migrated from Tenejapa to the frontier community Maravilla Tenejapa associate white latex with treating wounds. It is easy to notice that the latex of several tropical species slowly hardens after bleeding from cut bark. It is possible that this has been metaphorically extended to the healing and scarring process in human tissue. But this was never mentioned to me despite repeated attempts to elicit such explanatory concepts during interviews.

In short, while the doctrine of signatures may have primary importance in other ethnomedical systems, like that of the Amazonian Yabashta (Shepard 1999), it appears to have little or no influence on the Tzeltal population that I studied.

Taste and medicinal plants

The way plants taste, especially if bitter, may serve as a guide to potential pharmacological phytochemicals (Brett 1994; Johns 1990). Many chemical compounds found in plants evolved as defense mechanisms against predatory organisms, such as herbivorous insects and mammals, fungi, and other pathogens (Harborne 1991). Many animals have evolved mechanisms for detecting these allelochemicals, such as the ability for humans to taste toxins in plants (Johns 1990). Some researchers believe that taste, combined with cognitive and cultural mechanisms to overcome aversions to bad tastes, allow humans to optimize the amount of allelochemicals they ingest in order to combat parasites without poisoning themselves (Johns 1990). This argument is supported by evolutionary evidence ranging from monarch butterflies eating milkweed to ingest cardiac glycosides as a defense against predatory birds (Harborne 1993) to wild chimpanzees eating bitter and toxic plants during times of high intestinal parasite loads (Huffman et al. 1996).

Further support for the role of taste in medicinal plant selection comes from the observation that species of Asteraceae tend to be represented in traditional pharmacopoeia in proportions higher than would be predicted by the number of Asteraceae species found in local environments (Moerman et al. 1999). People may be more likely to experiment with Asteraceae because those species are more likely to contain bitter phytochemicals. For example, the Asteraceae are believed to contain over 2000 types of sesquiterpene lactones, all of which are bitter and many of which induce physiological responses or are otherwise toxic (Bruneton 1995; Rodrigues et al. 1976).

The Tzeltal Maya of Highland Chiapas use many bitter plants as medicinals (Berlin and Berlin 1996: 452) and "favor" Asteraceae species (Moerman et al. 1999). Furthermore, many Tzeltal Maya cite bitterness as the reason that some plants have the power to cure (Berlin and Berlin 1996:450).

The Tzeltal have a comprehensive lexicon for describing the sensations caused by tasting or ingesting plants (Table 5.1).[1] Brett (1994:153) and Berlin and Berlin (1996:450) have shown that certain tastes tend to be affiliated with particular illness categories. For example, a large proportion of the bitter plants in the pharmacopoeia tend to be used for gastrointestinal or respiratory illnesses, astringent plants for eye or mouth infections, and sweet and sour plants for respiratory ailments. Similar observations by other researchers have led them to claim that systematic cultural interpretations of taste and smell guide medicinal plant selection within illness categories. These include Heinrich et al. (1992) for the Mixe and Frei et al. (1998) for the Zapotec of Oaxaca, Mexico, Weimann and Heinrich (1998) for the Nahua of Veracrus, Mexico, and Gollin (2001) for the Kenyah of Borneo, among others.

Table 5.1. Some Tzeltal terms describing plant characteristics.

Tzeltal term	English gloss
bilil	slippery, mucilagenous
buts'an	pleasant
ch'a	bitter
chi'	sweet
chi' pik pik	salty
kojol	acrid, burnt
lek	good, not averse taste
paj	sour
sik	cooling
sup	astringent
xin	sulfurous
sakil spojowil	white latex
tsajal spojowil	red sap
ya	pungent

Brett (1994:159) has suggested that different tastes serve as cognitive cues for the Tzeltal to identify phytochemicals that are appropriate for treating particular categories of illnesses. He proposed that observations of physiological response after ingestion, cultural interpretations of illness events, and sharing of information may result in a tendency for the Highland Maya to focus on bitter plants when searching for new cures for GI illnesses, sour or sweet plants for respiratory ailments, and astringent plants for dermatological illnesses.

I observed these types of patterns in the communities where I conducted research, and therefore was interested in testing whether taste has influenced the acquisition and dissemination of medicinal plant knowledge among the Tzeltal of Nabil and Maravilla Tenejapa—either through learning, cultural transmission, or individual recall of appropriate medicinal applications.

My first goal was to verify that the medicinal plants known by the novice populations in Nabil and Maravilla Tenejapa conform to the pattern of illnesses being affiliated with particular plant tastes. I analyzed plant interview data from the high-elevation Tzeltal community Nabil (2100 m) and the tropical migrant Tzeltal community Maravilla Tenejapa (400 m). I also compared my findings with Brett's findings from the mid-elevation Tzeltal community of Cancuc (1400 m) to determine the importance and resiliency of these patterns given different flora. For example, does the association of bitterness with diarrhea treatments hold for people living in areas with different plants? Have the Tzeltal who migrated to the tropical frontier replicated the taste-illness affiliations using a new flora? I wanted to determine whether taste-based models guided knowledge acquisition, or alternatively, whether the local flora and information obtained from outside the communities have guided the taste-based models.

My second goal was to analyze these processes at the finer scale of individual human cognition to better understand whether the observed taste-illness affiliations might result from a direct cognitive association of tastes with illnesses or whether the identity of a plant is needed to cognize the curing model, and taste is only a secondary association. The key was to isolate taste as a variable by conducting taste experiments with prepared remedies for which participants did not know the identity of the plants.

The third goal was to determine if taste intensity is a predominant theme contributing to the acquisition and dissemination of medicinal plant knowledge amongst the novice population. Is the pharmacopoeia biased toward plants that have strong and disagreeable tastes? I used structured interview data to test the prediction that the probability of a plant species being known as a medicinal throughout the population will increase with the strength of its averse taste.

In summary, I am asking four specific questions in this chapter: 1) are illness categories affiliated with specific taste categories by the novice populations in Nabil and Maravilla Tenejapa; 2) are the plant character-illness affiliations the same in the different communities; 3) are these relationships based primarily on tastes or primarily on particular plants, and taste is a *post hoc* correlation; and 4) do any of these patterns mean that plants with more averse tastes are more likely to be known throughout the population?

Correlation of tastes with specific Tzeltal illness categories

In this first analysis I tested the prediction that taste categories recognized in medicinal plants by the Tzeltal will be affiliated with particular illness categories.[2] The data are from structured ethnobotanical interviews with 28 adults from the Highland community of Nabil using mounted specimens of 130 species, and 18 adults from the migrant community of Maravilla Tenejapa using 116 specimens (see Chapter 2, Methods). For each plant, I asked if the plant cured any illness (*Ay bal chamelil ya xpoxta ja' ini*?), I prompted respondents for additional illnesses until they could think of no more (*Ay bal yan chamelil ya xpoxta*?), and asked if the plant had any taste (*Bi ya'el sbuts'*?). I used chi-square goodness of fit (Zar 1996:458) to test whether any taste categories were overrepresented or under-represented within each illness category as compared to what would be predicted (expected) by the overall distribution of tastes within the pharmacopoeia. Thus, I computed chi-square values based on the distribution of responses within taste categories for all illnesses combined (expected distribution) and the distribution within taste categories for each individual illness category (observed distribution).

Non-structured interviews and conversations in the tropical frontier community Maravilla Tenejapa prior to these structured interviews indicated that three morphological features (white latex, red sap and white powder) were also influencing individual models of illness curing. I included these characteristics in the Maravilla Tenejapa interviews. Morphological characters were never mentioned in Nabil, and therefore are not included in that analysis.

Chi-square values show that the distribution of taste categories deviated significantly from the distribution in the overall pharmacopoeia for every illness category in the temperate Highland community of Nabil (Table 5.2). Clearly, some tastes are affiliated more with certain illnesses. The strongest deviation (shown to the left of Table 5.2) as expressed by chi-square values is for oral thrush, which is highly biased toward astringent-tasting (*sup*) plant species. As predicted by Brett (1994:152), diarrhea treatments were over-represented by bitter plants.

Table 5.2. Proportion of responses for taste characteristics of plants used to treat the major illness categories in Nabil, and chi-square deviations from the overall (expected) distribution.

Taste	All illness categories combined	oral thrush	burns	wounds	epigastric pain	fever	abdominal pain	diarrheas	dermato-logical	dental	aches & pains	coughs
bitter	0.34	0.12	0.05	0.14	0.10	0.18	0.31	0.65	0.26	0.29	0.17	0.55
bitter/astringent	0.02	0.06	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.00	0.05	0.01
astringent	0.16	0.67	0.05	0.00	0.00	0.09	0.07	0.10	0.11	0.37	0.12	0.19
sour	0.01	0.12	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00
pungent	0.04	0.00	0.00	0.00	0.00	0.00	0.15	0.03	0.00	0.06	0.10	0.04
pleasant or sweet	0.20	0.03	0.05	0.09	0.46	0.30	0.35	0.12	0.05	0.11	0.21	0.15
cold	0.04	0.00	0.09	0.18	0.02	0.15	0.00	0.04	0.05	0.06	0.05	0.02
sulfurous	0.03	0.00	0.14	0.00	0.00	0.03	0.02	0.00	0.05	0.03	0.10	0.01
tasteless	0.10	0.00	0.41	0.32	0.06	0.09	0.00	0.05	0.21	0.06	0.14	0.01
don't know	0.05	0.00	0.23	0.27	0.00	0.12	0.02	0.00	0.00	0.03	0.07	0.02
Total responses	125	33	22	22	48	33	54	105	21	35	42	176
Chi-square value		344.37	258.54	233.54	83.83	66.32	58.55	46.06	42.42	40.23	39.73	30.15
Significance		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dominant taste	bitter	astringent	no taste	no taste cold	pleasant	pleasant cold	pungent pleasant	bitter	no taste	astringent	pleasant bitter no taste	bitter

Table 5.3. Proportion of responses for taste and morphological characteristics of plants used to treat the major illness categories in Maravilla Tenejapa, and chi-square deviations from the overall (expected) distribution.

Characteristic	All illness categories combined	oral thrush	epigastric pain	dental	burns	abdominal pain	aches & pains	fever	diarrheas	wounds	dermatological	coughs
bitter	0.24	0.08	0.03	0.06	0.00	0.21	0.14	0.14	0.57	0.10	0.16	0.19
bitter/astringent	0.02	0.08	0.00	0.06	0.00	0.00	0.02	0.00	0.04	0.00	0.00	0.02
astringent	0.16	0.79	0.03	0.33	0.08	0.08	0.06	0.06	0.26	0.16	0.09	0.11
sour	0.07	0.04	0.03	0.00	0.08	0.01	0.05	0.21	0.04	0.00	0.05	0.07
pungent	0.07	0.00	0.00	0.39	0.00	0.37	0.11	0.02	0.00	0.02	0.00	0.08
pleasant	0.22	0.00	0.77	0.06	0.23	0.23	0.19	0.39	0.04	0.11	0.09	0.32
cold	0.02	0.00	0.00	0.00	0.15	0.03	0.05	0.02	0.00	0.00	0.00	0.06
sulfurous	0.01	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.02	0.02	0.00
acrid	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00
tasteless	0.10	0.00	0.10	0.06	0.38	0.04	0.20	0.13	0.00	0.18	0.12	0.13
red sap	0.00	0.00	0.05	0.00	0.00	0.03	0.00	0.00	0.01	0.02	0.00	0.00
white sap	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.28	0.26	0.00
white powder	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.00
don't know	0.04	0.00	0.00	0.06	0.08	0.00	0.11	0.04	0.02	0.08	0.05	0.02
Total responses	875	25	51	19	13	86	77	109	225	63	51	156
Chi-square value		329.40	252.89	188.01	177.40	159.59	76.55	60.59	45.92	39.50	25.76	17.02
Significance		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	0.20
Dominant Characteristic	bitter pleasant	astringent	pleasant	pungent astringent	tasteless	pungent pleasant	none	pleasant sour	bitter astringent	white sap	white sap	pleasant bitter

Distributions of taste and morphological characters were also biased in most illness categories in the tropical frontier community Maravilla Tenejapa (Table 5.3). Again, the strongest deviation from the expected resulted from the affiliation of astringent plants with oral thrush. And again, diarrhea treatments were more likely to be bitter. But note that respiratory treatments were not likely to be bitter as they were in Nabil. Indeed, respiratory treatments in Maravilla Tenejapa show no affiliation with any particular taste (chi-square = 17.02, df = 13, $P = 0.20$). Another difference between the communities is that dental treatments in Maravilla Tenejapa are likely to be pungent as well as astringent, whereas they are mostly astringent in Nabil.

Most of the similarities between patterns in the two communities can be explained by the fact that most responses within illness categories were limited to a few plant species, and there was high agreement about the tastes of those species. In some cases it was the same species in both communities. For example, *Verbena litoralis* is very bitter and represented 32% of the treatments reported for diarrhea in Nabil. The remaining responses were spread over several other plants (some not bitter) and no other plant accounted for more than 11%. *Verbena litoralis* also grows in the tropical Lowlands, and combined with another bitter-tasting species *Neurolaena lobata*, it accounted for 48% of the reported treatments for diarrhea in Maravilla Tenejapa. Although *Neurolaena lobata* does not grow in Nabil, it is common in other lower-elevation communities in Tenejapa and is well known as a treatment for diarrhea. Thus, the affiliation of bitterness with diarrhea in the new community is largely due to the availability of the same plants already known from the Highlands. In other words bitter taste has not necessarily guided experimentation and learning for diarrhea treatments in the new environment.

The same pattern applies for some of the other illness categories. Reported treatments for abdominal distension and bloating (*pumel*) rely almost exclusively on the very pungent *Nicotiana tabacum* in both communities. Treatments for epigastric pain and burning (*koliko*) rely almost exclusively on the pleasant-tasting *Foeniculum vulgare* in both communities. The gelatinous sap of *Aloe vulgaris*, which has no taste, dominates treatments for burns in both communities. Cures for aches and pains (*ik'*) are not affiliated with any taste in either community.

Oral thrush (*chin yej alal*) is most strongly affiliated with astringent-tasting (*sup*) plants in Nabil because the astringent inner bark and shoots of *Rhus terebinthifolia* accounted for 65% of reported treatments in Nabil. The astringent inner bark of another species, *Psidium guajava*, accounted for another 21%. Oral thrush is also strongly affiliated with astringency in Maravilla Tenejapa (Table 5.3). However, it is almost exclusively (86%) the highly astringent sap of the banana flower (*Musa* spp.) that accounts for this pattern in the tropical community. *Rhus terebinthifolia* does not grow in the tropics, but *Psidium guajava* is abundant in Maravilla Tenejapa. I believe that the sap of banana flowers is preferred because it is easily collected during the daily process of harvesting bananas and applied raw directly to the affected child's mouth. The bark of *Psidium guajava* must be removed from the tree (possibly damaging its edible fruit-bearing potential) and boiled in order to obtain the astringent treatment.

I turn now to two important differences between the two communities regarding affiliations of plant characteristics with illnesses. First, treatments for wounds and dermatological conditions in Maravilla Tenejapa include a higher proportion (28% and 26% respectively) of plants that exude a white latex than the overall pharmacopoeia. These are mostly represented by species of *Ficus*, but also *Asclepias curassavica*, *Euphorbia hirta* and *Calophyllum brasiliense*. All but *A. curassavica* are tropical species and do not occur in Nabil. There are other latex producing species in Nabil (e.g., *A. curassavica* and *Lobelia laxiflora*), but these plants were never identified as medicinals by Nabil residents.

Perhaps the most important difference between the two communities is that although bitterness is affiliated with cough treatments in Nabil, it is not in Maravilla Tenejapa. I will argue that this is evidence that cultural conceptions of taste do not guide acceptance of treatments, but rather are *post hoc* explanations based on plants that are widely believed to be effective. This notion is based on the observation made by Ankli et al. (1999a) that medicinal plants of the Yucatec Maya were no more likely to be bitter than non-medicinal plants, which led them to contradict the proposition that “a plant was a medicine *because* it had a certain taste or smell property,” and claim instead “often that the plant was used for a certain illness *and* it was bitter, astringent, or aromatic” (p. 562; emphasis in original).

Brett (1994: 151-153) also found bitter plants to be associated with respiratory illnesses in the Highland Tzeltal community of Cancuc, although his data did not show as strong an affiliation as mine. This is mostly because the extremely bitter plant *Salvia lavanduloides* is one of the most important respiratory treatments found in the high-elevation communities like Nabil, Matsab, and Tenejapa center, but *Salvia lavanduloides* does not grow in lower-elevation communities like Cancuc.

None of the other bitter respiratory treatments documented by Brett or I (e.g., *Baccharis vaccinioides, Cornus disciflora, Erigeron karwinskianus*) occur amongst the tropical flora of Maravilla Tenejapa. Why haven’t the people of Maravilla Tenejapa adopted new bitter treatments for respiratory illness? I don’t think this is because there are no potential bitter cough treatments. *Tithonia diversifolia, Verbesina turbacensis,* and *Struthanthus quercicola* are bitter plants with reputations for curing respiratory illnesses in Highland Tzeltal communities. These plants also grow in Maravilla Tenejapa, but are not known there as treatments for respiratory illnesses.

Brett found that, in addition to bitter plants, sour and sweet plants were strongly affiliated with respiratory illnesses in Cancuc. But respiratory illnesses are not affiliated with any particular plant characteristic by residents of Maravilla Tenejapa. Indeed, sourness is affiliated more strongly with fevers in Maravilla Tenejapa (mostly represented by *Citrus limon* and *Begonia heracleifolia*)—a trend not documented by either Brett or myself in the Highlands. This indicates that neither sourness, sweetness, nor bitterness have guided acceptance of respiratory treatments in Maravilla Tenejapa.

I should point out that several residents of Maravilla Tenejapa, including the four older men and women from Nabil, remembered *Salvia lavanduloides* as a powerful, bitter, respiratory treatment, indicating that this information has not been forgotten. But neither does it continue to guide conceptions about curing respiratory illnesses. These people did not affiliate bitterness with respiratory illness treatments. They have learned a few new respiratory treatments—few or none of which are bitter—and have simply adopted new explanatory models, or they have no taste-based model at all.

Comparing Brett's results from Cancuc with my results from Nabil and Maravilla Tenejapa (three somewhat different floras, but all Tzeltal speakers) it appears that either the same plants are used for some illnesses or new treatments have been found for other illnesses that do not necessarily conform to Highland explanatory models based on plant characteristics.

Brett (1994:153) proposed that "it may well be the underlying chemical sensation that determines plant use, rather than the fact that it is taxon x, y, or z." This may be the case for expert healers in Cancuc. But I will show throughout this dissertation that the novices of this study are learning about plants from a variety of sources (Chapter 9), that other factors (including social pressure) may take precedence over individual explanatory models for accepting a plant as a cure (Chapter 8), and that many plants are widely known and used that do not conform to dominant taste-based models (this chapter, below). I am arguing that folk taxa "x, y, or z" come to be accepted as efficacious cures *a priori*, and that salient characteristics of these commonly used plants come to dominate cognitive models of the curing process, but that these characteristics have only a limited influence on the acceptance or cultural transmission of other potential cures within the illness categories (Alcorn 1984:287; Ankli et al. 1999a).

The role of taste in individual cognition

How much of the patterns described above are directly a function of taste, and how much are mostly a function of knowing that a plant cures, but also knowing that the plant happens to have a certain taste? The goal of this next analysis was to isolate taste as a variable by preparing remedies from commonly used medicinal plants and having participants taste the remedies without knowing the identity of the source plant. This allowed me to determine if participants could predict the proper medicinal use of a plant based on its taste alone. I did this by preparing remedies using well-known medicinal plants and asked participants to taste the remedies and provide the correct medicinal use and name of the plant without knowing the identity of the plant beforehand. I also showed mounted specimens of the same plants afterwards and asked for names and uses in order to verify that the informants indeed knew the plants and their uses.

I selected nine plants from among those that were most frequently cited in freelists (Chapter 2) in Nabil and that also represented various tastes and illness classes (Table 5.4). For example, two of the nine were bitter species used primarily for treating diarrhea, while two bitter species were used to treat coughs or rheumatism as described by informants. Other plants were known to be astringent, sour, or pleasant tasting and were used for a variety of illnesses. I collected plant material to prepare remedies in the way that they are commonly prepared by the people of Nabil. This almost exclusively involves boiling either the bark, stems, or leaves of the plants. Lime (*Citrus limonia*) was included as a primer, and unflavored but colored water was included as a control with no taste.

Eight adult men and two women were interviewed individually in Tzeltal. Participants were asked to taste each of the preparations one at a time, and then were asked to provide a name for the taste, name of the source plant, and medicinal use. The tasting began with the lime-water preparation as a primer. This was followed by a pleasant, anise-tasting medicinal tea made from *Foeniculum vulgare*. The order of the remaining plants was

Table 5.4. Plant stimuli used in taste tests and the number of informants who cited each taste quality in Nabil.

Plant species	Tzeltal name	Taste	English gloss	Number citing taste
Citrus limonia ('lime')	*lima*	*paj*	sour	8
		lek	pleasant	2
Cornus disciflora	*sak ji*	*sup*	astringent	5
		ch'a	bitter	4
		unidentifiable		1
Eupatorium sp.	*ch'aj te'*	*ch'a*	bitter	10
Feoniculum vulgare	*inojo*	*lek*	pleasant	9
		ch'a	bitter	1
Gaultheria odorata	*ajate'es*	*sup*	astringent	6
		paj	sour	3
		lek	pleasant	1
Myrica cerifera	*ch'aj k'olol te'*	*ch'a*	bitter	8
		sup	astringent	2
Psidium guineense	*pajchak'*	*sup*	astringent	6
		ch'a ch'a tik	slightly bitter	3
		lek	pleasant	1
Quercus crassifolia	*jij te'*	*sup*	astringent	8
		ch'a	bitter	2
Salvia lavanduloides	*ch'a bakal*	*ch'a*	bitter	10
Verbena litoralis	*yakan k'ulub wamal*	*ch'a*	bitter	10
control	---	*ma'yuk*	no taste	8
		ch'a ch'a tik	slightly bitter	1
		chi' pik pik	salty	1

independently randomized for each interview to reduce potential bias of one taste masking the next. Participants were also given water, crackers, and sufficient time for tastes to subside between each tasting.

Consensus analysis (Romney et al. 1986) was performed using ANTHROPAC (Borgatti 1996a) to determine that participants agreed about the taste of the unknown remedy. I tested for correlations between the various tastes and each of the appropriate illness categories indicated by the results of the previous chi-square analysis. For example, I tested for correlation between each answer that a plant was bitter and that it was used to treat a gastrointestinal (GI) illness by treating taste as bitter/non-bitter and use as gastrointestinal/non-gastrointestinal binary (1/0) variables. I used the Pearson correlation coefficient (Zar 1996:372) to test for correlation. The same process was used to test for correlation between bitterness and respiratory illnesses, astringency and oral thrush, astringency and dental caries, and the pleasant taste of *Foeniculum vulgare* and epigastric pain, as suggested by the results of the previous analysis. It was not possible to test for fever, burns, and rheumatic pains because no particular tastes are associated with these illness categories (Table 5.2).

After the taste tests, participants were shown herbarium specimens individually and were asked to identify the Tzeltal plant name, taste, and medicinal use. Consensus analysis was used to verify participants' overall knowledge of medicinal plants, to determine the "culturally correct" name of each plant, and to determine the common-knowledge uses of each plant. This analysis showed high agreement about names, medicinal use, and expected taste (Table 5.5). These results from visual stimuli indicate that participants were generally knowledgeable about the plants and that plant names, medicinal uses, and taste terms are widely shared and culturally meaningful.

Table 5.5. Nabil medicinal plant taste experiment consensus analysis results.

	Visual stimuli		
	Plant names	Medicinal use	Expected taste
Agreement (ratio of 1st to 2nd Eigen value)	7.9	6.1	5.3
Average estimated knowledge of participants	0.71 (SD = 0.15)	0.51 (SD = 0.11)	0.47 (SD = 0.20)

	Taste stimuli		
	Plant names	Medicinal use	Reported taste
Agreement (ratio of 1st to 2nd Eigen value)	2.4	1.1	7.8
Average estimated knowledge of participants	0.08 (SD = 0.39)	0.10 (SD = 0.41)	0.76 (SD = 0.14)

Taste tests revealed high agreement about how remedies actually tasted (i.e., they generally used the same Tzeltal lexeme to describe the taste; Tables 5.4 and 5.5). Most responses about the medicinal uses of plants in Nabil involved the treatment of GI illnesses. However, responses from the taste tests show that bitterness was not significantly correlated with GI illnesses ($r = 0.18$, df = 90, $P > 0.10$) or respiratory illnesses ($r = 0.13$, df = 90, $P > 0.10$) when treated as individual variables. In other words, an individual who identified the taste of an unknown remedy as bitter was no more likely to say that the remedy was appropriate to treat a GI illness than respiratory. However, combining GI and respiratory does yield a significant correlation with bitterness ($r = 0.34$, df = 90, $P < 0.05$). This supports the observation discussed above in which the Tzeltal of Nabil associate both GI and respiratory illnesses with bitterness (Table 5.2).

Surprisingly, no correlation was found between astringency and oral thrush ($r = 0.14$, df = 90, $P > 0.10$). Also, no respondents offered dental caries as a potential treatable illness for astringent samples, thus precluding the ability to test for correlation. Most respondents (61%) simply could not provide any potentially treatable illness for the astringent samples. And finally, there was no correlation between the pleasant taste of *Foeniculum vulgare* and epigastric pain, despite this being one of the most widely known treatments in the region.

Medicinal uses of individual plants obtained by visual stimuli in Nabil were not correlated with the use obtained using taste stimuli ($r = 0.12$, df = 38, $P > 0.05$). In other words, although a plant may have been recognized as bitter, the participants could not distinguish which of the bitter plants it was, and thus could not guess correctly whether it was appropriate for a GI or respiratory treatment. For example, participants could not distinguish between bitter plants like *Verbena litoralis,* which they know as a treatment for diarrhea and not cough, and other bitter plants like *Salvia lavanduloides,* known to treat respiratory and not gastrointestinal illnesses.

In the cases of the other taste categories, respondents generally failed to remember appropriate illness treatment categories, even though they did recall uses when presented with visual stimuli. Thus, culturally meaningful categories of illness treatments could not be formed based on taste alone. These results clearly indicate that participants need to know the identity of the plant prior to forming meaningful ideas about how it is used. They also indicate that bitterness may play a more important role in Tzeltal cognition regarding medicinal plant use than the other taste categories.

The effects of plant taste on the distribution of medicinal plant knowledge

Interview data show general affiliations of selective plant characteristics with illness categories in Nabil and Maravilla Tenejapa. But closer scrutiny of these patterns and results of the taste experiments indicate that these effects may be more *post hoc* explanatory than they are "guiding principles." This suggests that the role of taste in the dissemination of medicinal plant knowledge and the eventual structure of the pharmacopoeia may be minimal. In particular, the strength of taste may not be correlated with the widespread distribution of knowledge. Since I am ultimately interested in why some plants are more widely known than others, I tested for correlation between ratings of taste strength and probability of being known as a medicinal in Nabil.

During the structured interviews using mounted specimens with 28 adults from Nabil I asked participants to rank the taste of each specimen according to the verbal scale shown in Table 5.6. This scale was then assigned numerical values. Scores were averaged for each plant over all of the interviews and then ranked by their average score. For example, most of the informants stated that *Pinaropappus spathulatus* was very bitter (*lom ch'a*), which resulted in it being ranked as having the strongest averse taste. *Mentha* sp. (mint) was the most pleasant tasting plant. The same plants were also ranked according to the proportion of interviewees who provided a medicinal use (Figure 2.1). Spearman ranked correlation was used to test for the correlation between the strength of taste and proportion of people who knew the medicinal use of each plant.

Table 5.6. Hedonic characters and values for ranking intensity of tastes.

Hedonic character	Rank value	Example of Tzeltal response	English gloss
Most offensive	3	*lom ch'a*	very bitter
Moderately offensive	2	*ch'a*	bitter
Slightly offensive	1	*ch'a ch'a tik*	somewhat bitter
No taste	0	*may'uk sbuts', lek*	no taste, goes down easy
Pleasant taste	-1	*buts'an*	pleasant
Very pleasing	-2	*lom buts'an*	delicious

I found no correlation between the strength of taste and proportion of people who knew the medicinal use for each plant (r_s = -0.14, n = 30, P = 0.41). In other words, just because a plant is known as a medicinal (by at least a few people) and has a very strong taste does not mean that it will be well known throughout the population. This includes very bitter (*lom ch'a*), very astringent (*lom sup*), very sour (*lom paj*), or very pungent (*lom ya*) plants.

These results suggest that although certain tastes are affiliated with certain illnesses, the intensity of averse taste does not account for the popularity of most treatments in the Nabil pharmacopoeia. There are several major issues involved with the explanation of these results. First, even within categories like the gastrointestinal and respiratory illnesses there are popular treatments that are not bitter. This is because not all pharmacologically active phytochemicals taste bad. For example, *Mentha* sp. (common mint) is widely known for relieving abdominal cramping associated with diarrhea both in Nabil and Maravilla Tenejapa. The free menthol and esters of menthol that occur in the pleasant-tasting volatile oil of mint tea have shown significant antispasmodic activity (Tyler et al. 1981:116-121). According to interviewees in Nabil they taste pleasant.

In a previous study I found that *Tagetes lucida* was well known in Tenejapa center as a pleasant-tasting remedy for diarrhea and abdominal pain (Casagrande 2000). Pharmacological studies indicate that *Tagetes lucida* contains compounds effective against a variety of intestinal parasites (Berlin and Berlin 1996). Caceres et al. (1990) found *Tagetes lucida* to be the most effective entero-bactericide in the Highland Guatemalan pharmacopoeia—exhibiting the highest antibacterial activity against *Salmonella enteritidis* and *Salmonella typhi*. Although the human capacity to detect harmful chemicals based on taste is impressive, these examples show how we still fall short of detecting a wide range of potentially bioactive phytochemicals based on taste alone.

In the only study I am aware of that compared the frequency of bitter compounds in a pharmacopoeia with non-medicinal plants in the environment, Ankli et al. (1999a) showed that medicinal plants of the Yucatec Maya were no more likely to be bitter than non-medicinal plants. This further suggests that factors other than bitter taste are more important in the acquisition of knowledge.

A second issue is that there are several illness categories that are not affiliated with any averse taste sensation. For example, epigastric pain (*koliko*) is treated almost exclusively in Nabil (and throughout the Highlands; Berlin and Berlin 1996) with the very pleasant tasting *Foeniculum vulgare* (fennel). Treatments in Nabil for wounds appear to be unaffiliated with any particular taste or morphological characteristic. Nevertheless, knowledge about these types of treatments is well distributed throughout the community. Thus, while taste may be important for detecting some potential medicinals, it is useless for detecting many others. In Chapter 4 I showed that cultural ratings of plant efficacy were correlated with knowledge. I should point out here that ratings of efficacy were not significantly correlated with ratings of averse taste intensity ($r_s = 0.27$, n = 34, $P = 0.16$). This suggests that interviewees were perfectly willing to consider some plants as efficacious regardless of their taste, and that it is the perception of efficacy, not taste, that most accounts for the distribution of knowledge about medicinal plants.

A third important issue is that a variety of very bitter plants are known as gastrointestinal or respiratory treatments by only a few people. Thus, while the chi-square analysis shows affiliations based on the total number of plants, that analysis does not account for the distribution of knowledge about the plants throughout the study population. While individuals may hold concepts that bitter plants are more appropriate for treating these illnesses, and some individuals may know more bitter plant treatments than others, other factors that may outweigh the importance of bitterness come into play when sharing this information. For example, people are potentially addressing a variety of symptoms or pathogens within each illness category—some of which may involve bitter constituents, others may not. Within the category of diarrheas (*tza'nel*) bitter plants like *Ageratina* sp. may be more effective at killing parasites (Berlin and Berlin 1996:466). On the other hand, the non-bitter *Mentha* sp. may be more important as an antispasmodic and is used to relieve symptoms of cramping associated with diarrhea. This matter is further complicated by the variety of contexts within which medicinals are used. For example, people may sometimes prefer to use a non-bitter treatment for diarrhea, especially for children (Berlin and Berlin 1996:63), because some bitter phytochemicals may be too toxic or because children simply will not drink it.

A final issue is that personal models of illness curing that focus on taste can be self contradictory. I treat this topic with more detail in Chapter 8 when discussing cognitive models. Here I will only mention that on several occasions I was told during interviews in Nabil that bitter plants are best for treating diarrhea or respiratory problems. Also, when I asked why various plants had the power to cure, I was often told it was because they were bitter. These individuals always also cited non-bitter plants to treat the same illnesses in other sections of the interviews. When I confronted participants with this contradiction by asking why the non-bitter plants could cure given that they told me the illness required bitter plants, I always received the standard answer: "*max k'il, ja' nax ya xpoxta*" 'who knows, it just cures.'

Conclusion

Anecdotal discursive data and the research of others (Berlin and Berlin 1996; Brett 1994) suggest that salient characteristics of plants influence the way people think about medicinal plants. My chi-square analysis of data from interviews using mounted specimens and results of taste experiments showed that some illness categories tend to be affiliated with distinct salient characteristics such as bitter taste and white latex. But further analysis shows that this is probably not guiding knowledge acquisition. I will present data in Chapter 9 showing that the novices of Nabil and Maravilla Tenejapa are extremely hesitant to experiment either with new plants as medicinals, or to try known medicinals for different illnesses. Individual explanatory models that focus on plant characteristics are not guiding medicinal selection and experimentation or the dissemination of such knowledge for the novice populations in this study.

In this chapter I have argued that the role of plant characteristics is confined mostly to *post hoc* explanations of curing. The evidence I presented includes patterns in the replication of relationships between illness and plant characteristics in the migrant frontier community Maravilla Tenejapa. These data suggest that new plants have been learned, especially regarding febrile and respiratory illnesses, that do not conform to Highland models, and that new taste-based models have developed to explain them. Furthermore, participants in taste tests in Nabil did not appear to be able to relate tastes directly with illnesses, but instead needed to identify the plant first in order to guess the appropriate use that they provided using visual stimuli. Also, individual models are often self-contradictory and appear to be highly violable. Given these issues, it is not surprising to find that rankings for the strength of averse taste were not correlated with the distribution of knowledge.

The high frequency of non-averse tasting plants in the Nabil pharmacopoeia, the complicated and diverse strategies for treatments within "bitter-dominated" illness categories, self-conflicting individual models regarding the role of taste, the failure of taste intensity to correlate with either perceptions of efficacy or the distribution of knowledge all suggest that other factors may be as important, if not more important, than individual explanatory models based on taste for guiding acceptance and dissemination of medicinal plant knowledge. Again, these patterns taken together suggest that cultural conceptions of taste are not guiding knowledge acquisition among this population, but rather that the tastes of the more efficacious plants are guiding *post hoc* explanatory models of curing.

As I show in Chapter 8, plant characteristics are only one of many integrated aspects of highly malleable individual and shared cognitive models of plant-based curing. The gist of the shared models is that medicinal plants taste bad, but this rule is highly violable, and is often superceded by other evidence regarding a plant's efficacy, especially when accompanied by social persuasion. This explains why plant characteristics appear *prima facie* to be fundamental to medicinal plant knowledge, but in the end contribute little to the overall distribution of knowledge as shown in Figures 2.1 and 2.2. In the next chapter, I will make a similar argument for the *post hoc* explanatory role of the Tzeltal humoral ('hot' vs. 'cold') classificatory system.

Notes

[1] This list is compiled from Berlin et al. (1974), Berlin and Berlin (1996), Brett (1994), and my interviews and taste experiments. See Brett (1994) for a thorough analysis relating Tzeltal with English lexemes using chemical stimuli in taste experiments.

[2] For these experiments, medicinal uses (e.g., for the various types of diarrheas, coughs, rashes, etc.) are grouped into major illness categories (i.e., gastrointestinal, respiratory, dermatological, etc.) based on the categories of Brett (1994), Maffi (1994), and Berlin and Berlin (1996), who have shown that these are culturally meaningful categories (see Chapter 3).

Chapter 6
Humoral Classification, Mnemonics, and Knowledge Distribution

Introduction

'Hot' and 'cold' classification appears to be a fundamental aspect of Tzeltal knowledge about medicinal plants (Berlin and Berlin 1996:61; Brett 1994:81). I include it in this dissertation since it may have an important role in the recall and dissemination of medicinal plant knowledge throughout the study population.

The humoral medicinal system, which can be traced back to the pathology of Hippocrates, is based on the notion that health and disease result from a balance between opposing qualities that exist in the body, food, and medicinal herbs—most notably hot versus cold and wet versus dry (Etkin 1988a; Foster 1994; Mathews 1983). 'Hot' and 'cold' classification permeates Ladino and indigenous thought throughout Latin America (Foster 1994:147-164).

Berlin and Berlin (1996:61) found that 'hot' and 'cold' designations were the most important properties of medicinal plants mentioned by Highland Tzeltal and Tzotzil informants when they were asked the open-ended question "why does this plant have the power to cure?" The overall response rate across all illnesses showed slightly more 'warm' (49%) plants than 'cold' (32%), and strong affiliations of 'hot' or 'cold' properties within illness categories. For example, gastrointestinal illnesses were mostly considered 'cold' and treatable with 'hot' plants. Similar patterns were observed by Brett (1994) and Maffi (1994) for the Tzeltal, which led Brett to suggest that humoral concepts may be guiding Tzeltal medicinal plant selection and experimentation, along with taste and other criteria (Brett 1994:162).

The implication for this dissertation is that humoral concepts may also guide or otherwise facilitate the acquisition and dissemination of knowledge throughout the population. The potential role of the humoral system as a mnemonic device is best explained by Alcorn (1984:287) in her discussion regarding the Huastec Maya:

> In actual usages, all available "cold" plants may not be used to cure a "hot" disease but only a particular "cold" plant(s) for a particular "hot" disease . . . . Such systems may be created to provide a semblance of logically derived order, when in fact the principles given as the basis for the order (e.g., hot/cold, latex production, root shape) are not the criteria for assigning uses at all. Instead of being used for selecting remedies, the systems may be construed to "explain" plant use or to provide a memorization device for particular remedies.

Alcorn is suggesting a system that functions as a mnemonic device in individual cognition; in particular, in facilitating recall of appropriate treatments. But the 'hot' and 'cold' classification system is also cultural in that the beliefs are shared and reified in social discourse and behavior (Foster 1994:143-146). As such, it may represent the type of shared cultural model that is necessary for cultural transmission (Strauss and Quinn 1997:176). It seems reasonable to suggest that such a system may guide learning and dissemination of information throughout the population. In other words, humoral classification serves as a cultural mnemonic as well as individual cognitive mnemonic.

But closer examination of the behavioral and cognitive processes bring both the individual and cultural mnemonic status of humoral classification into question. As the quote from Alcorn points out, the system may be *post hoc* explanatory as well as mnemonic. These dual roles may not be compatible. As Foster (1994:131) has argued, the humoral system need not be prescriptive nor guide selection of potential medicinals. Instead, appropriate medicinal treatments accrue through other empirical processes and the humoral system serves more to explain these treatments and reify belief in the validity of the overall system (see also Etkin 1988a). In my case, people may be learning plants through discourse or participating in curing events that have little to do with humoral reasoning and applying such reasoning as a *post hoc* explanation. One implication of a *post hoc* explanatory process is that there may be a lack of agreement among informants regarding 'hot' or 'cold' properties.

Indeed, one of Foster's main arguments for the non-prescriptive *post hoc* status of the humoral system in Latin America is the inconsistency of inter- and intra-informant classification, and he sites numerous studies as well as his own data (Foster 1994:134-137). Brett (1994: 83) also found poor agreement among Tzeltal healers about the 'hot' or 'cold' quality of several illnesses. The important point for this study is that if there is inconsistency in the shared beliefs, then 'hot' and 'cold' classification may not be a cultural mnemonic, and the distribution of knowledge would not be expected to correlate with agreement about 'hot' or 'cold' classification.

Another important consideration is the inconsistency in humoral classification across interview occasions with the same informant. Mathews (1983) has attributed this to shifting contexts of classification. She claims that there are many semantic dimensions that vary in their importance depending on the cognitive task. It is likely that people are actually changing their classification to fit the requisite combinations of dimensions, and not that the dimensions are being arranged to conform to a standard classification. This suggests that 'hot' or 'cold' designation is less likely to be held in long term memory, and therefore is not serving as a cognitive mnemonic for individuals. Both Brett (1994:81) and Ankli et al. (1999a) noted that people needed to relate a plant to an illness first and then recall the 'hot' or 'cold' property of the illness in order to ultimately derive the medicinal plant's opposite property. The implication again is that the plant's humoral status is not serving as a mnemonic device.

Thus, a plant's 'hot' or 'cold' status may be derived as a *post hoc* cognitive process in short-term recall, and it may also be a *post hoc* process in cultural transmission. We would expect that if 'hot' versus 'cold' classification results from *post hoc* individual cognitive reasoning and transmission and is inconsistent, it probably doesn't contribute substantially to knowledge recall, acquisition, or dissemination. In other words, it is not a helpful individual or cultural mnemonic. The goals of the research presented in this chapter were to 1) determine inter- and intra-informant agreement about ‘hot’ and ‘cold’ classification of medicinal plants, 2) elucidate the cognitive processes involved in recalling a plant’s property, and 3) determine if agreement about ‘hot’ or ‘cold’ properties is correlated with the distribution of knowledge in the population (Figures 2.1 and 2.2).

Inter-informant agreement about ‘hot’ or ‘cold’ qualities of plants

The data are from interviews with 28 adults from the Highland community of Nabil using mounted specimens of 130 species (see Chapter 2, Methods). For each plant that was identified as medicinal by an interviewee, I asked if the plant cured because it was ‘hot’ or ‘cold’ (*Sik la bal mak k’ixin la bal ta poxta?*). I analyzed consensus about ‘hot’ and ‘cold’ properties using ANTHROPAC (Borgatti 1996a). I also conducted detailed interviews with 11 adults in which I asked them to describe the etiology and ‘hot’ or ‘cold’ properties of the most common illnesses. These qualitative data were coded and analyzed using HyperResearch (see Chapter 2, Methods).

The results show that inter-informant agreement about ‘hot’ or ‘cold’ qualities varied considerably for the medicinal plant species in Nabil (Table 6.1)—ranging from 100% agreement that *Aloe vulgaris*, *Sedum praealtum*, and *Satureja brownei* cure because they are ‘cold,’ to complete lack of agreement (50% ‘cold’ and 50% ‘hot’) for *Myrica cerifera*, *Erigeron karwinskianus*, *Matricaria recutita*, and *Quercus* sp. The ratio of the first to second eigenvalue derived from the consensus analysis was 2:1, indicating that there is no single systematic pattern to the answers.

It is clear, however, that there is more agreement about some plants than others. I have identified five groupings of plants that represent different patterns of relationships between plants and illnesses, and which help to explain why agreement is higher for some plants than for others.

Table 6.1. Agreement about 'hot' or 'cold' properties and distribution of knowledge about medicinal use for the 30 most commonly known medicinal plants in Nabil.

Tzeltal name	Botanical species	Percent of respones cold	Percent of respones hot	Rank for agreement about humoral quality	Rank for knowledge about use
sávila	*Aloe vulgaris*	100	0	1	11
poxil majben	*Sedum praealtum*	100	0	2	6
chicle wamal	*Satureja brownei*	100	0	3	7
paj 'ul 'ul	*Rhus terebinthifolia*	93	7	4	10
chijil te'	*Sambucus mexicana*	93	7	5	8
k'ajk'an	*Chenopodium ambrosioides*	8	92	6	27
pajchak	*Psidium guineense*	92	8	7	22
bankilal	*Nicotiana tabacum*	17	83	8	13
wena	*Mentha citrata*	17	83	9	19
inojo	*Foeniculum vulgare*	82	18	10	2
kampana nichim	*Brugmansia candida*	23	77	11	9
ajate'es	*Gaultheria odorata*	69	31	12	15
we'el buluk' sit	*Borreria laevis*	67	33	13	29
tujt	*Equisetum myriochaetum*	67	33	14	17
nujkupat	*Cupressus lusitanica*	38	63	15	31
tzajal nich wamal	*Oenothera rosea*	42	58	16	23
sak ji	*Cornus disciflora*	57	43	17	28
taj	*Pinus* sp.	43	57	18	25
tujkulum ch'ix	*Solanum lanceifolium*	56	44	19	12
turezna	*Prunus persica*	44	56	20	18
mes te'	*Baccharis vaccinioides*	45	55	21	3
tziltzil 'uch'	*Litsea glaucescens*	46	54	22	21
ch'aj kojtom	*Pinaropappus spathulatus*	54	46	23	32
yakan k'ulub	*Verbena litoralis*	47	53	24	1
ijk' al ok tzib	*Adiantum andicola*	51	49	25	20
ch'a bakal	*Salvia lavanduloides*	52	48	26	5
sera te'	*Myrica cerifera*	50	50	27	16
sakil nich wamal	*Erigeron karwinskianus*	50	50	28	4
manzanilla	*Matricaria recutita*	50	50	29	14
jijte'	*Quercus* sp.	50	50	30	24

These data and other observations I made while living in Nabil indicated a clear pattern of agreement about ‘hot’ or ‘cold’ properties of some plants that exhibit obvious temperature-based sensory properties. Examples include the burning sensation experienced by ingesting chili peppers, *Nicotiana tabacum*, and ginger, as well as the cooling sensation derived from the topical application of certain succulents that exude a mucilaginous sap (e.g., *Aloe vulgaris* and *Sedum praealtum*). These plants form the first group, for which ‘hot’ or ‘cold’ properties of the plants can be directly sensed, and for which agreement about ‘hot’ or ‘cold’ classification is unanimous. My intuition is that through semantic extension to other members of the category (see Chapter 8) plants in this group encourage the expectation that other medicinal plants also have some “hidden” ‘hot’ or ‘cold’ property.

The other groups of plants reflect *post hoc* explanations that are not readily conceptualized as a character of the plant unless the plant is matched to an illness first—sometimes only when informants were required to do so; and then interviewees engaged in a reasoning process using illnesses known to be treated by the plant to arrive at an opposite property for the plant (see below). Any consensus regarding ‘hot’ or ‘cold’ properties of these plants is a function of consensus regarding the ‘hot’ or ‘cold’ property of the illnesses they treat. For example, skin infections, burns, wounds, oral thrush, fever, and toothache were consistently considered ‘hot’ illnesses by informants, while informants agree that infertility and infestations of *Ascaris* sp. worms are ‘cold’ illnesses. These results are consistent with those of Berlin and Berlin (1996) and, with the exception of worms, Maffi (1994). All plants that people agree are used *primarily* to treat these illnesses show high consensus regarding ‘hot’ or ‘cold’ property. Plants in this second group include *Psidium guineense*, *Rhus terebinthifolia*, *Chenopodium ambrosioides*, and others (Table 6.1).

Interviewees were ambivalent about the ‘hot’ or ‘cold’ nature of other illnesses like common cough and common diarrhea, which may or may not be accompanied by fever or sensations of heat around specific organs (e.g., a burning throat or abdomen). Also, although generally considered ‘cold’ and on a trajectory to the “ultimate cold state” of death (Berlin and

Berlin 1996:55), particular cases of these illnesses may not be considered 'cold' if they are not perceived as serious. In other words their 'hot' or 'cold' classification is context specific, and answers during interviews probably vary according to the most recent experiences with these illnesses.[1] Plants used primarily for these illnesses form the third group, which show a corresponding pattern of interviewee ambivalence regarding these plants' 'hot' or 'cold' properties (e.g., *Verbena litoralis, Baccharis vaccinioides,* and *Salvia lavanduloides*). Some of these are the best known plants in the community and are used to treat the most common illnesses.

There is a fourth group of plants strongly affiliated with particular illnesses, but the illnesses have no 'hot' or 'cold' quality (e.g., *xiwel* 'fright'). Informants show no agreement about the properties of plants used exclusively for these illnesses, and indeed are often incapable of deriving one (e.g., *Adiantum andicola*).

Finally, there are those plants for which there is poor consensus regarding their medicinal use. People do not agree about the properties of these plants (e.g., *Pinus* spp., *Quercus* spp.), often contradicting themselves within the same interview.

These results indicate that the 'hot' or 'cold' properties are derived directly for only a few plants during recall and discourse (group 1). In all other cases people are actually thinking and talking about 'hot' or 'cold' properties of illnesses and not directly cognizing the property as being of the plant.

In short, the temperature-based classification system is probably not an individual or cultural mnemonic. As I will show below, 'hot' and 'cold' properties of plants did not help people remember medicinal uses. Instead, most people had to remember the illness that is treated by the plant first in order to derive the 'hot' or 'cold' property of the plant.

Intra-informant agreement about 'hot' or 'cold' qualities of plants

I analyzed data to determine if interviewees were consistent with their own conceptions of 'hot' or 'cold' properties of medicinal plants and whether they recalled these properties primarily by invoking the illness as a concept as opposed to the plant alone. The technique was to code the transcribed interviews (see Chapter 2, Methods) in order to compare multiple occasions during which each plant and its property were discussed by the same informant.

Informants contradicted themselves about the 'hot' or 'cold' quality of a plant 41% of the occasions when a plant's property was discussed more than once. Here is an example in which an interviewee has just told me that *Baccharis vaccinioides* is used to treat common colds and coughs (*bats'il obal*):

Excerpt 6.1 (from Nabil Interview 122)
Casagrande: Sik la bal mak k'ixin la bal ta poxta mes te'?
Does *Baccharis vaccinioides* cure because it's hot or cold?
Subject: Sik.
Cold.

Later in the same interview the interviewee was viewing another plant that he said was used to cure diarrhea when he remembered that *Baccharis vaccinioides* was also used as a mixture with this second plant to treat diarrhea. I asked again if *Baccharis vaccinioides* was 'hot' or 'cold,' and this time he said it was 'hot.' Brett (1994:83) found that Tzeltal healers in Cancuc also stated different 'hot' or 'cold' properties when plants were used for different illnesses.

The qualitative analysis also revealed a pattern of interviewees expressing uncertainty with responses. For example:

Excerpt 6.2 (from Nabil Interview 122)
Casagrande: Sik labal mak k'ixin la bal ta poxta ch'a bakal?
Does *Salvia lavanduloides* cure because it's hot or cold?
Subject: K'ixin niwan.
Perhaps it's hot.

Excerpt 6.3 (from Nabil Interview 113)
Casagrande: Sik labal mak k'ixin la bal ta poxta ch'a bakal?
Does *Salvia lavanduloides* cure because it's hot or cold?
Subject: Sik niwan. Max k'il.
It's cold, I guess, I don't know.

Thirty-nine percent of responses were qualified with these types of statements of uncertainty. Interviewees were much more confident when answering about other topics such as taste or medicinal use. This is consistent with results from consensus analyses, which showed cultural consensus about the tastes of plants (Chapter 5) and medicinal use (Chapter 2), but not ‘hot’ or ‘cold’ properties (see above). Although, interviewees did show more consistency and confidence when answering about plants that were only used for illnesses with obvious temperature-based physiological manifestation, such as fever and burns.

I do not mean to present frequency of contradictions and statements of uncertainty as indications that the ‘hot’ versus ‘cold’ system is neither legitimate nor important for the participants in this study. On the contrary, every participant expected every plant to have a ‘hot’ or ‘cold’ property and they were often frustrated that they could not remember what is was. Furthermore, when Berlin and Berlin (1996:61) asked the open-ended question “why does plant *x* have the power to cure,” 80% of answers were that the plants were ‘hot’ or ‘cold’ (the remaining 20% were distributed over 34 other possible terms). It is interesting that interviewees in this study agree so little about a concept that is apparently so important to them.

I doubt that ‘hot’ and ‘cold’ designations serve as mnemonic devices helping people recall the proper medicinal use of each plant. Discourse analysis suggests instead that people often had to recall the ‘hot’ or ‘cold’ property of an illness before deriving the plant’s property. Ankli et al. (1999a) found the same pattern among Yucatec Maya healers, as did Brett (1994:81) with Tzeltal healers in Cancuc. Here are examples from my data:

<u>Excerpt 6.4. (from Frontera Interview 36)</u>

<u>Casagrande</u>: Sik la bal mak k’ixin la bal ta poxta kampana?

Does *Brugmansia candida* cure because it’s hot or cold?

<u>Subject</u>: Bueno, quiero decir . . . bueno . . . porque . . . cura . . . bueno, voy imaginar. Creo que tal vez k’ixin. Porque cura ik’, aire. Probablemente una planta fria no cura aire. Porque el aire es fria. Duele. Fria. Entonces, creo que caliente este.

> Well I want to say . . . well . . . because . . . it cures . . . well. I'm making this up. I think maybe it's hot. Because it cures aches and pains. A cold plant probably wouldn't cure aches and pains. Because aches and pains are cold. It hurts. Cold. Therefore, I think this is hot.

Excerpt 6.5. (from Nabil Interview 102)

Casagrande: Sik la bal mak k'ixin la bal ta poxta yakan k'ulub?

> Does *Verbena litoralis* cure because it's hot or cold?

Subject: Majna'tik bit'il, ay . . . ja' te ch'ae. Ja' te ch'ae. Melel ya xpoxta. Sik niwan melel k'ajk' te tsa'nel. Sik.

> We don't know which. There's . . . there's bitterness. There's bitterness. And it really cures. Cold maybe, because, really, the diarrhea burns. Cold.

Notice in the next excerpt that the interviewee recalls an itchy cough as the illness treated by *Salvia lavanduloides*, but can not remember if the cough is 'hot' or 'cold', and therefore can not derive a property for the plant

Excerpt 6.6. (from Frontera Interview 85)

Casagrande: Ma la ch'ay ta aw'otan ya spoxta obal ch'a bakal, pero sik la bal mak . . .

> You didn't forget that *Salvia lavanduloides* cures cough, but is it cold or . . .

Subject: Majna' me yu'un sik melel ya skejcha ts'in ta me la jkuxtik ini ala nich tame ben sak' te obale, ya skejcha yu'un. Sik niwan te obale . . . ma . . . ma jna.

> I don't know if it's cold, the truth is we chewed the flower of this and it calms the cough. If the cough is really itchy, this calms it. Maybe the cough is cold . . . no . . . I don't know.

Casagrande: K'ixin bal te wamalil?

> Is the plant hot?

Subject: Max k'il.

> I have no idea.

As I argue in Chapter 8, people are generally recalling specific illness events when they are engaging in these types of reasoning processes about the plants they are looking at. Observations about the 'hot' or 'cold' nature of the most recent or otherwise salient illness events (e.g., a child who almost died) are likely influencing answers about the 'hot' or ‘cold’ properties of the plants. It appears unlikely that ‘hot’ or ‘cold’ properties for most plants are held in long-term memory. Rather the properties are derived via a *post hoc* reasoning process that begins with a salient illness event and proceeds to ‘hot’ or ‘cold’ attributes associated with the event. Therefore, the ‘hot’ or ‘cold’ properties of plants are not serving as mnemonics for recalling which illnesses are treated by plants. It appears to be the other way around.

Given the inconsistency and uncertainty about ‘hot’ or ‘cold’ properties of plants within and between interviews, and the *post hoc* process of remembering the properties, it would seem unlikely that agreement about ‘hot’ or ‘cold’ properties of plants could be facilitating the acquisition and dissemination of knowledge throughout the population.

Knowledge of medicinal use and agreement about ‘hot’ and ‘cold’ properties of plants

Agreement about the ‘hot’ and ‘cold’ properties of plants was not correlated with the percentage of interviewees who cited a medicinal use for each plant (Table 6.1; r_s = 0.10, n = 30, $P > 0.50$). In other words, some plants are known by most individuals as being effective for achieving a culturally-defined goal even though there is little or no agreement about the plant’s ‘hot’ or ‘cold’ property (e.g., *Verbena litoralis*, *Baccharis vaccinioides*, and *Erigeron karwinskianus*). Conversely, some plants are known as medicinals by few people in Nabil, but those people agree quite well about the ‘hot’ or ‘cold’ property (e.g., *Chenopodium ambrosioides* and *Psidium guineense*).

If ‘hot’ and ‘cold’ properties of plants do not serve a mnemonic function, and are not contributing to the acquisition or dissemination of knowledge in this population, then why might such a system persist? There are several possible explanations.

First, some information presented by nature is simply too salient not to notice (Berlin 1992:8). This includes physiological states ranging from fever to a cold dead body and the burning and cooling effects of some plants. People often attempt to apply inferences drawn from some items of a semantic category to all items in that category (Cushing 1990; Rips 1975). It is probably a fundamental process of individual and shared cognition to combine such inferences to form explanatory models (Markman 1989), and these models need not be logically coherent (Collins and Gentner 1987; Strauss and Quinn 1997:177). Inferences drawn from items may serve as a basis for deductive empiricism (Gelman et al. 1994), or they may not serve any function other than satisfying the basic human need to make inductive inferences.

Another possibility is that 'hot' and 'cold' concepts are more important and coherent for people who are more knowledgeable about medicinal plants. Some of the people I interviewed were more knowledgeable than others, and they did tend to have more coherent individual 'hot' and 'cold' models. This may be especially important for Tzeltal experts who use a variety of concepts, including 'hot' and 'cold' properties, taste, the doctrine of signatures and empirical observations, to guide experimentation with new plants (Brett 1994:162). Although people in the population I studied were less knowledgeable than Brett's informants, and rarely experimented with new plants, they respect experts and interact with them regularly. As a result, they may believe 'hot' and 'cold' concepts are important, even if they don't fully understand them. I have no doubt that this is true for explanatory aspects of any medicinal system that has experts, including modern biomedicine.

Garro (2000) has suggested that Tarascan medicinal specialists did not know substantially different information than novices, but that they either knew more or cognitively manipulated the information differently. In her original analysis (1986), Garro suggested that if the information was too different, the novices might have problems understanding or believing in the experts. 'Hot' and 'cold' concepts may be examples of the kind of information that serves as an interface between Tzeltal experts and novices.

The Tzeltal 'hot' and 'cold' system may also serve as an interface with Ladino medicine. As nearly every researcher who has studied indigenous Mexican medicine has pointed out, indigenous systems are integrally linked with Ladino systems, and ideas flow in both directions (e.g., Alcorn 1984:302; Foster 1994; Mathews 1983; Weiss 1998). Ladino humoral concepts can be traced back to Europe and have heavily influenced indigenous medicinal ideologies and knowledge about particular plants (Foster 1994; Mathews 1983). The Tzeltal that I interviewed indicated that sources of information about medicinal plants include Ladino-run herbal shops in major towns and cities and respected Ladinos living in municipal centers like Tenejapa and Maravilla Tenejapa. For example, several women told me they learned to use ginger (a 'hot' plant) to treat infertility (a 'cold' illness) at shops in San Cristóbal. I traced the origin of the widespread knowledge about using *Hyptis verticillata* ('hot') to induce labor in prolonged pregnancies ('cold') in Maravilla Tenejapa to a Ladina midwife who lived there for several years. Berlin and Berlin (1996: 337) showed the European origin of using *Foeniculum vulgare* ('cold') to treat epigastric pain ('hot'). Furthermore, a Ladina woman in Maravilla Tenejapa who was consulted regularly by her Tzeltal neighbors about medicinal herbs told me she also learned medicinal treatments from the Tzeltal in town and Guatemalan migrants, and that 'hot' and 'cold' qualities were important in their exchanges.

Finally, humoral concepts may serve to reify the Tzeltal belief system. As Etkin (1986:7) has pointed out, "From an emic perspective, the medical and other uses of plants can be considered to be effective if they meet culturally defined expectations (of healer, patient, and social group) and, thus, confirm and reaffirm shared beliefs about the nature of health." She states that this may be the case even if the cultural expectations appear logically inconsistent from an etic perspective.

Most likely, the humoral system is popular among Tzeltal novices as a result of a combination of all of the above: it satisfies basic intuitive propensities, it provides an interface with experts and the Ladino health system, and it reifies shared values. But it appears to be neither predictive nor mnemonic. As I will argue in Chapter 8, individual explanatory models are easily overridden by compelling contradictory evidence of a plant's efficacy, especially in highly socialized learning events.

Conclusion

‘Hot’ and ‘cold’ classification of medicinal plants is clearly important to the Tzeltal who participated in this study. People expect every plant to have a ‘hot’ or ‘cold’ character and think they should know it. But interviewees needed to classify the *illness* treated by a plant as ‘hot’ or ‘cold’ *before* classifying the plant using the opposite feature, indicating that humoral classification does not serve as a mnemonic device for recalling medicinal uses of plants. Furthermore, classification was idiosyncratic and inconsistent for most plants both across interviewees and across different occasions with the same interviewee. Also, interviewees tended to qualify their classifications with statements of uncertainty.

These results support the *post hoc* explanatory nature of humoral classification as proposed by Foster (1994). The *post hoc* nature of ‘hot’ and ‘cold’ classification of medicinal plants and the likelihood that classification serves neither as an individual nor cultural mnemonic explain why agreement about ‘hot’ and ‘cold’ quality was not correlated with knowledge distribution. There was poor agreement about the ‘hot’ and ‘cold’ quality of widely known plants and high agreement among the few individuals who knew other plants. Therefore, although humoral classification is an important component of shared cultural models of curing, it is probably not influencing the acquisition or distribution of knowledge about medicinal plants within the community, although it may provide a social-based interface for exchange of information with other knowledge systems, such as Ladino folk medicine.

As I will show in Chapters 8 and 9, these results can at least partially be explained by differences between individual and shared cultural models and the role of models in cultural transmission. In particular, the notion that from a socially contextualized standpoint it appears to be more important for the Tzeltal participants to agree about the general principles of medicinal plant use than to agree about the details. In this case, it may be more important to agree that all plants have ‘hot’ or ‘cold’ properties than to agree about what the particular property of each plant is.

Notes

[1] My results regarding agreement about the 'hot' or 'cold' nature of the gastrointestinal illnesses appear to differ from Berlin and Berlin (1996) who claimed that most gastrointestinal illnesses were considered 'cold' and treatable by 'hot' plants. This may result from different methods. The Berlins were asking open-ended questions about why each plant had the power to cure, and their answers focused on the most salient humoral, organoleptic and even spiritual properties of plants (p. 61). I specifically asked for the 'hot' or 'cold' nature of each illness, which may have forced people to make decisions about less salient features. Second, their interviewees were clearly more knowledgable about medicinal plants than mine and may have possessed more coherent models of curing. The goal of my study was specifically to understand how and why knowledge is distributed throughout a less-knowledgeable population of novices.

Chapter 7
Effects of Medicinal Plant Abundance and Frequency of Use on Knowledge Distribution

Introduction

So far I have considered cultural perceptions of efficacy, organoleptic and morphological salience of plants, and humoral classification of plants as variables that might influence the distribution of medicinal plant knowledge. In particular, I am trying to explain why knowledge about the medicinal use of some plants is much more widely distributed than for other plants as shown in Figures 2.1 and 2.2. Only emic perceptions of efficacy have been found to contribute significantly to this pattern (Chapter 4). In this chapter I test the possibility that the abundance and accessibility of plants, and the frequency with which they are used, also influence the distribution of knowledge.

There is a growing body of literature showing that indigenous people around the world rely on disturbed habitats close to their homes for most of their medicinal plants. Stepp and Moerman (2001) have documented this pattern for both Native North Americans and the Tzeltal of Tenejapa. Voeks (1996) showed that secondary forest plots in Bahia Brazil contained 2.7 times the number of medicinal plant species as primary forest plots. Frei et al. (2000) found that both Mixe and Zapotec in Oaxaca, Mexico rely more on plants growing closer to homes as medicinals than plants from other habitats. Heinrich and Barrera (1993) found similar results for the Lowland Mixe. And Gollin (2001) found that the Kenyah of Borneo were more likely to use medicinal plants from disturbed areas, with 34% coming from fields and gardens.

Stepp and Moerman (2001) have argued that one possible explanation for this trend is that plants from disturbed habitats are more likely to contain bioactive phytochemicals. But it has also been proposed that it is easier to share information about plants that are more abundant and accessible, and this also might explain why the medicinal uses of these plants would be better known in a community (Moerman 1998; Stepp and Moerman 2001; Voeks 1996). Caniago and Siebert (1998) conducted surveys of medicinal plant abundance in a Dayak village in Borneo and showed that novices were more likely to know medicinal uses of plants from secondary forest, which were more abundant, than primary forest plants, which were much less abundant.

The argument for the influence of abundance on knowledge is based on the notion that information is largely exchanged during curing events and abundant plants are used more frequently (Moerman 1998). It is possible that frequency of use is more a function of plant accessibility than perceived ability to cure. Alcorn's work among the Haustec Maya led her to comment that "a better but less accessible remedy may be foregone in favor of a less effective but easily accessible plant" (1984:309). Is it possible that information about less effective plants could be more widely distributed than more effective plants simply because they are more common? My research presented in Chapter 4 suggests this can not be true for the Tzeltal. Efficacy is a variable strongly correlated with knowledge. Kohn (1992) has also shown that plants that were rarely used by Amazonian Runa were still well known, probably because they had a reputation of being effective treatments. This implies that plants from disturbed habitats are not necessarily used more frequently because they are more likely to contain bioactive phytochemicals, but simply because they are more accessible. Adu-tutu et al. (1979) found that availability of dental treatments was a more important factor than efficacy when the Ghanaians that they studied were choosing what species to use. And Alexiades (1999:315) found that for the Ese Eja of Amazonia, "accessibility is a primary consideration when selecting between different treatment options, at least during the early stages of an illness episode."

It is quite possible that all three notions are correct. That is, it's easier to communicate about more common plants; more common plants are used because they are more accessible; and more common plants are more likely to contain bioactive phytochemicals because they are from disturbed habitats.

Much of this confusion derives from a failure to isolate and test the interactive effects of all three variables (abundance, use, and knowledge) within the same study. Here, I attempt to disentangle these issues, at least for the Tzeltal, by testing for the correlation between these three variables and supplementing the correlation analysis with qualitative data from interviews. I am testing for three relationships: 1) plants that are more abundant will be more frequently used (i.e., abundance is correlated with use); 2) knowledge about medicinal use is more widely distributed for more abundant plants (i.e., abundance is correlated with knowledge); and 3) knowledge about medicinal use is more widely distributed for plants that are more frequently used (i.e., knowledge is correlated with use). I used qualitative data from interviews to understand how people are making decisions about use. I conducted this analysis in both a Highland community (Nabil) and tropical frontier community (Maravilla Tenejapa) to see if patterns documented in the Highlands were replicated in the tropical frontier environment after migration.

Methods

Overall distributions of knowledge (Figures 2.1 and 2.2) were derived from structured interviews with 28 adults from the Highland community of Nabil using mounted specimens of 130 species, and 18 adults from the migrant community of Maravilla Tenejapa using 116 specimens (see Chapter 2, Methods). Here, I explain my estimation of the other two variables (relative abundance of medicinal plants and frequency of use), methods for testing correlations, and qualitative analysis.

Relative abundance of medicinal plants

I estimated the relative abundance of 114 medicinal plant species in Nabil and 92 in Maravilla Tenejapa. These were all of the species said to be medicinal by two or more informants in each town, which also grew within the town boundaries.

Relative abundances were estimated using a random sampling design stratified by habitats. First I estimated the relative abundance of each species within each of the habitat categories (Table 7.1 and see Chapter 1), and then adjusted for the proportion of land area included within each of the habitat types. This method was relatively simple and appropriate because landscapes in both communities are intensively managed and each habitat shows striking unique characteristics based on land use. For example, secondary forest growing on abandoned corn fields (*unin k'inal*) is cut and burned for new corn fields long before it begins to resemble stands of large trees that are thinned and managed for firewood (*te' tikil)* or old-growth forest (*ja'mal*). Transitions between habitats are not gradual, but are clear and abrupt (Figure 7.1).

I estimated relative abundance within the earlier successional habitats (*ak'il, k'altik, k'ajbenal, wank'altik, unin k'inal, k'inal*) using a random quadrat sampling method (Hawley

Table 7.1. Tzeltal habitat classifications[1] and their percentage of total land area in Nabil and Maravilla Tenejapa.[2]

Tzeltal Lexeme	Swidden stage	Percentage of area in Nabil	Percentage of area in Maravilla Tenejapa
pat na	houseyards	8	3
ak'il	pasture	3	6
k'altik	swidden (1-3 years)	18	9
k'ajbenal	1st year fallow corn field	6	3
wank'altik	2nd year fallow cornfield	10	10
unin k'inal	3-7 year secondary growth	40	14
k'inal	6-12 year secondary growth	5	0
kafetal	shade-grown coffee groves	0	15
te'tikil	secondary forest, woodlot	10	0
ja'mal, montaña	old growth forest	0	40

[1] Determined from interviews with three principle informants in each town.
[2] Determined from transect intercept surveys.

Figure 7.1. Transitions between habitats in the heavily managed landscape are abrupt.

1978; Rice 1967) because species within these habitats tend to be evenly distributed (González-Espinosa et al. 1991). I selected eight stands representing each habitat type. Transects were laid out through the center of each stand and 3 m x 3 m quadrats were randomly located along the transects. A total of 32 quadrats were sampled within each habitat type yielding a total of 192 quadrats. Using a checklist, I noted the presence or absence of plant species within each quadrat and calculated the percentage of quadrats for which each species was present in order to determine relative abundance of each species within each habitat.

Mature (*te'tikil*) and old growth forests (*ja'mal*) tend to have more variable distributions of species (González-Espinosa et al. 1991; Lang et al. 1971; Zuill 1973). I used quadrats with 20 m length and unlimited distance widths in these habitats. Again, eight stands were selected to represent each habitat.

I also conducted inventories of medicinal species in 24 houseyards in Nabil and 13 houseyards in Maravilla Tenejapa. I walked entire houseyards (usually about 800 m^2) with my Tzeltal assistant and also accompanied by family members of each house. Together we attempted to find all of the 114 (Nabil) or 92 (Maravilla Tenejapa) plant species using the checklists. We noted the presence or absence of each species in each of the houseyards. Again, I calculated the percentage of houseyards for which each species was present in order to determine relative abundance of each species in houseyards.

For each plant species I multiplied the percentage of quadrats (or houseyards) within which the species was detected in each habitat by the percentage of land area occupied by each habitat to determine the overall relative abundance.

The proportion of land area comprising each habitat type within both communities was estimated using the transect intercept method (Kuchler and Zonneveld 1988). I laid out three parallel and evenly spaced transects that spanned from the eastern border of each town to the western border. I walked the transects following a compass bearing with a Tzeltal field assistant and we counted the number of our steps between each habitat transition. The number of steps that fell within each habitat was divided by the total number of steps to determine the percentage of land area in each habitat. We sampled 7.5 km of transect in Nabil and 12.5 km in Maravilla Tenejapa.

These plant abundance surveys were conducted in the Highland community of Nabil between March and May 2001 in order to give sufficient time after the last frost and the beginning of the rainy season for perennials to leaf-out or annuals to sprout so that they could be identified. Surveys were conducted in the tropical frontier community Maravilla Tenejapa during the rainy season between May and August 2001.

Relative frequency of medicinal plant use

I conducted three door-to-door surveys in Nabil during 2001 to determine the frequency with which medicinal plants were being used. Along with a Tzeltal assistant, I attempted to interview residents of every household in Nabil (n = 150) who were over the age of 16 and ask them (preferably as a group) which plants they had used within the last week. Some people were not at home and others did not want to participate. As a result, 31 Nabil households provided information during the survey conducted May 11-12; 41 during the July 1-2 survey; and 36 on July 21-22. We asked if anyone in the house had been sick within the past week (*Ay bal mach'a ta a'na la stsak chamel ta xemana i'ni?*), what action was taken to cure the illness (*Binti la a'pas?*), and whether any plants were used to treat the illness (*Ay bal wamalil la a'tuntes swenta poxil* ____?). All plants that were reported were ranked according to their frequency of use.

I was unable to obtain permission to survey all households in Maravilla Tenejapa. Therefore, I asked about medicinal plant use (using the same questions as in Nabil) in each of the 13 participating households once every week between May 17 and August 15, 2001.

Data analysis

I used Spearman-ranked correlation (Zar 1996:389) to test for correlation between ranked relative abundance and ranked frequency of use. To gain additional insights into the effects of abundance on frequency of use, I asked informants during open-ended question interviews what they did when someone was ill with each of the major illnesses (*Te me ay macha schamel swenta* ___, *binti ya a'pas?*). My assumption here was that people would reveal typical plans, or scripts, which can be considered fairly stable cognitive models of anticipated behavior that result from repetitive instantiation of past behaviors (Holland and Quinn 1987; Wallace 1972). In other words, answers might indicate how plant abundance may influence the way people are thinking about curing strategies. I asked these questions for each of five major illnesses during 11 interviews in Nabil and seven interviews in Maravilla Tenejapa.

I also used Spearman-ranked correlation to test for correlation between relative abundance and knowledge distribution. Knowledge distribution was based on a ranking of plants according to the percentage of interviewees who cited a medicinal use for each specimen during the interviews with dried specimens (Chapter 2).

Finally, I used Spearman-ranked correlation to test for correlation between rankings of knowledge and frequency of use.

Results and discussion

The most abundant habitat in Nabil is secondary forest growing on abandoned corn fields (*unin k'inal*), followed by corn fields currently in cultivation (Table 7.1). Some medicinal plants, like the weedy *Erigeron karwinskianus* and *Borreria laevis*, were very common in more than one habitat, and thus are ranked high for abundance (Table 7.2). Others, such as *Salvia lavanduloides* and *Rhus terebinthifolia* were much less common, appearing in only two or three quadrats.

Results from the household surveys of medicinal plant use in Nabil showed that some plants were used much more frequently than others. *Verbena litoralis* was reported to be used on 43 occasions. Other plants were used rarely. For example, *Aloe vulgaris* was only reported once, and *Satureja brownei* was never reported to have been used (Table 7.2).

The most abundant habitat in Maravilla Tenejapa is old-growth rainforest, followed by coffee groves, and then by active and fallow corn fields (Table 7.1). Again, some medicinal plants, like *Vernonia patens*, were very common in one or more habitats and thus are ranked high for abundance (Table 7.3). Others, like the sparsely distributed old-growth forest tree *Pimenta dioica*, were quite rare. Some plants, like *Verbena litoralis* were used often, while others were never reported to be used during the survey period (Table 7.3).

Spearman ranked correlation analysis shows a strong correlation between estimates of abundance and frequency of use in Nabil (r_s = 0.34, n = 34, P = 0.05) and Maravilla Tenejapa (r_s = 0.44, n = 27, P = 0.02). In other words, plants that are more abundant (or accessible) are more likely to be used. This pattern appears to be replicated by the Tzeltal who have migrated from the Highlands to the tropical Lowlands.

Answers to open ended questions about curing strategies suggest that accessibility is a dominant influence in short-term plans. During 43 answers to open ended questions that I obtained in Nabil (which pertained to medicinal plants as opposed to visits to

Table 7.2. Rankings of abundance in the landscape and frequency of use of medicinal plants in Nabil.

Tzeltal name	Species	Ranked by frequency of use	Ranked by abundance
yakan k'ulub	*Verbena litoralis*	1	8
ch'a bakal	*Salvia lavanduloides*	2	29
sakil nich wamal	*Erigeron karwinskianus*	3	1
mes te'	*Baccharis vaccinioides*	4	5
nujkupat	*Cupressus lusitanica*	5	19
nuk balil jonon	*Prunella vulgaris*	6	9
wena	*Mentha citrata*	7	22
chijil te'	*Sambucus mexicana*	8	18
inojo	*Foeniculum vulgare*	9	26
turezna	*Prunus persica*	10	13
sera te'	*Myrica cerifera*	11	11
ajate'es	*Gaultheria odorata*	12	15
tziltzil 'ujch'	*Litsea glaucescens*	13	4
tzajal nich wamal	*Oenothera rosea*	14	10
sak ji	*Cornus disciflora*	15	17
taj	*Pinus sp.*	16	12
we'el buluk' sit	*Borreria laevis*	17	3
tujt	*Equisetum myriochaetum*	18	33
tujkulum ch'ix	*Solanum lanceifolium*	19	14
bankilal	*Nicotiana tabacum*	20	24
kampana nichim	*Brugmansia candida*	21	25
poxil majben	*Sedum praealtum*	22	27
ch'aj kojtom	*Pinaropappus spathulatus*	23	20
yak' tz'i' wamal	*Rumex obtusifolius*	24	23
k'ajk'an	*Chenopodium ambrosioides*	25	21
manzanilla	*Matricaria recutita*	26	28
jijte'	*Quercus sp.*	27	7
paj 'ul 'ul	*Rhus terebinthifolia*	28	31
ch'aj te'	*Ageratina ligustrina*	29	6
sávila	*Aloe vulgaris*	30	30
ijk' al ok tzib	*Adiantum andicola*	31	2
pajchak	*Psidium sp.*	32	34
tzemen	*Epidendrum radicans*	33	16
chicle wamal	*Satureja brownei*	34	32

Table 7.3. Rankings of abundance in the landscape and frequency of use of medicinal plants in Maravilla Tenejapa.

Tzeltal name	Species	Ranked by frequency of use	Ranked by abundance
yakan k'ulub wamal	*Verbena litoralis*	1	11
kulix pimil	*Chaptalia nutans*	2	10
albaka	*Ocimum basilicum*	3	20
pajal majben	*Begonia heracleifolia*	4	6
k'ajk'an	*Chenopodium ambrosioides*	5	13
wena	*Mentha citrata*	6	16
chikin buro	*Neurolaena lobata*	7	7
palo de awa	*Eupatorium schultzii*	8	3
sitit	*Vernonia patens*	9	1
nantsin	*Byrsonima crassifolia*	10	14
ruda	*Ruta chalapensis*	11	23
chijil te'	*Sambucus mexicana*	12	18
pimil wamal	*Bryophyllum pinnatum*	13	19
curarina	*Cissampelos sp.*	14	5
warum	*Cecropia peltata*	15	2
San Martin	*Hyptis verticillata*	16	4
pimienta ak'	*Arrabidaea patellifera*	17	17
sakil nich wamal	*Parthenium hysterophorus*	18	12
limon	*Citrus limon*	19	15
ch'ajkil	*Tithonia diversifolia*	20	24
laj	*Urera* sp.	21	9
pimiente te'	*Pimenta dioica*	22	27
ch'ilwet	*Lantana trifolia*	23	8
tujt	*Equisetum* sp.	24	26
kampana nichim	*Brugmansia candida*	25	22
páta	*Psidium guajava*	26	21
san sibre	*Zingiber officinale*	27	25

clinics or other strategies) 31 began with plants that were easy to find (i.e., ranked in the top 20 most abundant; Table 7.2). Here is an example:

Excerpt 7.1 (from Nabil Interview 124).

Casagrande: Te me ay macha schamel swenta bats'il obal, binti a'pas sbabilal?

> If someone has the common cough, what do you do first?

Subject: Sbabilal? Jich ya jpaytik te sakil nich wamale. Ay . . . ay skap . . . sok mes te'. Ay yan poxil obal. Lom ch'a. Ch'a bakal sbil. Ja' mero poxil obal. Pero lom wokol ta ta'el. Ya xch'i ta ti' bej. Ma xch'i li'i.

> First? Of course we boil *Erigeron karwinskianus*. There's . . . there's a mixture . . . with *Baccharis vaccinioides*. There's also another cure for cough. It's very bitter. *Salvia lavanduloides* it's called. That's real medicine for cough. But it's difficult to find. It grows on the trail, not here.

Casagrande: Te me ma sutsub sakil nich wamal sok mes te' binti a'pas?

> If *Erigeron karwinskianus* and *Baccharis vaccinioides* don't work, what do you do?

Subject: Ya jlejtik ch'a bakal. Te me lom sak' te obale, ya jlejtik sak ji.

> We go and look for *Salvia lavanduloides*. Or if the cough is very itchy we look for *Cornus disciflora*.

This woman's strategy for treating cough is reflected in the general data. Although *Erigeron karwinskianus* was not rated as being a highly efficacious treatment for common cough (Chapter 4), it nevertheless is the 3rd most frequently used medicinal plant (Table 7.2). This is because it is both known to have some beneficial effect and is also the most common medicinal plant in Nabil. Similarly, *Borreria laevis* is not considered a strong treatment for diarrhea, yet it is the 17th most commonly used medicinal plant, mostly by virtue of its being the 3rd most common plant in Nabil.

The tendency to use accessible plants is duplicated in the frontier migrant community Maravilla Tenejapa. Sixteen out of 22 answers to interview questions about plans began with abundant plants near homes. Here is an example of a response to my asking a woman why she used a plant from her yard for diarrhea—a treatment for which the plant is not widely known:

Excerpt 7.2 (from Frontera Interview 74)

> Subject: Como ja' ay ta tsa'nel ku'un a me alale, ja' la jtenbej yuch'. Utsub. Ja' sik yu'un a. Ja' sik te yakan k'ulub, pero ma xch'i li'i. La k'ak'bej mene. Ya xch'i li'i ta jpat na.
>
> > My son had diarrhea. I crushed it and give it to him to drink. It worked. So it must be cold. *Verbena litoralis* is cold, but it doesn't grow here. So I gave him this one. It grows here in the yard.

Thus, when the participants of this study are constructing plans or strategies they most often start with plants that are easier to obtain, and resort to less accessible plants if the first treatments don't achieve desired goals. I should note here that emic rankings of efficacy (Chapter 4) were not correlated with frequency of use ($r_s = -0.03$, n = 34, $P > 0.50$). But note also that a minority of people answered questions about medicinal plant use by beginning with the most powerful plants, not necessarily those close at hand (n = 15 in Nabil). This seemed most important if the respondent was cognizing a severe case of the illness being discussed. Also, *Salvia lavanduloides* shows a clear exception to the general pattern in Nabil (Table 7.2). Although it is ranked 31st in abundance, and most respondents commented that it was hard to find, it is the 2nd most commonly used medicinal plant.

Does it also follow that plants are more likely to be known as medicinals because they are more common; or alternatively, that rare plants are not widely known throughout the community? Apparently not. I found no correlation between rankings of knowledge about medicinal use and rankings of abundance in Nabil ($r_s = -0.23$, n = 34, $P > 0.20$) or Maravilla Tenejapa ($r_s = 0.05$, n = 92, $P > 0.20$). The explanation for this is simple. Many people know about some plants even though they may be rare or even nonexistent in the community. *Salvia lavanduloides* is an uncommon wild plant that was known by 100% of interviewees in Nabil as a cure for cough. Likewise, *Foeniculum vulgare* is a domesticate that is planted in only a few yards in Nabil. Nevertheless, it is known by 98% of interviewees as a treatment for epigastric pain. *Psidium guineense* is widely known as a treatment for oral thrush in Nabil even though it can not survive the cold there and is only found in other Tzeltal communities at lower elevations.

I documented 32 plants that do not grow in Nabil, but are known as medicinals by at least one Nabil resident. Many people learn Lowland plants because they own land or otherwise work at lower elevations. Also, many medicinal plants (e.g., garlic and ginger) are known and purchased from markets in Tenejapa center and San Cristóbal. This points out the importance of the population's mobility and learning that takes place outside of the community.

A similar pattern exists in Maravilla Tenejapa where much knowledge derives from urban markets and educational programs led by teachers visiting from as far away as Europe. This is the primary reason people know about *Pimenta dioica*, which is very difficult to find in the tropical forest in Maravilla Tenejapa. Some people knew where this tree grew and were able to show it to me, but others simply buy dried material in markets for medicinal use.

Also, many older residents of Maravilla Tenejapa remember the high-elevation plants from their communities of origin, and younger people learn these plants during visits with their cold-country relatives. For example, I never found *Baccharis vaccinioides* growing in the tropical Lowlands, but many people who were born and raised in the Lowland frontier, including some young children, could name the mounted specimen as *mes te'* and tell me its Highland medicinal use. Also, some Highland plants did appear in my tropical survey plots, although very rarely. This is probably because they are accidentally introduced (e.g., *Castilleja arvensis*) or intentionally planted (e.g., *Montanoa hexagona*), but can not compete with tropical species. Knowledge about some of these plants appears to be maintained in Maravilla Tenejapa even though they are very rare in the local environment. Again, this is probably a result of visiting the Highlands.

Does it also follow that plants are more likely to be known as medicinals because they are more frequently used? My best answer is "perhaps." Frequency of use was not correlated with knowledge at a probability level of 0.05, but was at 0.10 in both Nabil (r_s = 0.31, n = 34, 0.10 > P > 0.05) and Maravilla Tenejapa (r_s = 0.34, n = 27, 0.10 > P > 0.05).

This suggests that the more frequently some plants are used, the more likely knowledge about them will be distributed, but that other plants are well known even though they are rarely used. For example, 72% of interviewees in Nabil knew that *Rhus terebinthifolia* was used to treat oral thrush, even though it was only reported being used once during surveys, and many people told me that they have never used it more than once or twice during their lifetimes. Gollin (2001) also found discrepancies between use and knowledge among the Kenyah of Borneo, leading her to contend that "while plant *knowledge* is shared by practitioners, *use* is very personal, case dependent and therefore diverse" (p. 223; emphasis in original). Both her results and mine indicate that these two variables are somewhat independent. This points out the need to clearly distinguish between use and knowledge, which has largely not been the case in the literature and has led to considerable confusion regarding such issues as "cultural importance."

Conclusion

The data presented in this chapter show that the relative abundances of medicinal plants in the landscape appear to influence people's plans and strategies for curing, and that participants in this study were most likely to use more accessible plants. But the percentage of people who knew individual plant species as medicinals does not appear to be a function of the relative abundance of plants. Plants that are relatively rare and inaccessible are still well known as medicinal treatments. Also, this pattern appears to be so fundamental that it is very closely replicated in the migrant community.

While plant abundance is clearly influencing behavior, it does not help us to explain the distribution of knowledge as shown in the curves of Figures 2.1 and 2.2. So far I have identified one variable in Chapter 4—perceived efficacy—that appears to be strongly correlated with knowledge distribution. Data in this chapter suggest that another variable—frequency of use—may also be contributing to knowledge distribution, although the correlation is much weaker than for efficacy. These results enhance the ability to explain the shape of the knowledge distribution curves in Figures 2.1 and 2.2, but many problems remain unresolved.

For example, if plant abundance is correlated with frequency of use, and frequency of use is weakly correlated with knowledge, then why is knowledge so poorly correlated with plant abundance? For that matter, if organoleptic and morphological plant characteristics clearly influence the way people think about medicinal plants as others have shown (Brett 1994; Gollin 2001; Johns 1990), and I have shown in Chapter 5, why are these variables so poorly correlated with knowledge distribution? In the next chapter I will show how these problems can be resolved using theoretical concepts from the cognitive sciences; in particular by distinguishing between individual and distributed cognitive processes, and by socially contextualizing shared cognitive models. For example, I will show that although plant abundance and frequency of use are the primary variables influencing category typicality, typicality does not influence category inclusion, which is based primarily on socially shared perceptions of efficacy. And, although plant characteristics like taste and morphology are salient aspects of individual cognitive models, these models are largely *post hoc* explanatory and are often overruled by compelling observations and social factors. Even more important are the effects of social and discursive structure on the diffusion of information, which I discuss in Chapter 9.

Chapter 8
The Influence of Individual and Distributed Cognitive Processes on Patterns of Agreement about Medicinal Plants

Introduction

In previous chapters, I have shown that explanations for patterns of medicinal plant knowledge proposed by other authors can not adequately explain all of the patterns that I observed. One potential reason that these explanations are inadequate is that they do not account for the different ways in which people can arrange information about different types of observed phenomena in their minds while they are recalling information, sharing information, and developing plans of action. It may be true that a plant's taste (Brett 1994; Johns 1990; Logan and Dixon 1994), it's location and abundance (Moerman 1998; Stepp and Moerman 2001), it's humoral property (Etkin 1988a; Mathews 1983), the doctrine of signatures (Alcorn 1984; Etkin 1988a), and cultural constructions of efficacy (Etkin 1988a) all "guide" knowledge. But, which of these variables are most important? How do these "guiding principles" interact? How do the interactions change with context? How are they transformed and manipulated in the highly socialized process of sharing information? Are there different principles, and thus different variables, operating at the scale of individuals versus sharing information in a group? For example, is taste more important in individual cognition than cultural transmission? I don't believe that we can understand how variables like taste, efficacy, or humoral classification explain patterns in knowledge without explicating the specific cognitive and communicative mechanisms that are involved at individual and shared scales of analysis.

In this chapter I use theoretical concepts from the cognitive sciences to synthesize the themes presented in previous chapters in an attempt to explain why some plants are better known as medicinals than others. I hope to explain why there is wider agreement throughout information-sharing communities that some plants are included in the category "medicinal plants" versus others plants. I make heavy use of the concepts of categorization, category typicality, schemas, and shared cognitive models. The goal is to show how the variables introduced in the partial explanations offered above are cognized and communicated by the Tzeltal, and I make particular effort to explicate how these processes interact at the scale of individual versus collective shared cognition.

Categorization and typicality

Categorization is perhaps one of the most fundamental concepts in cognitive studies (Berlin 1992; D'Andrade 1995; Rosch 1978). People derive categories from experience in order to make sense out of their world. Evidence for this process comes from linguistic categorization of games (Wittgenstein 1953), plants (Berlin et al. 1974), animals (Hunn 1977), ceramics (Kempton 1982), diseases (Frake 1961), facial expressions (Ekman et al. 1971), and things to pack in a suitcase (Barsalou 1991), to name only a few of the infinitely possible types of categories that the human mind can produce. Neuropsychological evidence for categorization as a fundamental cognitive process is provided by category-specific aphasias, in which trauma to specific regions of the brain can lead to loss of the ability to recall selective types of information, such as names of animals, fruits, vegetables, and artificial objects (Hart Jr. et al. 1983; Sartori and Job 1988; Warrington and McCarthy 1983). Positron emission tomography (PET scans) and functional magnetic resonance imaging (fMRI) corroborate these studies by showing that retrieval of distinct categories like animals, tools, people, and places all take place in unique areas of the brain (Aguirre and D' Esposito 1997; Damasio et al. 1996; Grabowski et al. 1998).

Categories are necessary for learning and communicating, and their structure can tell us what's important to people (Barsalou 1991; Coley et al. 1997; Kronenfeld et al. 1985;

Medin et al. 1997). Most importantly for this discussion, category structure limits the domain for cognitive processing by intuitively guiding and limiting people's hypotheses about the world around them (Hampton 1998; Keil 1994; Markman 1989). In order to understand why knowledge about medicinal plants is distributed in the patterns I have described we need to know how people are learning and communicating about medicinal plants. A logical first step is to elucidate the structure of the category "medicinal plants." Here, I provide a brief review of theory regarding category structure focusing only on those aspects that might pertain to a category like "medicinal plants."

First, there are "things that people know about items" (D'Andrade 1995:70), and I will refer to these as item attributes.[1] Categories are sets of items with shared attributes (Rosch 1978). For example, most Tzeltal know that some medicinal plants are bitter, others may be sour, still others have no taste. Taste is a potential attribute, along with where plants grow, their 'hot' or 'cold' property, or who told them about the plant. Attributes form bundles of information used to distinguish a set of items from other items that are perceived as less likely to share the same attributes (Rosch 1978). The resulting categories are most often named (Berlin 1992:34; Frake 1972). The Tzeltal label for medicinal plants is the secondary lexeme *poxil wamal* (plural *poxil wamaletik*), derived from the roots *pox* 'to cure' (Maffi 1996) and *wamal* 'herbaceous plant' (Berlin et al. 1974:30). Much of this chapter will be devoted to elucidating the semantic meaning of this label.

Most cognitive researchers now accept that people produce many different types of categories depending on context and the nature of items being categorized (Barsalou 1991; Hampton 1998). Because different kinds of categories have different structures and result from different cognitive processes, an important aspect of my research was to determine what type of category *poxil wamal* is. For the sake of brevity, this discussion will be limited to two types of categories: natural categories, such as birds, plants, and illnesses (Berlin 1992; Frake 1961; Rosch 1978) and goal-derived categories (Barsalou 1991). My discussion begins with a review of definitional category attributes versus graded category structure because I will argue below that the Tzeltal category *poxil wamal* is definitional.

Categorization was originally thought to be based on definitional criteria (Frake 1972; Goodenough 1964). As expressed by Tyler (1969:8): "A semantic domain consists of a class of objects all of which share at least one feature in common which differentiates them from other semantic domains." That is, all items in the category were expected to share some attribute or attributes. For example, if the definitional attribute for *poxil wamal* was "stops symptoms," then subjects would include a plant in the category only if they believe it to have the definitional attribute of stopping symptoms. If any item was not perceived to have that attribute, that item would not be included.

But many researchers have argued against generative and structural checklists of semantic features that constitute necessary and sufficient conditions for set membership (e.g., Fillmore 1982; Tsohatzidis 1990). By the mid-1970s researchers had shown that many categories were graded (Berlin and Kay 1969; Berlin et al. 1974; Rosch 1978). Not all members possessed all of the attributes used to judge category inclusion, and some possessed more attributes than others (Wittgenstein 1953). Rosch (1978) described this as "centrality"—those items that possess all of the features are central, and other items less central. All of the attributes considered together are referred as the "prototype" (Rosch et al. 1976). Those items that most closely resemble the prototype are considered most "typical." Some researchers have argued that when judging an item for inclusion in the category, people match the new item to the prototype attributes (Mervis and Pani 1980; Tsohatzidis 1990; and see Hampton 1998 for a review). Many categories from birds to ceramic pottery have been shown to fit this model (Boster 1988; Kempton 1982). In the case of medicinal plants, efficacy, bitter taste, proximity to households, frequency of plant use, or salient morphological characters could all be attributes forming the prototype. And members of the category would represent these qualities to varying degrees. A plant like *Verbena litoralis* might serve as a highly typical (central) item because it represents all of these attributes to a high degree: it's very bitter, known to cure diarrhea, grows abundantly in houseyards, and is used often. Potential members of the category could be judged for how well they match these prototypical attributes. Note that I am not yet claiming that they are comparing new items with the typical item, just the attributes represented by that item (Rosch 1978). If this is the case it would provide an explanatory cognitive mechanism for the proposals that various plant characteristics guide knowledge acquisition (Brett 1994; Etkin 1988a; Johns 1990; Logan and Dixon 1994). By correlating variables like taste or efficacy with typicality, we might be able to determine what attributes are most important for category inclusion.

Some cognitive researchers have argued that prototypicality has even more important effects than simple category inclusion. Keil (1994), Gelman (1988), and Medin et al. (1997) have suggested that some categories, although initially based on innate intuitions and experience, can lead to beliefs about the essence of items in those categories. Gelman et al. (1994) and Keil (1994) have suggested that early ontogenetic development of prototypes is required for subsequent cognitive development. Keil (1994), for example, showed that children learn the category of plants based on sensory experiences first, and later develop the intuitive expectations that all members of the category will exhibit properties like growth, life, and changing morphological states—expectations that children would not attribute to a category like "furniture." Typicality may form the basis for such intuition because it is a system of expectations about the likely character of an object or class of objects (Cushing 1990). Furthermore, prototypes serve as a basis for inference to other categories (Kronenfeld et al. 1985); in this case it may form a link between medicinal plants and the categorization of illness. These notions would provide an even more powerful cognitive mechanism for the explanations of medicinal plant selection proposed by other researchers. Plant characteristics that they claim "guide" selection, such as bitter taste, could be operationalized as prototypical attributes that structure category acquisition and contribute to an underlying intuition about the essence of *poxil wamal*—plants that have a perceived innate power to cure.

But other researchers have argued that the effects of typicality are more limited (e.g., Wierzbicka 1990). Hampton (1998) has argued that underlying essences of category inclusion are independent of typicality. That is, essence precedes typicality and may be more important than typicality for constructing categories. Regarding medicinal plant categorization, this suggests that attribute-based typicality (i.e., taste, habitat, etc.) is less important than some *a priori* essence-based intuition such as efficacy—a point that I will return to in the discussion of models below.

Although the precise role of typicality is debatable, "no other variable is as prevalent or robust in category processing as prototype structure" (Barsalou 1991:7). A principle goal of the research presented in this chapter was to define the effects of typicality in the category *poxil wamal*.

Goal-derived categories

In addition to categories derived to make sense of the world, some categories are derived purely for functional reasons (Casson 1981:82). Barsalou (1991) has done extensive research with what he calls "goal-derived categories." These are categories constructed by people solely for the purpose of achieving goals. Examples include "things to pack in a suitcase" or "ways to escape being killed by the Mafia." *Poxil wamal* is probably a category derived entirely within the goal of curing illnesses. I will briefly discuss the differences in structure between natural categories and goal-derived categories as proposed by Barsalou (1991)—in particular the nature of typicality—because these have important implications for how the Tzeltal may be thinking and communicating about medicinal plants.

According to Barsalou (1991) a goal-derived category is an *ad hoc* category derived during the process of constructing a plan, such as deciding what one needs to take on a vacation. These categories can develop stability over time as a result of repeated instantiation and sharing between individuals; for example, for someone who travels often and with the same friends or family members. These types of categories are more likely to: 1) have clear definitional attributes based on goals; 2) show typicality that is based on concept combination rather than item-based learning; and 3) be more flexible and prone to context shifts.

Regarding definitional criteria for category inclusion: because the category is derived only for the purpose of achieving a goal, then only items perceived as potentially achieving the goal will be included in the category (Barsalou 1991). The important implication for my case is that if *poxil wamal* is a goal-derived category it should show definitional criteria for category inclusion. In other words, a plant is considered medicinal if it is perceived to cure regardless of its taste, morphological characters, habitat, or other such attributes which vary considerably across items. Thus, my research goals included determining if inclusion in the category *poxil wamal* is based on a definitional goal-based attribute versus a combination of variables. In other words, is *poxil wamal* a natural category or a goal-derived category?

The structure of typicality in goal-derived categories also differs from natural categories. Barsalou (1991) distinguishes between two types of learning. The first is "exemplar-based learning," in which items are experienced and compared to each other, and inductive inferences are drawn from those comparisons. This results in what Barsalou calls "normative knowledge," or "knowledge about the world" (p. 4). This process provides the basis for typicality-based categorization as described above for natural categories. Another type of learning is from concept combination, in which people combine different types of knowledge already in memory. Barsalou gives the example of "purple ocean;" a concept not likely to derive from direct experience, but which can convey meaning because it is based on combinations of normative knowledge. Barsalou calls this second type of knowledge "idealized." It is knowledge about how the world could be (p.4). Because goal-derived categories are based on concept combination—perhaps in my case "plants that cure diarrhea"—typicality should not be based on comparisons between items. Typicality would more likely be based on how well an item is perceived to achieve the goal. Barsalou (1991) conducted a series of typicality experiments with goal-derived categories and determined that goal-based ideals and the frequency of instantiation (frequency with which items were experienced as members of the category) contributed more to typicality than central tendency (resemblance to other items).

If *poxil wamal* conforms to the structure of goal-derived categories proposed by Barsalou, typicality would be based primary on how well a plant is perceived to cure and how often it is experienced as a cure. A variable like bitter taste would only contribute to typicality as much as it correlates with perceived efficacy. A plant's location and abundance would contribute to typicality only if it correlates with frequency of use. As with the definitional criteria for category inclusion, the implication is that efficacy should be the most important variable, to which all other variables must correlate in order to influence Tzeltal thought and communication about medicinal plants. In particular, attribute-based typicality may not influence the distribution of knowledge as would be the case for exemplar-based learning in categories of natural kinds. Again, this points out the need to analyze the structure and effects of typicality. Barsalou (1991) admonished analyzing prototype structure of goal-derived categories in order to reveal category ideals. I tested for correlations between typicality and five variables (plant abundance, frequency of use, strength ratings of taste, efficacy ratings, and agreement about humoral quality), and also tested for correlation between typicality and category membership to determine both the structure and the effect of typicality within the category *poxil wamal*.

A third important difference between natural and goal-derived categories is the higher flexibility (less stability) of goal-derived categories (Barsalou 1991). This is because the contexts in which goals are derived are probably more variable and more likely to change, and because judgements about whether an item meets the definitional criteria are more subject to flexible individual interpretations than natural categories, which are based primarily on natural discontinuities in nature (Atran 1990; Hunn 1977). I am sure it would be easier to convince a Tzeltal informant that a plant they do not know as a medicinal is a valid cure for diarrhea than to convince him that a deer is a type of bird. Although I also should note that *poxil wamal* is probably more stable than "things to pack in a suitcase," because while vacation goals may change often, perceptions of illnesses and their symptoms are much less likely to change.

A final distinction between natural categories and goal-derived categories as presented by Barsalou (1991) is that natural categories must exist *a priori* in order to derive categories to achieve goals. This is because the concepts combined to form idealized knowledge derive from normative knowledge. In other words, the category *poxil wamal* cannot exist without *a priori* classification of illnesses (Berlin and Berlin 1996; Maffi 1994) and plants in general (Berlin et al. 1974).

Although a firm understanding of the structure of the category *poxil wamal* is necessary to understand how categorization is related to the acquisition and dissemination of medicinal plant knowledge, it alone is probably insufficient. Next I turn to the concept of shared cognitive models because "experientially rooted 'cognitive models' provide a basis upon which categories, including linguistic ones, are comprehended and used" (Edwards 1991:515).

Shared models

The term "cognitive model" refers to shared observable patterns in the way people think, speak, or act regarding a topic. Strauss and Quinn (1997:49) have argued that bits of knowledge are organized in the mind by patterns of connections, and these interrelated sets of information are stable within individuals, and broad (or schematic) versions of the patterns are shared by people. It is this shared schematic patterning of experience that allows people to engage in social interaction and meaningful communication. D'Andrade (1995:152) provides the example of the "commercial transaction," in which there is a shared expectation that someone will acquire some good or service in exchange for some form of payment. These internal representations of related information are manipulated by people to solve problems and to navigate their way through life. Many researchers have documented cognitive models of illness and curing (e.g., Barsh 1997; Garro 2000; Tannen and Wallat 1986; Young 1981).

There are at least three reasons why I need to consider models in my attempt to explain patterned distributions in medicinal plant knowledge: 1) the study of models can help contextualize category acquisition; 2) typicality may guide the distribution of knowledge at the scale of shared models even if it does not guide category membership at the scale of individual cognition; and 3) models provide the structure for cultural transmission. My other motivation to study models in combination with categories derives from the surprising dearth of attempts by cognitive researchers to reconcile these two concepts despite their importance as indicated in the literature. I hope to provide preliminary insights into how categories and models may interact.

Categorization of natural kinds is based primarily on the recognition of patterns as presented by nature (Atran 1990; Berlin 1992). The ultimate goals of goal-derived categories are probably also of universal origin (e.g., maintaining well-being and minimizing effort; Barsalou 1991). But proximate goals are highly variable and goal-derived category knowledge acquisition happens in highly contextualized environments. One must continuously derive intuitive notions from the disparate domains of knowledge about plants and illnesses and combine them in some meaningful manner. This is an important role for models, and other researchers have argued that the development of model-based intuition is essentially a social process (Garro 2000; Price 1987).

How might this work? At first it appears that there is little in the attribute-based structure of the natural categories of plants and illnesses that could lead to inferences between these highly disparate domains. Plant categorization is based primarily on morphological attributes of plants (Berlin et al. 1974), while illness classification is based on observation of human physiological phenomena (Berlin and Berlin 1996; Maffi 1994). This indicates that a whole new model is required to link these domains. But where might this model come from, if not from intuitive inferences deriving from the two categories of which it is comprised?

Boyer (1998), Gelman et al. (1994), and Keil (1994) have provided compelling arguments for innate (evolved) intuitive ontologies, such as infants' expectations about living kinds, people, and physics. It is through social interactions with adults that children develop these intuitions into full-fledged explanatory models, with the implication that a lack of social interaction would preclude development. I propose that an innate predisposition to notice cause-and-effect relationships between one's actions (such as ingesting a certain plant) and the resulting physiological response is another case of a socially-mediated intuitive ontology. The research programs of Glander (1994), Huffman et al. (1996), and Phillips-Conroy (1986) provide good evidence for the ability of nonhuman primates to learn to overcome aversions to eating very nasty plants in response to temporal variations in parasite loads. Phillips-Conroy (1986) and Glander (1994) have shown that this is not a hard-wired evolutionary trait, but a socially-distributed, learned ability. Baker (1996) has shown that capuchin monkeys that topically apply plants to control epidermal parasites learn this behavior through the social process of grooming. What's more, this ability to learn socially may extend farther back in evolution. Clark and Mason (1985) showed that starlings who did not line their nests with *Solidago rugosa* had higher nest parasite and pathogen loads. They identified the phytochemicals responsible for lowering pathogen and parasite loads, and showed that olfactory detection of these compounds and their use in nests were learned and socially transmitted behaviors. These are probably not evolved traits, because starlings who did not learn the behavior from their parents did not line their nests. Humans, no doubt, posses a much greater innate potential for learning and sharing such cause-and-effect relationships. What is unique about humans is our potential to symbolically "pool" common experiences to enhance potential explanatory scope and rigor.

The relationship between medicine and diet is another key component of the explanation for the development of medicinal plant use that I am outlining here. Intuitive expectations of efficacy are applied to plants largely because of the numerous potential pharmacological agents that occur in them (Johns 1990), and a major precursor for humans to develop models about plants and their ability to cure may be the occurrence of pharmacoactive chemicals in plants that are eaten (Johns 1986; Katz 1982). Etkin and Ross (1991) have shown that 90% of Hausa antimalarial plants appear in their diet. The argument proposed by the advocates of the link between diet and medicine is that people recognize a link between physiological states and patterns in their diet, and then develop explanatory models based on culturally-determined salient characteristics of both plants and illnesses (Johns 1990). Although as Katz (1987) notes, the process of discovery and the implications of implicit versus explicit knowledge (trial and error versus empirical observation) remain very unclear. I suggest that people probably use analogies from diet-based models to generate new models and new inferences. Collins and Gentner (1987) have shown that this is commonly done by mapping transition rules from a known domain to a target domain. Etkin (1988a) has argued that a fundamental component of explanatory models of illness is "process," and this could be an example of the type of insight derived from diet-based models and applied to the larger domain. But as Collins and Gentner note (1987), when a source domain (e.g., in this case food) is inadequate, information from several domains (e.g., food and salient morphological characteristics of plants) may be combined in a way that does not necessarily form a logically coherent whole. This could explain my observation that individual Tzeltal models of medicinal plants are quite often self-contradictory regarding taste, humoral properties, and morphological characteristics. As Garro (2000) points out, individual schemas are based on unique experiences, while shared models are built from common experience. Models need not always be logically consistent at the individual level (Strauss and Quinn 1997:177).

Whatever the exact process of model development in any given population, explanatory models do not develop on an individual basis—potential hypotheses, perhaps—but not full models. Intuitions are combined and manipulated within a shared schematic patterning of experience (Garro 2000), and models are socially negotiated (Garro 2000; Price 1987; Strauss and Quinn 1997:188). Thus, what becomes widely accepted as the most important features of the model—for example, taste and morphological characters (Etkin 1988a), irritative qualities of emmenagogues (Browner and Ortiz de Montellano 1986), which symptoms are most important to control (Luber 1999)—is as much a result of relationships of power, individual persuasive abilities, and patterns in communication networks, as it is patterns in the basic information that people are presented with. Thus, people living in environments with nearly identical floral and epidemiological context, but who do not talk to each other, can develop radically different models of medicinal-plant curing (Shepard 1999).

Explanatory curing models bring new meaning to the general category of plants and to plant characteristics that may not have been part of the structure of basic plant categorization. Item attributes, like taste, that did not contribute to category acceptance or classification acquire new meaning within models of efficacy (but probably without altering the basic classification of plants). Salient attributes of folk taxa considered to be particularly effective cures can become salient aspects of models of efficacy in general (e.g., bitter taste). And by extension, typicality in models (like taste) may guide acceptance into the category *poxil wamal* even if typicality in the category of plants in general (*wamal*).

Typicality notwithstanding, other normative knowledge and intuitions derived from the structure of natural categories *are* fundamental to the structure of both models of plant-based curing efficacy and the category *poxil wamal*. If theories of category-based intuitions are correct, there is an expectation that all plants posses a variety of yet-unknown essential properties (Keil 1994). In this case, if some plants in the diet are discovered to cure, it could be expected that all plants share that power. Iwu (1986) has claimed that the Igbo believe all plants have a curative spirit in them that must be divined. Discursive data that I present below show that many Tzeltal believe that for every illness there is a plant imbued by God with a power to cure that illness, and it is the responsibility of humans to discover which plants cure the various illnesses.

There are also important intuitions derived from the internal structure of natural categories. Rosch (1978) and her colleagues showed that judgments about internal category structure operate primarily at a basic taxonomic level that corresponds with folk and scientific genera. The most important intuition that people derive from basic-level categorization of plants is that contrasting folk genera are expected to differ in some essential properties (Coley et al. 1997). Just because one folk genus may relieve symptoms of diarrhea, doesn't mean people will expect that another genus will necessarily have the same property. In other words, although a general model of medicinal plant efficacy and intuitions at the broadest taxonomic level of life form may lead to expectations that all plants will cure, basic-level contrast provides an expectation that different plants will cure different illnesses. Hence, people have an incentive to continue to explore the general category (life form) of plants for potential medicinals. Thus a new category (*poxil wamal*) is derived, which is based on innate intuitive ontologies of nature, life-form and basic-level differentiation, efficacy, and socially-mediated saliency.

What I am calling the innate propensity to discover efficacy leads all cultures to develop models of curing that link disparate domains of knowledge and experience. Since most people eat plants, and many edible plants have pharmacological properties, it is inevitable that plant-based models of curing will arise. There is no evidence of any human population that does not exhibit some broad concept of plants that cure some category of physiological conditions perceived as being deleterious. The diet-based theory that I have outlined here is not new (Etkin and Ross 1991; Iwu 1986; Johns 1990). I have simply explicated some potential fundamental cognitive processes that may be involved. The important implications for my research are that models will limit the domain for processing by intuitively guiding and limiting hypotheses, efficacy may dominate all other variables in attempts to explain patterns of knowledge acquisition and transmission, and the social elements of shared models can give us key insights into the processes of learning and sharing. The implications for cognitive theory in general lie in my having provided a tentative outline of how processes of categorization and cognitive modeling may interact.

I have also provided important points to consider for the cultural transmission of medicinal plant knowledge discussed in the next chapter. Cultural transmission via discourse, observation, or practice is structured and patterned by the culturally-shared schematic components of models (Strauss and Quinn 1997:176). The Tzeltal maintain a cognitive division of labor not unlike that described by Hutchins (1995:176) for team-based navigation. In my case, men know some things, women know others, but all cooperate. Shared models form a nexus for disparate and sometimes conflicting ideas so that people can communicate (Fillmore 1982) and interact (Hutchins 1995:175-228).

Discourse pragmatics provide an example. Determining the intended meaning of utterances requires extensive inferences on the part of listeners (Schwarz 1996:7). In making these inferences, speakers and listeners rely on a set of tacit assumptions that govern the conduct of conversation in everyday life. Shared models provide those inferences, and shared models show an hierarchical structure of dominant and subordinate themes that allow for flexibility within some discursive structure (Strauss and Quinn 1997:118). The order of importance of themes probably provides a basis for cultural transmission of Tzeltal medicinal plant knowledge. Dominant themes could simultaneously enhance transmission by providing shared understandings while potentially limiting the diversity of information transmitted if typicality leads to domination of those themes by a limited domain of model features.

The remainder of this chapter deals with methods of analysis, results, and discussion. The overall goal was to determine which, if any, of the interactive cognitive concepts described above help explain patterns of knowledge distribution in the four Tzeltal communities. The first goal was to determine the psychological validity and structure of the category *poxil wamal*; in particular, determining whether it shows characteristics of goal-derived categories and analyzing the nature of typicality within the category. I also analyzed individual and shared models to show what themes and features are important, and how individual cognition is linked with shared cognition; especially, how plant-based typicality might lead to typicality in models. Next, I tested for effects that plant-based typicality in model features might have on knowledge acquisition and dissemination. Finally, I make suggestions for the role of category and model-based typicality in cultural transmission—the subject of the next chapter.

Category validity methods

The first analysis was intended to determine if *poxil wamaletik* 'medicinal plants' is a culturally meaningful category to the Tzeltal of Nabil. I elicited freelists from 42 survey participants in Nabil by asking for the names of all the medicinal plants (*poxil wamaletik*) that they knew (*binti sbil jujuten poxil wamaletik ya a'na?*). Using ANTHROPAC (Borgatti 1996b:21) I used the freelists to generate an informant by plant matrix for the respondent population. Each plant was coded as 1 or 0 depending on whether informants mentioned the plant in their freelist or not. I performed consensus analysis on the matrix to determine if informants agreed about which items belong in the set (determined by a ratio of the first to second eigenvalue of at least 3:1). I also applied consensus analysis to the plant-based interview question "does this plant cure?" (*ya bal xpoxta ja' ini?*), which I asked during the 28 interviews that included all 130 potential medicinal plants in Nabil. Responses were coded as 1 or 0 depending on whether respondents answered yes or no. Again, I used a ratio of the first to second eigenvalue of at least 3:1 as the criterion for determining if there was a shared meaningful category.

The next analysis involved three techniques to determine the definitional attributes of the category. First, I counted the occasions in which utterances about various plant attributes were volunteered by respondents during freelist tasks. The assumption was that such “thinking out loud” would reveal what attributes were involved with instantiation, and that the frequency with which the attributes were volunteered were correlated with their importance in the instantiation process.

Second, after freelist interviews I randomly selected four plants from freelists of 11 participants who I knew I was going to interview again. I asked them at the beginning of the second interviews: “Why is ___ a medicinal?” (*Bi yu’un ja’ poxil* ____?), inserting the name of each of the four plants. I then summed the total responses for the various attributes to determine which were most common.

Third, I analyzed discourse data using HyperResearch (see Chapter 2) by searching and coding cases in which someone was talking about excluding or including a plant in the category *poxil wamal*. The goal was to see which attributes were being used in reasoning processes.

Category typicality methods

The goal of the next analysis was to determine if the structure of the category *poxil wamal* shows typicality effects, and if so, to determine which variables most contribute to typicality. I was not successful in asking respondents to rate items for typicality (Rosch 1978) because of problems translating the instructions into Tzeltal. Therefore, I used item saliency in freelists to generate typicality ratings (Borgatti 1996a:2-3). Since the time that research on typicality began, it has been shown that the order in which items are listed when subjects were asked to name members of a category is strongly correlated with typicality (Rosch 1975). Rosch et al. (1976) showed that prototypical items were more likely to be listed first and more frequently. Subsequent research suggests that this is because of the strong influence of category typicality on the process of instantiation during recall (Ishige and Hakoda 1984; Storm 1980). Barsalou (1983) showed that typicality was also correlated with item listing for goal-derived categories.

I used Smith's Index of Saliency (Borgatti 1996b:21) as a measure of typicality because it accounts for both the order and the frequency with which items appear in freelists (Borgatti 1996b:21). All items that appeared in freelists were ranked according to their freelist saliency. I used Spearman ranked correlation (Zar 1996:389-392) to determine which variables (frequency of use, plant abundance, overall knowledge, strength ratings of taste, efficacy ratings, and agreement about humoral quality) were significantly correlated with typicality as derived from freelist saliency in Nabil, based on the assumption that those variables most strongly correlated with typicality were the variables that most influence respondents' cognitive representations of typicality

Shared model structure methods

My first task regarding cognitive models was to elucidate the structure of individual and shared models of plant-based illness curing by using thematic discourse analysis (Colby 1975; Strauss and Quinn 1997: 167-168). The basic assumptions underlying the analysis were: 1) meaning is subsumed within conceptual networks that are hierarchical cognitive models of features within themes (Holland and Quinn 1987); 2) these themes and features are revealed in discourse (Colby 1975; Palmer 1996:291; Strauss and Quinn 1997:118); and 3) the relative frequency and hierarchical position of themes and features indicates their importance in discursive thought and communication.

I tape-recorded responses to open-ended questions and opportunistically tape-recorded spontaneous natural conversations in the Highland community of Nabil and the migrant frontier communities Maravilla Tenejapa and Salto de Agua (see Chapter 2). I tape-recorded 21 hours of discourse from 32 different participants ranging in age from 18 to 77. The original Tzeltal transcriptions were entered into the Macintosh-based text analysis software HyperResearch. I coded the data in HyperResearch and analyzed codes for hierarchical relationships to search for major themes and subordinate features. I then ranked the themes according to how often they appeared in order to determine their relative importance of themes in discourse.

Plant-based typicality in shared models: Methods

I have noted that because goal-derived category typicality is not based on within-category resemblance than it might not guide intuition about category membership. But category-based intuition also takes place within the context of shared models during discursive learning events. If typical plants come to dominate some models, it is quite possible that typicality effects could influence the sharing of information through models at the discursive scale of analysis.

First I coded and analyzed the data to determine if some plants and their characteristics dominate discourse. I coded each unique occasion when each of the nine most common illnesses were being discussed. For example, *tza'nel* (diarrhea) was a topic of discussion on 67 occasions. I then calculated the percentage of occasions during which individual plant species, plant tastes, methods of preparation, and humoral ('hot' vs. 'cold') properties were mentioned—in other words, the frequency with which various features were used to fill in plant-based themes. I analyzed these results to determine if any particular features were dominant, indicating their typicality.

I tested two possible ways that plant-based typicality in models was guiding the acquisition and dissemination of knowledge. The first notion was that typicality guides acceptance. That is, new medicinal information about plants that closely match the properties of the most typical medicinal plant in an illness model, including the new plant's perceived ability to relieve the same symptom as the typical plant, should become widely distributed throughout the community.

The second possibility is an alternative to the first: typicality discourages acceptance and dissemination of knowledge about plants that don't fit the models well. In other words, New medicinal information about plants that do not match the properties of the most typical medicinal plant in an illness model should not become widely distributed throughout the community.

I investigated these possibilities two ways. First I documented how many plants are known by a few people in the community and closely match the prototypical medicinal plants, but have or have not been incorporated into the shared knowledge system. Second, I analyzed the discourse data discussed above using HyperResearch by coding for cases in which people were reasoning about category inclusion, and then counting the frequency with which different themes and features were being used in the reasoning process.

The goal-derived category *poxil wamal*

The first analysis was intended to determine if *poxil wamaletik* ‘medicinal plants’ is a culturally meaningful category, and if so, if there is a definitional criterion for category inclusion. Consensus analysis of freelists from Nabil suggests that a meaningful category does indeed exist. The ratio of the first to second eigenvalue was 3.8, indicating that there was only one systematic pattern of responses shared throughout the population (Borgatti 1996a:45; Romney et al. 1986). Consensus analysis of the structured ethnobotanical interview question “does this plant cure,” asked for each plant, also showed agreement about what plants belonged in the category as expressed by the first to second eigenvalue ratio of 5.6. (Of course, there was more agreement about some plants than others, as is shown in Figures 2.1 and 2.2.) These results indicate that the population generally agrees about what items are appropriate to include in the category *poxil wamal*. In other words, there is a shared understanding of which plants are appropriate to use as cures, but some plants are better known throughout the population as medicinals than others.

Analysis of the attributes used to represent the category indicated that there is a primary definitional attribute—efficacy—that is used to judge inclusion in the category, and to which all other attributes are secondary. In short, the plant must alter a symptom of an illness in order to be considered *poxil* by the novice population of Nabil.

The number of attributes mentioned during freelists showed the importance of efficacy in item production. Respondents often began freelists by mentioning an illness, and they frequently mentioned illnesses and symptoms that plants cure throughout the freelists. Here is an example:

<u>Excerpt 8.1 (from Nabil Interview 35)</u>

<u>Casagrande</u>: Binti sbil spisil poxil wamaletik? A la jujuten ya a'na.

What are the names of all the medicinal plants that you know?

<u>Subject</u>: A la jujuten. Bueno, ja' te poxil obale. Ja' mene . . . ay ch'aj bakal. Ja' mero poxil mene.

All of them. Well, there are plants that cure cough. There's this . . . there's *Salvia lavanduloides*. It's a very good cure, that one.

[pause]

<u>Casagrande</u>: Bi yan?

What others?

<u>Subject</u>: Ja' ini ni ni . . . . sakil nich wamal, sipres . . . ja' ini ni . . . Bueno, ay yan wamaletik ya xpoxta ek tza'nel. Ja' yakan k'ulub . . . tsajal nich wamal. Ja' te mes te'e. Ya spoxta ek obal. Sak obal. Ay bayel yip yu'un mes te'.

There's this . . . *Erigeron karwinskianus*, *Cupressus lusitanica*. . . this . . . Well, there are plants that also cure diarrhea. *Verbena litoralis* . . . *Oenothera rosea*. There's *Baccharis vaccinioides*. It also cures cough. A dry cough. *Baccharis vaccinioides* is very powerful.

Altogether, illnesses, symptoms, and the abilities of the plants to cure were mentioned 235 times during the freelisting tasks. This far exceeded utterances regarding taste (n = 54), preparation (n = 18), how respondents learned about the plant (n = 15), and habitat or availability (n = 10). 'Hot' or 'cold' properties were never mentioned during freelists. In most cases participants appeared unable to recall plants at all without first considering an illness category. Not surprisingly, the order of plants in freelists shows a striking pattern of being grouped by the illnesses that they cure. These results strongly suggest that the ability of a plant to cure an illness was the most important attribute involved with the production of items in the category *poxil wamal*.

Responses to the direct question “Why is plant ___ a medicinal?” also showed the importance of efficacy. Most (70%) answered that the plant was medicinal because it cured a particular illness, and they always named the illness. Only 18% answered that it was medicinal because of it’s taste (mostly bitter), 5 % said it was because someone told them, 5% cited a ‘hot’ or ‘cold’ property, and 2% answered that they did not know, or that “God made it that way.”

The discursive data regarding category inclusion and exclusion also support efficacy as the primary definitional attribute. I documented 11 cases of speakers reasoning about category inclusion, and all were based on efficacy. The following three interview excerpts are examples of the importance of efficacy as a definitional attribute in the reasoning of category inclusion:

Excerpt 8.2 (from Nabil Interview 124)

Casagrande: Entonces, la yalbet ja’ poxil.

So, they told you it was a medicinal.

Subject: Jich’. La yalben ja’ sup. Sup sok sik. Bak ja’as spil. Ya jtentik. Ya skejcha yu’un k’ux eal xi. La xtiwan jkeh. La xtiwan jol. La jten. La kak’ te banti a, pero ma la skan. Lom sup. Pero ma ba poxil.

Yes. They told me it was astringent. Astringent and cold. The seed of *Pouteria mammosa* it’s called. You crush it. It calms the toothache, they said. My tooth was pounding. My head hurt. I crushed it and put it on the tooth, but it didn’t want to cure. It’s astringent, but it’s not medicine.

Casagrande: La yalbet anima a’me?

Your (deceased) mother told you?

Subject: Ja’. Anima jme' la yalben ya spoxta k’ux eal. Pero ma la skan.

Yes. My dead mother told me it cures toothache. But it didn’t want to.

Casagrande: Ja’ bal poxil wamal?

Is it a medicinal plant?

Subject: Mayuk. Ma ba poxil wamal.

No, it’s not a medicinal plant.

Excerpt 8.3 (from Maravilla Tenejapa Interview 34)

Casagrande: Bi yu’un ja’ poxil wamaletik mene?

Why are these plants medicinal?

Subject: Ya no sé. Bueno . . . El Señor nos da plantas para todas las enfermidades. Tenemos que buscar las plantas que cura cada chamel. Hay algunos ch’aj. Hay otros k’ixin. Pero no cura todo. Si no cura, entonces . . . ma ba poxil. Tenemos que buscar todo los medicamentos.

I really don't know. God gives us plants to cure every illness. It's up to us to discover what plants are good to cure the different illnesses. Some plants are bitter. Some plants are hot. But not all plants cure. If it doesn't cure then it's not medicine. We have to keep looking for all the medicines.

The next excerpt is from a conversation between a man from the Highlands (Subject 1) who was visiting his cousin (Subject 2) who lives in the tropical Lowlands. Subject 1 does not know about the medicinal use of *Solanum lanceifolium* and therefore is judging the possibility of category inclusion without the benefit of firsthand experience. The emphasis on efficacy is so compelling that Subject 1 ultimately agrees that it must be medicinal, despite his complete lack of knowledge about the illness in question:

Excerpt 8.4 (from Salto de Agua Interview 12)

Subject 1: Ya bal xpoxta Tujkulum ch'ix?

Solanum lanceifolium cures an illness?

Subject 2: Ja' in'i swenta la sida. Cartones la yich'bel te maestroe, yich'bel dos cartones, parte xkuchoj ta smochila, pero nojel ya yich'bel ta jo'bel. Te tujkulum ch'ixe. Ja', ta jun litro 50. Ya spasix preparar a, pero ja'naxi spay jich mene, mayuk asukar niwan. Mayuk kuch'oj.

This one cures AIDS. The teacher from here took it away in boxes, two boxes, and then some more in his backpack. He took it all to San Cristóbal. *Solanum lanceifolium*. One liter is worth 50 pesos. You prepare it by itself, you boil it . . no sugar I think. I haven't tried it.

Subject 1: Mayuk.

You haven't tried it.

Subject 2: Mayuk. Ja' te spoxta, maestro, ya sna be sba.

No, but the teacher uses it to cure. He knows it.

Subject 1: Ay la . . . yuch'oj te maestro.

The teacher drank it?

Subject 2: Yuch'oj. Yu'un la tsakot chajp chamel, ta Mejiko la tsajk'tal, sida, pero mayuk xpoxil sida, sino que ja' la yuch' in to, la la yuch', tujkulum ch'ix. Kol te sida. Kol te sida. Ja' yuch' mene, cheb maestroetik la kotok ta mejiko, maek xpoxil, k'ax ta radiografia, mayuk, sujt'anbel ta na ba male ora, tal smaleix ora ta k'ala alanix a, pero ja' la yai stojol ja' mene, ja' och stuntes, stuntes, stuntes. Bajt' xan ta mejiko ba spas checar ta radiografia maekix a.

He drank it, because he was grabbed by a strange illness. In Mexico City he was grabbed by AIDS. But there is no cure for AIDS. You can only use this, *Solanum lanceifolium*. He drank it and it cured the AIDS. Two other teachers arrived in Mexico City. There was no remedy when they received their X-rays, no cure. Better to return to their homes and await their hour of death. So they went to hot country, but they found out about this plant. They began to use it. They kept using it. They returned to Mexico City to check their X-rays again, and it turned out that they didn't have it.

Subject 1: Utsub.

It cured it

Subject 2: Utsub.

It cured it

Subject 1: Mayukix chamel.

No more illness.

Subject 2: Mayukix a. Spisil, ya sutsubtes. Mero poxil mene. Mak ay jich bi la wal ajkixe, ay jich ts'in ajk'a ta chuxnel, bati to achuxnej xane, o bati ts'in ajk'e . . . ja' yu'un mene

No more illness. It cures lots of things for you. This plant is real medicine. Like I told you a while ago. I told you it cures when you can't stop urinating. Again and again you have to urinate.

Subject 1: Ya jpas prueba ya jlebel.

I'm going to look for this and try it.

In summary, consensus analysis of freelists and the plant-based interviews indicate that *poxil wamal* is a shared meaningful category. Analysis of the attributes used to define the category indicate that efficacy (the ability of a plant to alter an illness symptom) is the primary definitional attribute of category inclusion. This strongly suggests that *poxil wamal* is a goal-derived category as described by Barsalou (1991).

A culturally shared representation based primarily on the definitional attribute of efficacy is important for the cultural transmission of medicinal plant knowledge. When people are talking about *poxil wamaletik*, the primary underlying assumption is that the plants being discussed will cure some culturally recognized symptom. This suggests that it is the definitional criterion of efficacy, not taste, abundance, or humoral quality, that would most influence the distribution of knowledge. I believe this is the primary explanation for the high correlation that I found between rankings of efficacy and the distribution of knowledge (see Chapter 4).

The goal-derived category of *poxil wamal* is different in structure from natural categories like *wamal* ('herbs' in general), which are based primarily on basic-level contrasts of salient morphological characteristics (Berlin et al. 1974; Berlin 1992). *Poxil wamal* is a category derived while constructing plans to achieve the goal of correcting illness symptoms. As such, we would expect the category to show characteristics of goal-derived categories as proposed by Barsalou (1991). In particular, the processes of category derivation would be more schematic and flexible. Unlike natural categories, the importance of attributes, other than the definitional attribute of efficacy, in category inclusion, plans, and conceptual combination with other categories could shift depending on context. More importantly for explaining the distribution of knowledge, we would expect typicality to be an ideal-based derivation as opposed to family resemblance or other normative knowledge, and typicality would have much less effect on guiding intuition and cultural transmission. In the following section I will analyze the structure of typicality in order to study its role in these processes. The structure of typicality is also important because it can show what ideals are being optimized in planning (Barsalou 1991). Typicality in goal-derived categories tells us how people are combining all of the possible category attributes and which are most important for behavior.

Typicality within the goal-derived category *poxil wamal*

Analysis of saliency in freelists using Smith's Saliency Index clearly indicated that some items were instantiated as representations of the category *poxil wamal* more frequently and sooner than other items (Figures 8.1-8.4), indicating that some items are more typical of the category. One item in particular, *yakan k'ulub* (*Verbena litoralis*), was much more salient in all four towns (Table 8.1).

Saliency falls rapidly after the first plant, and the second and third most salient plants form a "second tier" of saliency, beyond which the remaining plants show lower and

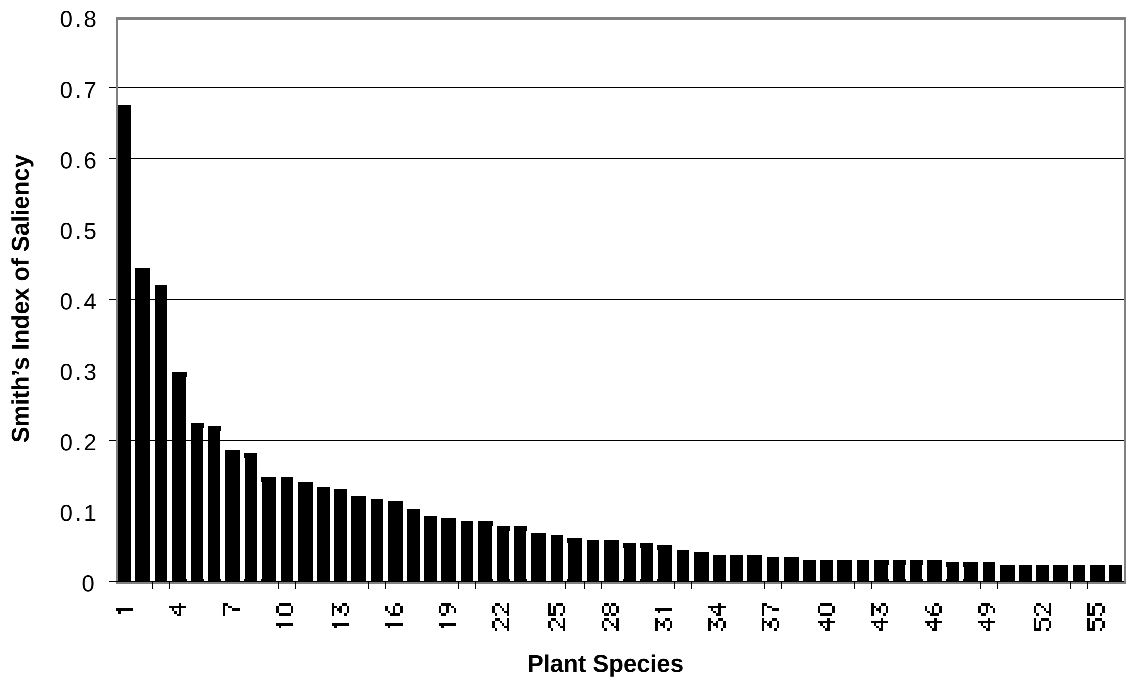

Figure 8.1. Freelist item saliency from the Highland community Nabil.

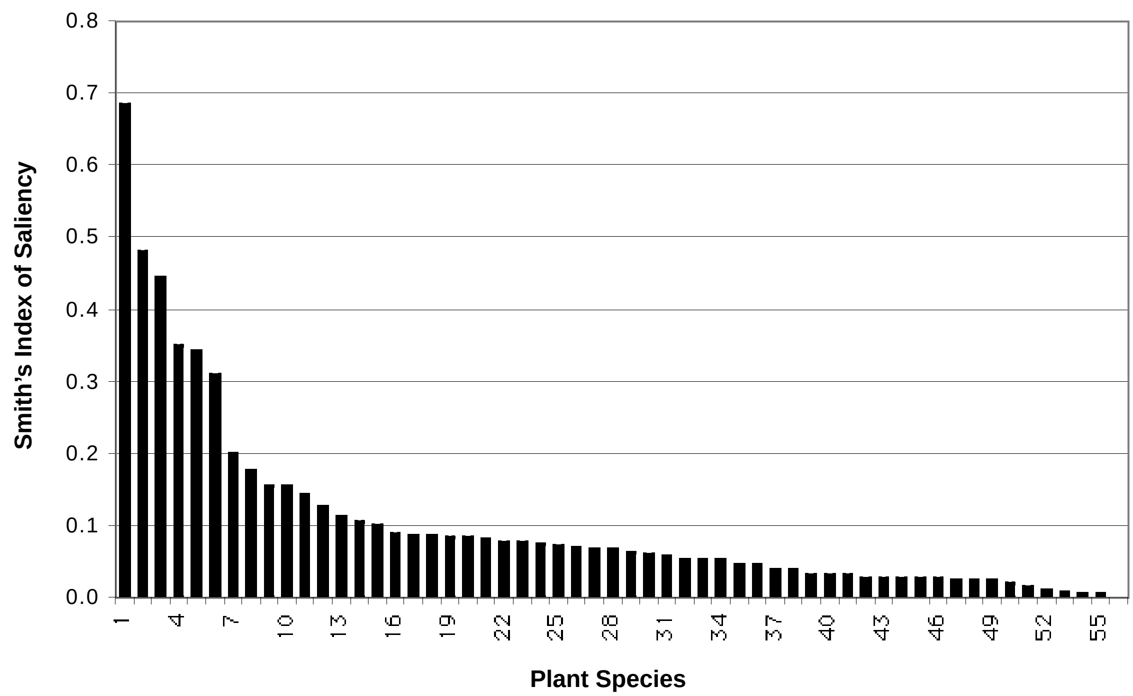

Figure 8.2. Freelist item saliency from the Highland community Ch'ixaltontik.

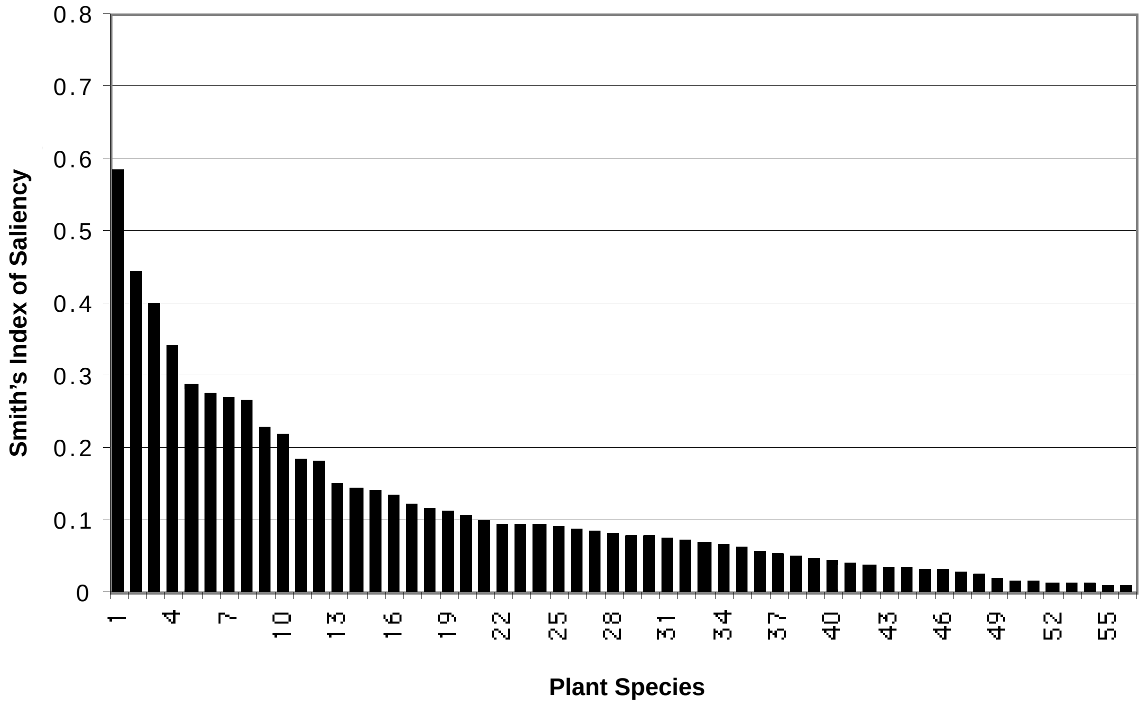

Figure 8.3. Freelist item saliency from the frontier community Maravilla Tenejapa.

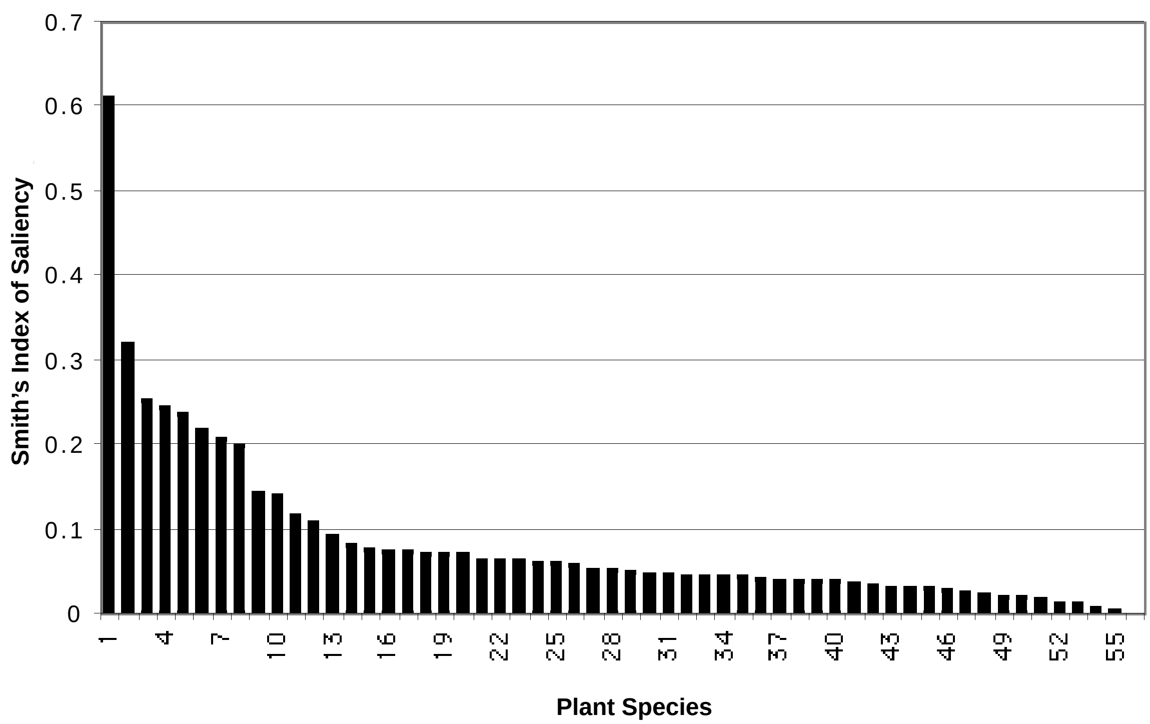

Figure 8.4. Freelist item saliency from the frontier community Salto de Agua.

Table 8.1. Freelist saliency indicating item typicality in the category *poxil wamal* for two Highland and two tropical frontier communities. (Only the 20 most salient species from each community are shown.)

Nabil (Highland)		
Species	Tzeltal Name	Smith's Index of Saliency
Verbena litoralis	*yakan k'ulub*	0.67
Salvia lavanduloides	*ch'a bakal*	0.44
Baccharis vaccinioides	*mes te'*	0.42
Lopezia racemosa	*tsajal nich wamal*	0.29
Erigeron karwinskianus	*sakil nich wamal*	0.22
Gaultheria odorata	*ajate'es*	0.22
Foeniculum vulgare	*inojo*	0.18
Myrica cerifera	*sera te'*	0.18
Cupressus lusitanica	*nujkupat*	0.15
Litsea glaucescens	*tziltzil 'ujch'*	0.15
Prunus persica	*turezna*	0.14
Solanum lanceifolium	*tujkulum ch'ix*	0.13
Ageratina ligustrina	*ch'aj te'*	0.13
Sedum praealtum	*poxil majben*	0.12
Borreria laevis	*we'el buluk' sit*	0.11
Cornus disciflora	*sak ji*	0.11
Eryngium sp.	*yak' tz'i' wamal*	0.1
Mentha citrata	*wena*	0.09
Chenopodium ambrosioides	*k'ajk'an*	0.09
Sambucus mexicana	*chijil te'*	0.08

Ch'ixaltontik (Highland)		
Species	Tzeltal Name	Smith's Index of Saliency
Verbena litoralis	*yakan k'ulub*	0.68
Salvia lavanduloides	*ch'a bakal*	0.48
Borreria laevis	*we'el buluk' sit*	0.44
Baccharis vaccinioides	*mes te'*	0.35
Mentha citrata	*wena*	0.34
Ageratina ligustrina	*ch'aj te'*	0.31
Prunus persica	*turezna*	0.2
Sambucus mexicana	*chijil te'*	0.18
Smallanthus maculatus	*ch'ajkil*	0.15
Foeniculum vulgare	*inojo*	0.15
Chenopodium ambrosioides	*k'ajk'an*	0.14
Peperomia sp.	*pimil wamal*	0.13
Nicotiana tabacum	*may*	0.1
Psidium guineense	*pajchak*	0.1
Aloe vulgaris	*sávila*	0.09
Musa sp.	*lobal*	0.09
Apium leptophyllum	*kulantu chitam*	0.09
Rumex crispus	*yak' tz'i' wamal*	0.08
Annona cherimola	*k'ewex*	0.08
Erigeron karwinskianus	*sakil nich wamal*	0.08

Maravilla Tenejapa (tropical)		
Species	Tzeltal Name	Smith's Index of Saliency
Verbena litoralis	*yakan k'ulub*	0.58
Neurolaena lobata	*chikin buro*	0.44
Byrsonima crassifolia	*nantzin*	0.4
Vernonia patens	*sitit*	0.34
Aspidosperma cruentum	*ch'ich' te'*	0.28
Citrus sinensis	*alchax*	0.27
Chaptalia nutans	*kulix pimil*	0.27
Solanum lanceifolium	*tujkulum ch'ix*	0.26
Begonia heracleifolia	*poxil majben*	0.22
Mentha citrata	*wena*	0.21
Cissampelos sp.	*curarina*	0.18
Sida sp.	*tzatzames*	0.18
Chenopodium ambrosioides	*k'ajk'an*	0.15
Foeniculum vulgare	*inojo*	0.14
Ruta chalapensis	*ruda*	0.14
Sambucus mexicana	*chijil te'*	0.13
Musa sp.	*lobal*	0.12
Psidium guajava	*pata*	0.11
Citrus limon	*limon*	0.11
Cecropia peltata	*warum*	0.1

Salto de Agua (tropical)		
Species	Tzeltal Name	Smith's Index of Saliency
Verbena litoralis	*yakan k'ulub*	0.61
Neurolaena lobata	*chikin buro*	0.32
Byrsonima crassifolia	*nantzin*	0.25
Psidium guajava	*pata*	0.24
Baccharis vaccinioides	*mes te'*	0.24
Mangifera indica	*mango*	0.22
Matricaria sp.	*manzanilla*	0.21
Sida sp.	*tzatzames*	0.2
Solanum lanceifolium	*tujkulum ch'ix*	0.14
Cornus disciflora	*sak ji*	0.14
Cissampelos sp.	*curarina*	0.12
Smallanthus maculatus	*ch'ajkil*	0.11
Psidium guineense	*pajchak*	0.09
Vernonia patens	*sitit*	0.08
Hyptis verticillata	*san martin*	0.07
Citrus limonia	*lima*	0.07
Citrus sinensis	*alchax*	0.07
Piper sp.	*mumun*	0.07
Gossypium hirsutum	*kaxlan tunim*	0.06
Aspidosperma cruentum	*ch'ich' te'*	0.06

gradually diminishing saliency (Figures 8.1-8.4). The second tier plants in Nabil freelists are almost the same as the plants that form a second tier in the neighboring Highland town of Ch'ixaltontik (Table 8.1), and the three most salient plants in the tropical frontier community Salto de Agua are identical to its neighboring community Maravilla Tenejapa. But there is very little agreement between any of the towns about which plants are most salient after the first three or four. These results clearly suggest that typicality is not only shared within the towns (as indicated by the sharp drop in saliency after the first plant in each of the four towns), but that agreement about the three or four most typical species is shared between towns as well. It is also clear that *Verbena litoralis* best represents the category *poxil wamal* in all four communities.

What then are the attributes that most contribute to category typicality, and for which plants like *Verbena litoralis* serve as the best examples? Spearman ranked correlations indicated that the frequency with which plants are used to treat illnesses is by far the most influential variable for typicality in the category *poxil wamal* in Nabil (Table 8.2).

Table 8.2. Correlation of key variables with medicinal plant typicality rankings in Nabil (df = 32; $r_{0.05} = 0.35$).

Variable	Correlation	Significance
Frequency of use	0.71	significant
Abundance of plant	0.36	significant
Overall category inclusion	0.26	not significant
Strength of taste	0.20	not significant
Efficacy	0.13	not significant
Agreement about humoral quality	-0.48	significant, but negatively correlated

The importance of frequency, reported here, is consistent with Barsalou's (1991) description of goal-derived categories. In a series of experiments, Barsalou found that frequency with which an item was instantiated as a member of a goal-derived category had the most significant influence on typicality. As discussed above, this differs from typicality in most non-goal-derived, or general, taxonomic categories in which resemblance to shared category attributes is most important (Boster 1988; Rosch 1978). This gives further evidence that *poxil* *wamal* is a goal derived category, and because typicality is not based on overall category attributes, we might not expect typicality to guide intuition about category inclusion.

The second most important variable, and the only other that is significantly correlated with typicality, was the abundance, or accessibility, of plants. It is possible, but not likely, that this results from bias due to visual cueing during freelists. Most interviews were conducted in houseyards and interviewees would occasionally glance around the yard when recalling medicinal plants. Common houseyard medicinals may have tended to be listed more frequently. But I believe this bias is minimal because some of the most typical plants never occur in yards (i.e., *Salvia lavanduloides* in the Highlands and *Neurolaena lobata* in the tropical Lowlands), and others that do occur in yards (e.g., *Verbena litoralis*, *Baccharis vaccinioides*) were usually not in visual range during interviews. The more likely explanation for the significant correlation of abundance with typicality is that abundance is also significantly correlated with the dominant variable, frequency of use (see Chapter 7). Accessibility fits the idealized, plan-oriented nature of the category (Barsalou 1991).

At first, it may be counter-intuitive that efficacy, being the definitional criterion for set inclusion, is not correlated with typicality. Given that people recognize that some plants are more efficacious than others, and curing illnesses is the category goal, then rankings of efficacy might be expected to correlate with rankings of typicality. In other words, it should be the primary attribute that is optimized in category-based planning. The counterintuitive explanation lies in the relationship between optimization of ideals and constraints in planning (Barsalou 1991). In the case of medicinal plants presented here, planning appears to be an optimization-based trade-off between efficacy and accessibility, with accessibility taking precedence in short-term plans. Recall from Chapter 7 that people will use more accessible plants more often than they use the most efficacious plants (i.e., rankings of efficacy were not significantly correlated with frequency of use, while abundance was). As Barsalou (1991) has demonstrated, goal-derived category typicality emerges from plans, but is primarily a function of how many times items are instantiated as members of the category.

My interview data also showed that when the Tzeltal are constructing plans they start with plants that are easier to obtain or prepare, and resort to more difficult plants considered to be more efficacious if the first treatments don't work (Chapter 7). In other words, the constraint of accessibility may be more important than the optimal ideal of efficacy in the short run. Also, many people, especially when treating small children, prefer not to use the strongest remedies for fear of hurting the child or because children may not accept plants that taste bad. Finally, some people indicated that they actually prefer to start with weak plants and move on to stronger plants only if the weak ones don't work. This was the minority, but may have been sufficient to decrease the correlation. The point is that efficacious plants need not be the most frequently used, nor need they represent the most important ideal in short term plans. Since frequency of instantiation and conformity to the ideals are the two most important progenitors of typicality in goal-derived categories (Barsalou 1991), it follows that efficacy need not contribute to typicality.

The distinction between the role of efficacy in typicality and its role in definitional category inclusion is crucial because it shows that the cognitive principles involved in goal-derived category inclusion are different from those involved in deciding what to do with a category. The process of goal-derived category inclusion is essentially dichotomous (cures/doesn't cure), whereas the process of developing a plan for treating an illness appears to be an optimization problem (efficacy vs. accessibility). As my analysis of curing models below will show, plans are further complicated by contextualizing efficacy and accessibility within multiple other considerations. Typicality may serve as a bridge between the goal-derived category and model-based, socially-situated plans. The question I will address below and in the next chapter is whether it enhances or constrains sharing of information.

Regarding the remaining variables tested here, taste was not correlated with typicality. Agreement about 'hot' or 'cold' properties was significantly, but negatively, correlated with typicality. I believe this relationship is coincidental and not causal. The plants used most frequently are used to treat the most common illnesses (diarrheas and coughs), and it just so happens that there is the least agreement about the 'hot' or 'cold' property of these most common illnesses (Chapter 6). I have no reason to believe that people are choosing to use some plants more frequently because they agree less about their humoral property.

In sum, the category *poxil wamal* shows typicality and it follows the pattern predicted by Barsalou (1991). Frequency of instantiation is the most important variable contributing to typicality and the constraint of accessibility appears to be the dominant influence in category-based planning. Although efficacy is the definitional criterion for category inclusion, it does not appear to be an important variable contributing to typicality.

Many researchers have argued that culturally recognized properties like taste and humoral designation are part of an empirical system that guides learning or selection of potential medicinal plants for trial (Brett 1994; Etkin 1988a; Johns 1990; Logan and Dixon 1994). I have argued in Chapters 5 and 6 that in the case of the Tzeltal novices these category attributes are part of *post hoc* explanatory models for why plants cure certain illnesses because they are characteristics of the most typical plants, and that they have little influence in guiding intuition about category inclusion. But note again that I am dealing with a novice population, not expert healers, and these novices were extremely reluctant to experiment with unknown plants.

Here is my logical argument thus far: 1) plants are considered to be medicines primarily because people are convinced, either in a social context or through firsthand experience, that the plants are efficacious,[2] often regardless of the plant's characteristics; 2) some plants are used more frequently because the illnesses they treat are more common and they are more accessible; 3) those plants used more frequently become the most typical members of the category; and 4) it is a *post hoc* explanatory process that then results in characteristics of the most typical plants, such as bitter taste or white latex, becoming strongly affiliated with explanations for why some plants cure certain illnesses. In the following sections I will provide further support for this argument while describing how categorization and typicality interface with shared models.

So, how does this help us to explain the distribution of knowledge, or population-wide category inclusion, as indicated by the curve in Figure 2.1? Typicality appears to account for the first few plants at the top of the curve. But typicality is not correlated with overall agreement about category inclusion ($r_s = 0.26$, df = 32, $P > 0.05$), and therefore does not account for the overall *J*-like shape of the curve.

The implication of these results is that typicality is not guiding category inclusion or cultural transmission. This can be explained by either: 1) the underlying essence of category inclusion (in this case efficacy) is more important than typicality (Hampton 1998); 2) the structural basis for typicality from a goal-derived category (i.e., idealized knowledge) is not based on family resemblance (i.e., normative knowledge), and therefore can not guide intuition about category acceptance (Barsalou 1991); or 3) typicality effects are limited to a few items that target only the most common illnesses (e.g., cures for diarrhea and cough) and would therefore have little effect on the other illness categories. These explanations are not mutually exclusive, and they all appear plausible.

I am not claiming that a very bitter plant like *Verbena litoralis*, which is used frequently to treat the most common illness (common diarrhea) and shows typicality of the category, has no influence on how people think and share information about medicinal plants in general. What I am claiming is that the typicality effects in this goal-derived category are limited. In the following section I will make the case that typicality effects may be limited to within illness categories and can only be understood in the context of the broader, shared cognitive models of how individual illnesses are cured. I will first discuss individual and shared models, and then test the possibility that properties of typical plants guide intuition within illness categories as a result of their dominating shared illness-curing models. In the next chapter I present a case in which typicality may enhance or constrain cultural transmission in the process of reconciling individual and shared models.

Individual and shared cognitive models

The goal of this section is to reveal the structure, themes, and features of individual and shared models of illness curing (Agar and Hobbs 1985; Garro 2000; Strauss and Quinn 1997:118). In particular, I was interested in which themes are most important for the acquisition and sharing of knowledge, how these themes are used to reconcile the domains of illness and plant categorization, and the role that typicality might play in these processes.

Analysis of the 32 discourses and narratives revealed themes that were common across individuals (Table 8.3). Of particular importance were socially-situated events, the names of plants and illnesses, and descriptions of symptoms. But the details (features) discussed within the themes were highly variable.

Table 8.3. Themes that comprise the shared schematic model of plant-based curing in order of importance (based on frequency and hierarchy).

Socially-situated events (especially learning experiences)
Name of the plant
Name of the illness
Symptoms
Efficacy
Preparation of the plant-based treatment
Caution (regarding the safety of the treatment)
Legitimacy of the information
Shared expectation that there should be a plant that cures each illness
Plant qualities, such as bitter taste or white latex
Spatial location or availability of the plants

The following four interview excerpts provide examples of the more common shared themes in Table 8.3 and the way they are filled-in with features:

Excerpt 8.5 (from Frontera Interview 34)

Casagrande: Binti ya spoxta inojo?

What does *Foeniculum vulgare* cure?

Subject 1: Inojo? Cura koliko dice. Cuando tiene mucho coler . . . colera que . . . pucha. Por ejemplo, tu no haste, pero si no lo quiere yo cuando vinó usted ayer que voy a trabajar contigo. Entonces vas enojar con migo, pucha. Porque? Que pasa pensar mal? Se entra corraje, dolor tu cabio, su cuerpo . . . duele tu cabeza. Se muere uno. Porque no le acepté tu palabra ayer. Ma la ch'ume te kojp puje. Bi ya ini ta. Ya mucho bi ya yal te ba'ay, bayel bi ya a'wotan. Entonces ya xtiwan a'jol. Ya xtiwan a'jol. Todo ese por corraje pues. Entonce cuando esta muriendo . . . por que? Ya ban te, te ja' ijk'a k'al. Bueno, binti poxil . . . pujkel ta taza . . . inojo . . .

Inojo? It cures koliko they say. Like, when you have a lot of anger. . . anger that . . . wow. For example, you didn't do it, but suppose you came to work yesterday and I said I wouldn't work with you. Well you would get mad with me. Wow. What's up? What's making you feel so bad? Anger has entered your body . . . your head hurts. It's killing you . . . because I wouldn't accept your word yesterday. There's a lot in your heart. That's koliko. So, your head hurts, it hurts, all of this because of anger. So, it's killing you. Well, how do you cure it? You crumble up *Foeniculum vulgare* in a glass with your fingers.

Subject 2 (Subject 1's wife): Paybil.

Boiled.

Subject 1: Paybil. Aahh paybil. Pero tambien crudo. Se toma crudo. Ya k'uch'tik i ya pokbatik. Ya xkejcha yu'un. Calma kolico.

Boiled. Aah boiled. But also raw. You drink it raw. And you also bathe with it. You drink it and you bathe with it. This calms the anger. It cures kolico.

Excerpt 8.6 (from Nabil Interview 124)

Casagrande: Ay bal wamalil ya xpoxta lukum?

Is there a plant that cures intestinal worms?

Subject: Ay laj ya yalik pero ma'yuk jpaso prueba.

I've heard of one but I never tried it.

Casagrande: Ma'yuk.

Never tried it.

Subject: Ja' jich yaloj me ja'me stat chuse, chus li'ta alan.

Jesus' father said it, he lives here down the hill.

Casagrande: Aahh stat chus.

Aahh Jesus' father.

Subject: Jojo' ja'jich yalo sok la te k'ajk'ane xi. Sok la te ch'aj te'e xi ya wuch'ik oxebuk k'al xi sok me ajo xi oxp'ej ye'tal ajo xi. Ja'jich la yalben, pero mala jpas ma'yuk la kil teme ya xlaj yu'un te lukume ma'yuk la jpas. Ja'jich yalo ya xlaj yu'un xi. Ya s'utsub yu'un. Ya smil loke'l te lukume xi, xila yalben te state chuse jich' la yalben.

> Yes. He said it, also there is *Chenopodium ambrosioides* he said. Along with *Ageratina ligustrina* he said. It's drunk for three days, he said. Along with garlic, he said, three bulbs of garlic. Yes, that's what he told me. But I haven't used it, so I haven't seen whether it kills the worms or not. I haven't tried it, but it's said to cure because it kills the worms and they come out, they say. Yes, Jesus' father definitely told me.

Casagrande: Stat chus.

> Jesus' father.

Subject: Juju'.

> Yep.

Casagrande: Este . . . Diego.

> Umm, Diego.

Subject: Ju' ja'jich la yal pasaik awil xi mawan ya waik te ya xti'wan a ch'ujtike sok te ma xju' ya kaytike xi ja'me xi lukum xi.

> That's it, try it and see for yourself, he said. If you've got a stomach ache this will get rid of the worms, he said.

Excerpt 8.7 (from Nabil Interview 31)

Subject: Jich' ya xpoxta ch'ich' tza'nel tujt. Yu'un la kiltik jtul winik ta pinka ya yich' ak'el te xpoxil yu'un te loktor ya yich' ak'el yich' ak'el ni ma s'utsub. I te bats'e te winik yich'a xbajtix, bajtix. Lok'tal ta yakan ma jna' te me oxeb k'al labental ta yakan sna. Ya kal te laj ta be jo'tik. A la jun semana li'ay ta balun k'anal. Kuxul ya'tik te winik. La kil ta lum. K'uxul yatik. Kajal ta jun semana jilem kil lojkombe ta lum teyoj. Kuxul te winik! Ma ba lajem. Ta'al kojpon. Bi la poxta ate ya xlajatix xkut, bila poxta? Ay jtul ants la yalben xi yala skuy ta ya xyakubon jich xjuchlajanon k'oel xi, ba yilon te jtul ants biya spas xi ma'yuk jchamel la' ilawil binti chamelil ma'yuk ch'ich' tsa'nel, bueno paybeik tal ta ora taye xi paybeik ta ora ya yuch' ala junuk baso, con eso lajla yuch' pajel ma'yuk chikan tsa'nel xi, ila kuch'ix ek aya staon te ch'ich' tsa'nel ja'ya xba kuch' ma'chuk ja'te ja'ch'ujte te tsa'nel ya kaltik ya s'utsub yu'un spisil smako, ja'nax ya yalik te tujt bayel smako.

> Yes, *Equisetum* cures dysentery. I saw a man at a coffee plantation. He had bloody dysentery. All blood, his feces. The doctor had to give him medicine. He gave it again and again, but it didn't work. So he had to leave. He left on foot. I don't know if it was three days on foot to get to the house. We all said he would die on the way. One week later I saw him here in Tenejapa. "He's still alive," I said. I saw him in town. He was still alive. He didn't die. So I talked to him. "What cured you so that you didn't die? What was the cure?" "There was this woman who told me," he said. "What did she tell you?" I said. "'Drink this and the dysentery will go away.' Well, she boiled some right away. 'Drink one

cup,' she said. 'If you drink this, tomorrow you won't have any diarrhea,' she said. So I drank it. It cured me," he said. So we say that it cures dysentery. It cures because it stops the diarrhea. It stops it all up. *Equisetum*, all by itself, they say.

Excerpt 8.8 (from Nabil Interview 113)

Casagrande: Bit'il ya xlijk ch'ujch'ul chamel?

How does oral thrush begin?

Subject: Jichnax ya xlijk. Jichnax ya xjach ta kak'tik ya xch'ijtal te ch'ujch'ul chamele wai. Ya xok' alal, ma skan chu'il. Tsajkot alal ini. Ja'ya mats'tik ts'ime paj 'ul 'ule porke sup ts'i ja'teya xba mats'tik ja' jich ya xba slamantes. Ya xko' te ch'ujch'ul chamele. Lom sup yu'un. Ya jtentik ya k'ak'bejtik te me ma skan. Ya xok' bayel. Ay xanek yechoj lobal . . . lom sup. Pero ma xch'i li'i, ta k'ixin kinal xch'i. A'way. A'waix stojol ch'ujch'ul chamel.

It just begins, the pustules just begin to grow in the child's mouth. Yes, oral thrush just starts in the mouth. The child cries a lot and doesn't want to breast feed. This one here had it. We treat it with *Rhus terebinthifolia*. You just chew it and it calms it. It calms oral thrush because it's very astringent. The pustules go away. I used it on this boy. Sometimes you have to crush it and put it on because the child won't take it. They cry a lot. There's another . . . banana flower . . . very astringent. But it doesn't grow here. Only in hot country. Now you know. You know about oral thrush.

The most striking pattern is that discourses and narratives are almost always situated in social events. In the first example above, *koliko* is explained in the context of the relationship between myself and the subject (who was my field assistant at that time). In the second example the subject situates her learning in a conversation with Jesus' father. The second excerpt, along with the story of the man who almost died of dysentery in the third example, follows the typical narrative style of retelling a past conversation about an illness event. The fourth example makes references to a particular illness event situated within the family. This pattern strongly suggests that people are instantiating representations of social events when attempting to recall details required by the context of the conversation (Donald 1991:124-161).

The data of Holland and Quinn (1987:164) showed that cultural knowledge was organized in sequences of prototypical social events. This suggests that events may serve as prime cognitive mechanisms for instantiating models in recall and discourse. Agar's (1981) groundbreaking analysis of heroin users' discourses showed the primacy of verb formation in discourse structure, leading him to conclude that representations were structured by events. If we accept the connectionist theory of human cognition, it would make sense that events, or episodic memory, facilitate recall. Donald (1991:124-161) has used empirical evidence from primate studies to argue that the presymbolic form of social intelligence is episodic. It is one of the earliest evolved schematic mechanisms and would lie at the center of most cognitive processes.

The results of this analysis also showed that events were socially situated—a finding that has been documented by other studies. Garro (2000) found sociality to be an important theme in her study of Ojibway models of diabetes. This was because most of the Ojibway didn't diagnose diabetes and plan treatments alone but in consultation with others, especially family members. Holland and Quinn (1987) argued that the framing of experience in cultural models and planning of action based on those models are based on observed actions of others (i.e., socially embedded), and the models serve to define social needs and obligations. Data from Strauss and Quinn (1997) and Hutchins (1995) showed that transmission of cultural knowledge requires role playing and other social interaction. This is consistent with the discursive excerpts above, which include hypothetical social interactions and the retelling of past conversations. Hutchins (1995) used ethnographic data to argue further that all models develop primarily through the process of social interaction. My observations of young Tzeltal children learning medicinal plants supports this concept. Learning was highly socialized and every family member present shared in diagnosis and curing. Young children were often made responsible for collecting plants and participated in preparation.

Price (1987) found that Ecuadorian illness stories revolved around episodes; usually beginning with symptoms, then moving forward chronologically, situating treatments and struggles to pay for treatments within social interactions. Much of the content of the Ecuadorian narratives was about social context, including models of family, neighbor and friend relations, and social hierarchy. Price concluded that these narratives were simultaneously born out of experience and gave shape to experience by imposing order on events at the interface of self and society. She claimed this is necessary because developing a sense of self as separate from others is a cornerstone of human cognition (see also Ochs and Capps 1996).[3]

An additional possible explanation for socially situating events derives from the pragmatic nature of discourse in cultural transmission (Rolfe 1996). It is quite often the intent of an utterance, rather than the meaning, that is most important (Schwarz 1996:7). I suspect that socially situating events in illness discourse is a form of conveying legitimacy and safety of the information—two other important themes that I discuss below. Speakers appear to be legitimizing information about medicinal plants by including a wider social network in their presentation. This is important for cultural transmission because interlocutors expect the theme of socially-situated events to be present as a means for legitimizing the discourse.

Results of the discourse analysis also indicate that names of plants and illnesses are a major theme. This is obvious. People can not communicate about cures if they don't have some idea of what plants and illnesses they are talking about. Again, this indicates the importance of categorizing natural kinds *a priori*.

Speakers always mentioned the symptoms involved in the illness event and always mentioned whether the plant altered the symptoms. This further indicates the importance of symptoms and efficacy in individual representations of events and in communication.

The method of preparation was mentioned often, but less than the previous themes. Preparation was sometimes necessary to remember the appropriate medicinal use. For example several people first remembered that a plant was supposed to be boiled, and later remembered what illness it was used for. This is consistent with the idea that they are instantiating an event. Events probably serve as the primary mnemonic, to which preparation, taste, ingestion, and morphological attributes of the plant are all subordinate but critical components.

Another common theme is the shared expectation that there is a plant to cure whatever illness is being discussed, although no one present may know what it is. Consider excerpt 8.3 above, in which the interviewee states that every illness has a plant to cure it, but we don't always know which plant it is. Here is another example:

Excerpt 8.9 (from Nabil Interview 97)

Casagrande: I bi yu'un ma'yuk wamalil ya spoxta k'ux jolol?

Why is there no plant that cures headache?

Subject: Ay niwan ja'nax te majna' stojol jo'tik, ay te wamale pero ja'nax te majna' stojol jo'tik.

Perhaps there is it's just that we don't know it, there is a plant, we just don't know it.

This idea was expressed often. Related to this is my observation that when respondents could not think of a plant to cure an illness during interviews, they never said that there is no plant to cure the illness. Instead, they either said *mayuk k'ayoj* 'I haven't heard' or *ma jn*a 'I don't know.' This implies that they believe there may be a plant to cure the illness, but they just don't know about it. This shared expectation is important because it keeps the channels of cultural transmission open.

Constraining the shared expectation of a cure for every illness are the two related themes of speaker/information legitimacy and caution. Excerpt 8.4 above provides an example of legitimization. One subject is clearly trying to convince the other that his information is legitimate by mentioning teachers and the biomedical concept of X-rays. This is related to the theme of efficacy. Also note that events are being used in the discourse to legitimize information.

Related to legitimacy is the theme of caution about sharing information due to the risk of poisoning or making the illness worse. First, I should point out that during the 3,848 instances in which I asked someone how they learned about the medicinal use of the plant in question, there were only nine cases in which they claimed they learned it through experimentation. In all other cases they learned it from someone else. This implies that the novice population I worked with was very reluctant to ingest unknown plants, or risk misusing known medicinal plants. This implication is supported by discursive data. For example, in excerpt 8.6 above the interviewee says she has heard about the medicinal use of *Chenopodium ambrosioides*, but was quick to point out she had not tried it herself. This pattern was common. Here is another more obvious example:

<u>Excerpt 8.10 (from Frontera Interview 34)</u>

> <u>Subject:</u> Mucha gente hechan mentira. No debe enganchar la gente. Si lo miro, lo digo. Si me lo escucho, no lo repito porque no lo miré. Cuando ay mucha gente . . . mira, mucha dicen falsos, se enganchan le gente. Pero no te digo como este. No me gusta. Si estoy cierto que me cura, entonces lo digo porque es cierto. Lo miré yo mismo. Es buena medecina. Pero cuando estan buscando la gente, alguien dice agarra una planta y es venenoso. No hace asi El Señor. Puede matar.
>
>> Lot's of people tell lies. One shouldn't deceive. When I see it, I'll talk about it. When I only hear about it, I won't repeat it because I didn't see it. When there are lot's of people . . . look, lot's of people make false statements, they'll deceive, but I'm not telling it to you like that. I don't like that. When I'm certain of what cured my illness, of course I'll say it because it's true. I saw it myself. It's a good medicine. But sometimes when people are looking, someone says to go and grab something and it's poisonous. It's not God's way. You could kill someone.

These themes indicate that although people expect there to be legitimate cures even though they don't know about them, the free flow of information is constrained by a concern about safety and the legitimacy of information.

Taste, morphological characteristics, the location of the plant, and the humoral property were themes that were mentioned much less frequently. The low significance of the location of the plant further indicates the differences between typicality in freelist recall and frequency of use, in which accessibility is important, and communication, in which it appears less important.

These results indicate that individual models have common themes, and the primary theme is to socially situate events. The other themes are subordinate, and the structure of the shared model is probably hierarchical as suggested by Holland and Quinn (1987).

Individuals fill in these themes with details, which I will refer to here as features of the models (Garro 2000; Strauss and Quinn 1997:122). For example, the shared schematic model for curing diarrhea includes the theme of a plant with a name. The individual models will include a particular plant as the feature within that theme—most typically *Verbena litoralis*. The schematic shared model also includes preparation of the treatment as a theme. Particular individual models may fill in details of crushing *Verbena litoralis* raw versus boiling it. The schematic model also relies on the important theme of social events. Individual models fill in a particular social event, such as the man who almost died from dysentery. Not only will individuals vary in the features they use to fill in the themes, but the same individual will fill them in differently on different occasions. In other words, the features are context specific. They will vary within and between individuals based on the context of the discourse or recall event. *But what is always present across individuals and occasions is the expectation of the major themes*. For example, everyone expects there to be a plant that cures the illness, everyone expects the plant to have a name and a 'hot' or 'cold' property, and everyone expects the information to be socially legitimized. It is this expectation of the themes that I am referring to as the shared cultural model, and it is very schematic.[4]

In conclusion, it appears that shared themes in schematic models enable people to combine the natural domains of illnesses and plants with issues of legitimacy, safety, and sociality by situating experience in events. Furthermore, the expectation of themes allows people to share information, and therefore these themes fundamentally structure cultural transmission. Individual models may differ at the feature level—for example, one subject may consider common diarrhea 'hot,' another may think it's 'cold,' and both may change depending on context (e.g., whether accompanied by fever; see Chapter 6)—but they agree in general on what they consider important—the illness is treated with a plant that has the opposite quality. Information can only be shared in a meaningful manner (i.e., legitimate, safe, and effective) because models provide such shared assumptions. But, it appears to be more important to agree about the general principles of using plants as medicinals than the details.

Plant-based typicality in shared models

Barsalou's (1991) notion that normative knowledge is required *a priori* for deriving goals suggests that illness categories form the basis for plant-based curing models. Plants are then needed to complete the curing models, and the definitional medicinal plant category attribute of efficacy is embedded within the social domain because models derive from shared experiences. The resulting order of importance of the schematic themes provides a basis for cultural transmission by encoding through experience what is most important. Characteristics of the most typical (i.e., most frequently used) plants may come to typify the models through shared experience, and thus the models show typicality regarding taste, humoral property, or salient morphological characters like white latex. For example, if *Verbena litoralis* is the most common plant associated with diarrhea, then perhaps the characteristics of *Verbena litoralis* (i.e., bitter taste, proximity to houses) could come to dominate the shared curing model. This section addresses two questions: 1) do some plants and their characteristics dominate, or typify, shared models of individual illnesses; and 2) does plant-based typicality in models guide, and potentially constrain, sharing of information?

Analysis of the frequency that items were mentioned in discourse shows that some plants and their characteristics dominate shared models (Figures 8.5 and 8.6). I documented and coded 67 occasions when people were discussing *tza'nel* (various forms of diarrhea). One species, *Verbena litoralis*, was mentioned during 100% of the occasions. The next most frequently mentioned species (*Oenothera rosea*) was only mentioned during 27% of the occasions. This strongly suggests that *Verbena litoralis* is dominating discourse about curing *tza'nel*. Plant-based variables associated with *Verbena litoralis* were also salient. For example, if taste was mentioned at all, only bitterness was mentioned (Figure 8.5). All of these variables appeared to be derived from the most typical plants. In the case of *tza'nel*, for example, *V. litoralis* is very bitter, while most of the other plants mentioned are not.

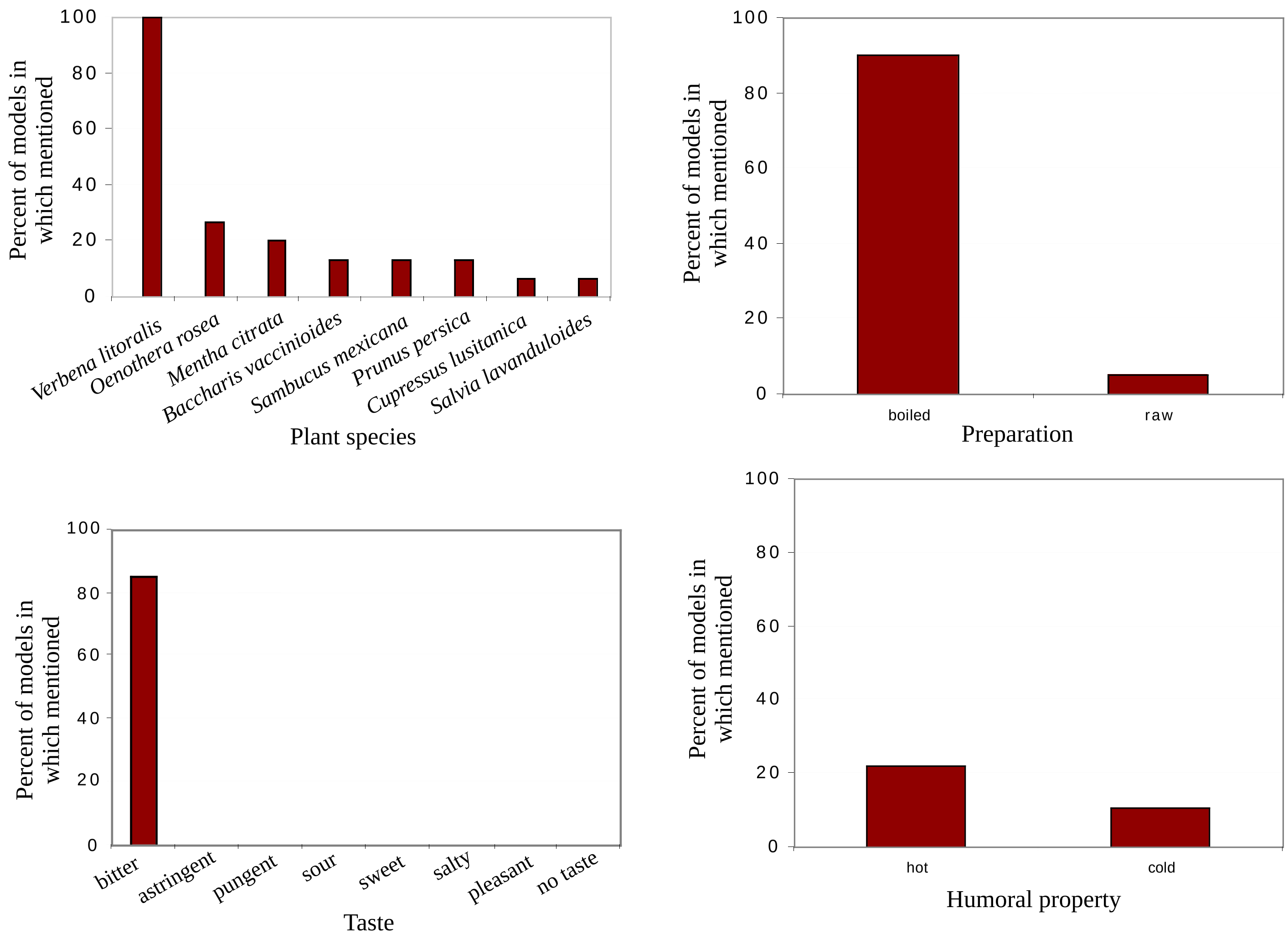

Figure 8.5. Typicality of four plant-based features in cognitive models of curing diarrhea (*tza'nel*) in Nabil.

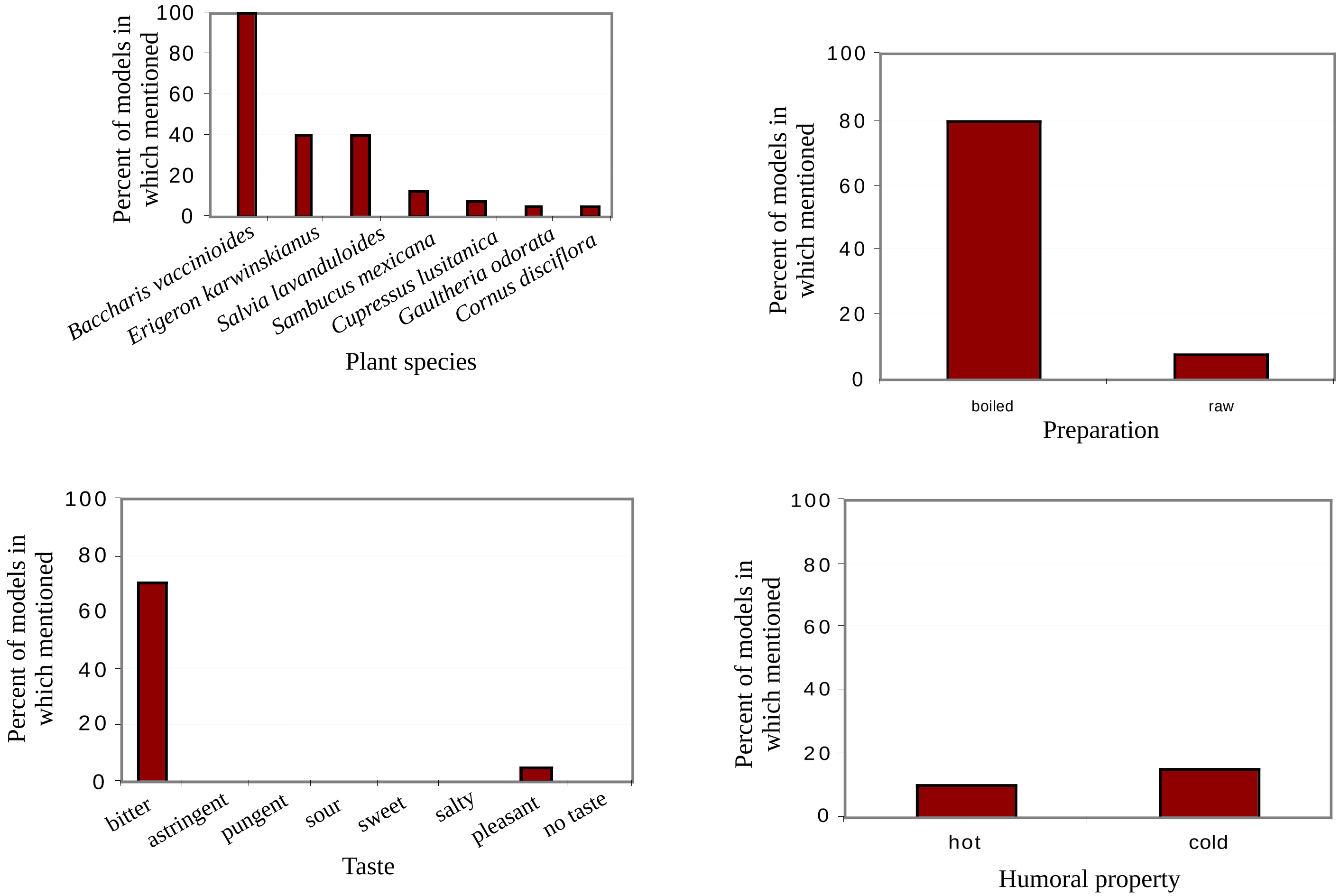

Figure 8.6. Typicality of four plant-based features in cognitive models of curing cough (*obal*) in Nabil.

Furthermore, people were always talking about plants when they mentioned the other variables, as in this example:

Excerpt 8.11 (from Nabil Interview 97)

Casagrande: I bi yu'un ya spoxta tza'nel?

And why do these plants cure diarrhea?

Subject: Maxkiltik ja'niwan yu'un te cha'j, komo me yakan k'ulub mero ch'aj ma stak'ix uch'el.

We don't know, perhaps because they're bitter, like *Verbena litoralis*, it's very bitter, you almost can't drink it.

These patterns were somewhat weaker for cough (*obal*; Figure 8.6). Although *Baccharis vaccinioides* was mentioned during 100% of the 49 occasions when coughs were being discussed, two other species were mentioned during 40% of occasions—showing slightly higher typicality than that of the second most typical species for *tza'nel*. Also, people mentioned taste less frequently when discussing *obal* (76%) than discussing *tza'nel* (85%).

I have only shown complete results of the two most common illnesses here, but the pattern of typicality is shared by the other common illnesses in Nabil (Table 8.4). There did not seem to be a pattern of plant-based typicality for less common illnesses for which widespread knowledge of plant-based cures is absent (e.g., headache and dermatological problems).

Table 8.4. Illness models from Nabil in order of their strength of plant-based typicality and the most typical plants.

Illness	Dominant plant	Frequency mentioned
Diarrheas (*tza'nel*)	*Verbena litoralis*	100%
Coughs (*obal*)	*Baccharis vaccinioides*	100%
Oral thrush (*chin yej*)	*Rhus terebinthifolia*	100%
Abdominal distension (*pumel*)	*Nicotiana tabacum*	99%
Epigastric pain (*koliko*)	*Foeniculum vulgare*	94%
Tooth ache (*k'ux eal*)	*Myrica cerifera*	71%
Body aches (*ik'*)	*Solanum lanceifolium*	65%
Headache (*k'ux jolol*)	none	--
Dermatological (*chin, chakal*)	none	--

Note that these results are very similar to those obtained from freelists (Table 8.1). This is probably because typicality in models is also based on frequency of use. Also, people were probably instantiating event-based schematic models during freelist tasks.

These results indicate that when people are sharing information about medicinal plants—either when someone is asking for advice, teaching children, or engaging directly in curing as a social group—much of the discourse is dominated by a very small, highly typical subset of the total pharmacopoeia. The characteristics of this small subset of plants dominate explanatory models of curing. Because *Verbena litoralis* is the most frequently used cure for diarrheas, bitterness is frequently instantiated with curing diarrhea—likewise, astringency for oral thrush, white latex for wounds in the tropical frontier, and so on. Does this plant-based typicality in curing models also guide, or potentially constrain, sharing of information? First, I reviewed discursive and structured ethnobotanical data to explore the possibility that new medicinal information about plants that closely match the properties of the most typical medicinal plant in an illness model should become widely distributed throughout the community.

For example, does a new plant perform as well as *Verbena litoralis* at stopping diarrhea? Is it bitter, 'hot,' or 'cold' like *Verbena litoralis*? I identified several discourses that tend to support typicality-based evaluation of new information. The following excerpt provides an example. This exchange took place after a woman told me she discovered a new plant to treat her son's diarrhea (a rare case of experimentation). Note the themes of taste, the 'hot' or 'cold' property, and her perceived efficacy of the treatment:

<u>Excerpt 8.12 (from Frontera Interview 74)</u>

<u>Casagrande:</u> Bueno, ya jk'an jojk'obet. Ja' ini la a'tuntes swenta tsa'nel?
Okay, I want to ask you, you used this plant for diarrhea ?
<u>Subject</u>: Laj.
I used it.
<u>Casagrande:</u> Pero mayuk mach'a la yalbet ya xpoxta?
But no one told you about it.
<u>Subject:</u> Mayuk.
No one.

Casagrande: Bi yu’un la a’tuntes mene?
Why did you use this plant?
Subject: Este . . . o sea . . . este . . . la nax jtuun, wai la jkai ch’a.
Well, well, I just used it, I knew it was bitter.
Casagrande: Ch’a?
Bitter?
Subject: Ch’a, como ja’ ay ta tsa’nel ku’un a me alale, ja’ la jtenbe yuch’. Utsub. Ja’ sik yu’un a. Ja’ sik te yakan k’ulub, pero ma xch'i li’i. La k’ak’bej mene.
Bitter. If my son has diarrhea, I crushed it and gave it to him to drink. It worked, so it must be cold. *Verbena litoralis* is cold, but it doesn’t grow here. So I used this one.

Such anecdotes suggest support for this notion. But these effects are operating at the scale of individual models. A more direct analysis using structured ethnobotanical survey data discredits this notion for the shared pattern. I documented many plants that are known by a few people in the community and closely match the prototypical medicinal plants, but have not been incorporated into the shared knowledge system. The following cases serve as examples.

Ageratina ligustrina (*ch’aj te’*) conforms to the shared model as a cure for diarrhea (*ja’ ch’ujt’*) in Nabil. It is well known as an efficacious treatment for various diarrheas in other communities of Tenejapa,[5] including the paraje of Ch’ixaltontik, which is adjacent to Nabil and is the community of origin for many young wives in Nabil. *Ageratina ligustrina* is also very bitter (hence its name ‘bitter tree’), congruent with *Verbena litoralis*, the typical bitter diarrhea treatment in Nabil. Vegetation surveys (see Chapter 7) verify that *Ageratina ligustrina* is common in Nabil. Four people I interviewed in Nabil knew it as a treatment for diarrhea or abdominal pain, and they were respected as knowledgeable people in the community, suggesting that legitimacy is not an issue. All four people said they used *Ageratina ligustrina* and that it stopped the symptom—indicating that it fits their expectations of efficacy. Despite this close fit with the shared model for curing diarrhea, and in particular the typical plant *Verbena litoralis*, none of the other 41 people I interviewed in Nabil knew about the medicinal use of *Ageratina ligustrina*.

Struthanthus sp. (*yijkatz te'*) conforms to the shared model as a cure for common cough (*bats'il obal*) in Nabil. It is well known as an efficacious treatment for cough throughout other parts of Tenejapa.[6] It is also very bitter, congruent with *Baccharis vaccinioides, Erigeron karwinskianus* and *Salvia lavanduloides*—the typical cough treatments in Nabil. Vegetation surveys verified that it is common in Nabil. Only one person I interviewed in Nabil knew it as a treatment for cough. She said she had used *Struthanthus*, although many years earlier, and that it calmed the cough. She learned it from her parents who were from Nabil. Despite this close fit with the shared model for curing common cough, and the presence of this knowledge spanning at least two generations, none of the other people I interviewed in Nabil knew about its medicinal use, although everyone knew it by name.

I identified 11 such plants that share attributes with the most typical plants used for the various illnesses, but are known as medicinals by four or less people in the community. Information about these plants obviously has entered Nabil—in some cases having existing there for many years. These plants fit the shared models for curing the various illnesses, including perceptions of efficacy, and share the attributes of the most typical plants used to cure those illnesses. If typicality in shared models is guiding the widespread acceptance of potential medicinal plants, then these 11 plants should be more widely known throughout the community.

Perhaps the guiding role of typicality is more a function of excluding plants that don't correspond well with the typical attributes of shared models. Alcorn (1984:287) suggested that the doctrine of signatures could "introduce noise" into the empirical system of plant knowledge. Perhaps Brett's (1994) claim that taste guides intuition could be interpreted as biasing intuition away from potential cures that don't fit expectations rather than guiding acceptance. This would help explain why the curve of agreement about plants drops off sharply in Figure 2.1. Some plants have come to dominate the illness curing models and they may bias expectations away from potential new treatments that may cure but don't fit the models well. A few people in the community may know these plants, but the information does not become widely shared because the plants don't fit well with the shared models. In other words, typicality reduces the widespread sharing of potential cures that don't fit the models well.

This leads to the prediction that plants that are very different from the prototypical plants used to cure an illness will not be widely known throughout the population. The ethnobotanical survey data are ambivalent on this point. Fifteen plants appear to support this possibility, while 13 appear not to support the idea. First, I present some supportive examples; that is, some plants are not well known because they are different from the typical cures.

Liquidambar styraciflua (*so'te'*) is widely known throughout Tenejapa as a cure for various types of coughing. Only three people in Nabil knew this. Perhaps this is because it is quite different from the three most typical cures in Nabil, *Baccharis vaccinioides, Erigeron karwinskianus* and *Salvia lavanduloides*, all of which are small, bitter plants. *L. styraciflua* is a tree with a pleasant or slightly astringent flavor when boiled.

Apium leptophyllum is a wild pungent herb that is known throughout Tenejapa as a treatment for stress-induced indigestion or heartburn (*koliko*). This is quite different from the shared model, which is dominated almost exclusively by the pleasant-tasting, cultivated herb *Foeniculum vulgare*. Only one person in Nabil knew of *Apium leptophyllum* as a cure for *koliko*.

Only two people in Nabil knew *Lobelia laxiflora*, a wild, slightly bitter shrub with white latex, as a cure for bloating and abdominal distension (*pumel*), although this is well known in other communities. The curing model for abdominal distension in Nabil is dominated by the very pungent, domesticated *Nicotiana tabacum*.

Other plants from the survey do not support this version of typicality bias—they are well known even though they show little similarity to the typical cures. Typicality did not appear to be biasing knowledge distribution by excluding these plants.

Oenothera rosea is a small herb with no particular taste, or said by some to be astringent. It was known by 41 respondents as a treatment for diarrhea. It is quite different from the very bitter *Verbena litoralis,* which is the typical diarrhea cure. *Mentha citrata*, a pleasant tasting domesticated mint, is also well known in Nabil as a cure for diarrhea (cited by 23 respondents).

Cornus disciflora and *Cupressus lusitanica* were cited by 16 and 13 respondents respectively as cures for various types of coughs. These astringent tasting trees are very different from the dominant, bitter, herbaceous cough treatments *Erigeron karwinskianus* and *Salvia lavanduloides*.

The data most damaging to this idea are discursive. Although I analyzed over 20 hours of conversations, narratives, and interviews, I never once found a case of someone not accepting the possibility of a new cure because it didn't fit existing models or was too different from the typical cures. Indeed, people were more likely to suspend their model if the new idea was in conflict, and focus instead solely on efficacy. Consider the following conversation in which I am asking a young man why he used boiled bark of *Swietenia macrophylla* to cure his father's infected foot given that it did not match the son's model (he previously had claimed that only plants with white latex like *Ficus* spp. and *Euphorbia* spp. are used to treat wounds):

<u>Excerpt 8.13 (from Frontera Interview 13)</u>

<u>Casagrande:</u> Ya jkan jojkojbet, la a'walben ya spoxta ejchin spojowil, pero la a'tuntes cawba, ma yu'un uk spojowil cawba . . .

> I want to ask you, you said white latex cures wounds, but you used *Swietenia macrophylla* . It doesn't have white latex . . .

<u>Subject</u>: Mayuk. Mayuk spojowil. La k'albet. Ja' cawba. La jtuun cawba. Ja' mukul te ya xch'i ta montaña, ya jsiltik ya jpaytik te spate. Ay spojow yakan jtat ts'in. Bajt ta loctor la skan skitzbe a, la jtun xanek jo'tik pero ma sutsub. La yalben k'ijtsin ya spoxta cawba. Ya xpoxta cawba, xi. Jich' utsub. Ila. Utsub.

> No. No white latex. I told you. It's *Swietenia macrophylla*. I used *Swietenia macrophylla*. A big tree that grows in the forest, you cut the bark and boil it. My father's foot had pus. He went to the doctor. The doctor wanted to cut it off. We tried other plants. They didn't cure it. My brother told me to use *Swietenia macrophylla*. "*Swietenia macrophylla* will cure it," he said. I used it and it cured. Look. It cures.

Subject’s mother: Utsub!
It cures!
Casagrande: Pero te me mayuk spojowil, bi yu’un ya xpoxta?
But if it doesn’t have white latex, how can it cure?
Subject: Ma jnatik, jich’nax ya xpoxta.
We don’t know. It just cures.

The final phrase was a standard response when respondents were presented with internal logical contradictions in their models. On 12 different occasions I purposefully confronted subjects with contradictions regarding explanations for curing. Each time the final response was either “I don’t know, it just cures” (n=9), or “I don’t know, that’s the way God made it” (n=3).

In conclusion, individual and shared models show typicality, but the data indicate that typicality is not influencing the sharing of information about plants throughout the community. The prime criterion for judging whether a plant is a cure for a particular illness is whether the plant is perceived to cure the symptom or not. Recall that efficacy was not correlated with typicality above, but it is the definitional criterion for category membership and it is strongly correlated with distribution of knowledge. Taste, morphological properties like white latex, humoral properties, and availability are all subordinate to efficacy in the processes of acquiring new information. Individual explanatory models are flexible, and subordinate themes, although important for model typicality, are quickly overridden by any persuasive evidence of efficacy, either through direct experience or discourse. In the highly social context of discursive learning, speakers can draw on a wide range of persuasive techniques to convince the hearer of efficacy (see for example Excerpt 8.4 above).

Conclusion

The category *poxil wamaletik* ‘medicinal plants’ is constructed by the novice populations I worked with exclusively as a means for achieving the goal of addressing illness symptoms. Plants are accepted as members of the category when people are convinced the plants are efficacious, often regardless of the plant's characteristics, and sometimes in contradiction to preconceived explanations of curing. Typicality within the category is based on the frequency with which plants are instantiated as members of the category. Some plants are used more frequently because the illnesses they treat are more common and they are more accessible. Plants that are used more frequently become the most typical members of the category, but typicality does not appear to guide category acceptance.

Models of illness are based on *a priori* symptomatology-based classification of illnesses. Explanatory curing models are built *post hoc* around plants perceived to be efficacious based on observation or social pressure. This process is heavily influenced by event-based typicality and the frequency with which plants are used (i.e., it is ultimately a function of the frequency of certain illnesses). This results in characteristics of the most typical plants, such as bitter taste, becoming strongly affiliated with explanations for why some plants cure illnesses.

Models are important for sharing information, and facilitate cultural transmission by structuring individual and shared expectations. But typicality in models does not appear to guide acceptance into categories or dissemination of information because typicality, and the features associated with typicality, such as taste or humoral property, are subordinate to efficacy. Efficacy is based primarily on pharmacoactivity and can be conveyed so convincingly through firsthand experience or social discourse that items can be accepted for category membership even if they are in conflict with the typical features of an individual's explanatory curing model.

This helps explain why individuals may expect cures for diarrhea to be bitter, while also knowing that many (if not most) of the plants they believe to be efficacious diarrhea cures are not bitter. Although features like taste may be important in some contexts (e.g., medicinal plant experimentation) and for some individuals (e.g., experts), they become less important at the scale of shared cognition and cultural transmission in the general population. Thus, while Brett (1994:162) may be correct that bitterness guides Tzeltal selection for gastrointestinal treatments by expert healers, these effects are limited in scale and do not guide category inclusion at the scale of the wider population, and therefore can not explain the broader pattern of knowledge distribution. This also shows why these types of explanations must be contextualized at a broader scale in order to understand their relationships with other variables and their limits of explanatory scope.

In previous chapters I have presented results of my tests of the explanations that have been proposed by other authors for the distribution of plant knowledge and provided evidence that they each only partially account for the patterns I have documented in four Tzeltal communities. In this chapter I have attempted to synthesize these disparate explanations using cognitive theory in order to enhance their explanatory power. The cognitive approach presented in this chapter does not adequately explain the pattern of knowledge distribution shown in Figure 2.1, with the exception of the three best known plants, which clearly results from frequency of instantiation-based category typicality. Most importantly, the *J*-like shape of the knowledge distribution curve (Figure 2.1) is not a function of how well plants fit shared models.

Nevertheless, I believe the cognitive approach moves us forward by at least explaining some of the contradictions and inexplicable observations that result from the previous explanatory concepts. Also, these cognitive concepts are necessary precursors to the next chapter, in which I will use processes of cultural transmission to explain patterns in medicinal plant knowledge more adequately. I will make the case that the *J*-like shape of the knowledge distribution curve (Figures 2.1 and 2.2) and the untreated illnesses are functions of patterned constraints of cultural transmission; in particular, the small size of potential communication networks as a result of social organization, limited opportunities to share information as a function of the frequency of illnesses providing periodic "windows of opportunity" for transmission, stochasticity, the limited amount of time available to talk about cures within those "windows," and (related to this chapter) typicality limiting potential discourse frames and ontogenetic learning trends. The analysis of cognitive processes presented in this chapter provides us with a more comprehensive explanatory mechanism for the process of cultural transmission by showing how people think and talk about plants, what is most important to them, and how typicality and issues of legitimacy and safety situated in social events may enhance or constrain transmission.

Notes

[1] D'Andrade (1995:70) calls these "features." I use "attribute" to avoid confusion with features of models.

[2] I should emphasize here that the plants are perceived as efficacious primarily because of their pharmacoactive properties. I will argue in the next chapter that some plants are mistakenly attributed with medicinal properties due to cultural transmission error. Such "noise" may persist in the empirical knowledge system, but the primary catalyst for the persistence of the system remains pharmacoactivity.

[3] This notion was fundamental for Vygotsky. Although Vygotsky's ideas were not widely accepted early in the 20th century, they have more recently gained popularity in the cognitive sciences because they appear to explain recent research results. See Holland and Valsiner (1988) for a review.

[4] I refer to the shared expectation of themes here as a model and not a schema following D'Andrade's (1995) distinction that models are schemata that are manipulated for plans or other purposes (p. 180) and models are more stable in long-term memory (p. 152).

[5] Data are from the PROCOMITH Traveling Herbarium database compiled by Drs. Elois Ann and Brent Berlin.

[6] Data are from the PROCOMITH Traveling Herbarium database compiled by Drs. Elois Ann and Brent Berlin.

Chapter 9
Structured Bias and Stochasticity in Cultural Transmission as the Primary Constraints of Knowledge Distribution

Introduction

The goal of this dissertation is to explain why the Tzeltal of the communities I studied know some plants as medicinals, but not others. I have shown that although cultural interpretations of plant characteristics, such as taste, visual cues, and hot versus cold classification influence individual cognitive models and may influence medicinal plant selection by experts, these variables have little influence on the distribution of plant knowledge throughout the general population of novices. The distribution of plants in the landscape has more of an effect than the aforementioned variables, but only insofar as this is a function of the accessibility of plants influencing the frequency of their use. Typicality within the goal-derived category 'medicinal plants' explains the dominance of the three or four best known plants in the communities, but fails to explain the remainder of the knowledge distribution. The most influential variable I have discussed so far, which shows a strong correlation with knowledge distribution, is emic perception of efficacy, which results from firsthand experience with plants, social interaction, and perceptions of legitimacy and safety in discourse.

Several important patterns in the distribution of knowledge remain to be explained: 1) the *J*-shape of the curves in Figures 2.1 and 2.2; 2) the long asymptotic tails of the curves, which represent a large amount of idiosyncratic knowledge; 3) why knowledge about some efficacious plants needed to treat important illnesses is not distributed throughout the communities; 4) why there appears to be widespread agreement regarding around only 50 plants, both in this study as well as numerous other studies; and 5) significant differences in knowledge between neighboring towns. In this chapter I describe the processes of cultural transmission of medicinal plant knowledge in the Tzeltal communities in which I worked, and I suggest that it may be possible to explain the aforementioned unexplained patterns as results of structured and stochastic bias in cultural transmission.

Particularly puzzling is the “missing” information about efficacious plants discussed in Chapters 2 and 4. To review briefly, in each community there are a few illness categories for which medicinal plant cures are not known by most of the population, even though these treatments may be common knowledge and are perceived to be efficacious in neighboring communities. It is evident from my observations and the discourses presented throughout this dissertation (see especially Chapter 8) that people would prefer to know a plant-based cure for every illness; either for economic reasons, or because they lack access to biomedical healthcare, or because they wish to maintain alternative strategies in case biomedical treatments or traditional curing rituals fail. Furthermore, most people believe there are plants that cure every illness, although they, or their immediate contacts, may not know which plant it is. Most importantly, they actively seek this information. Thus, the problem of the missing treatments is not that the information doesn’t exist, nor that there is a lack of impetus for dissemination of that information, nor as I point out in Chapter 4 that the information hasn’t entered the community, but rather that some forces are constraining the dissemination of the information.

My approach for explaining the remaining patterns is to model what an unconstrained information system might look like, and then to consider what processes might be contributing to the observed constrained patterns. Figure 9.1a is a graphic representation of an ideal, or unconstrained, distribution of knowledge—what Figures 2.1 and 2.2 would look like if there were no constraints on the dissemination of information. This representation assumes, for now, that for each illness there is at least one plant considered with equal probability by the entire population to be an efficacious treatment, and each treatment is known by 100% of the population. The only constraint is the total number of plants held in memory by each of the individuals. Based on the structured ethnobotanical

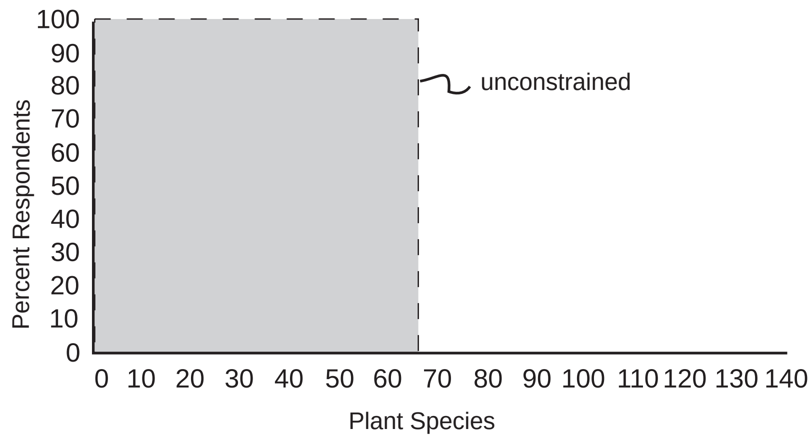

Figure 9.1a. An hypothetical unconstrained knowledge distribution. All knowledge is distributed evenly throughout the population. Total information is limited only by the average number of plants known by each individual.

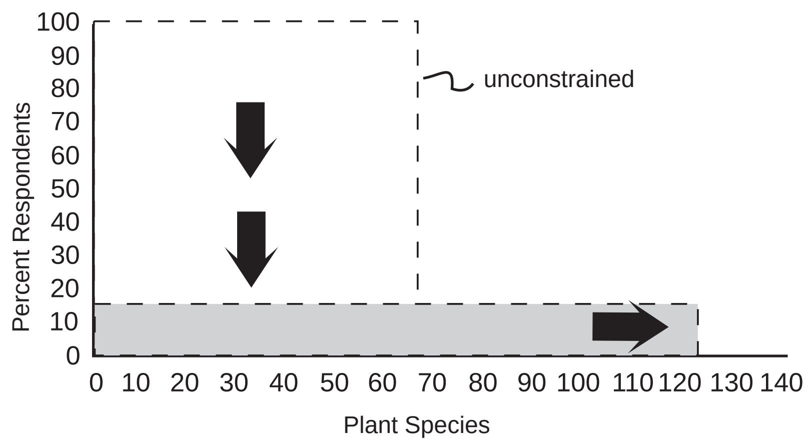

Figure 9.1b. The constraining effects of network size and transmission error, which increase idiosyncratic knowledge.

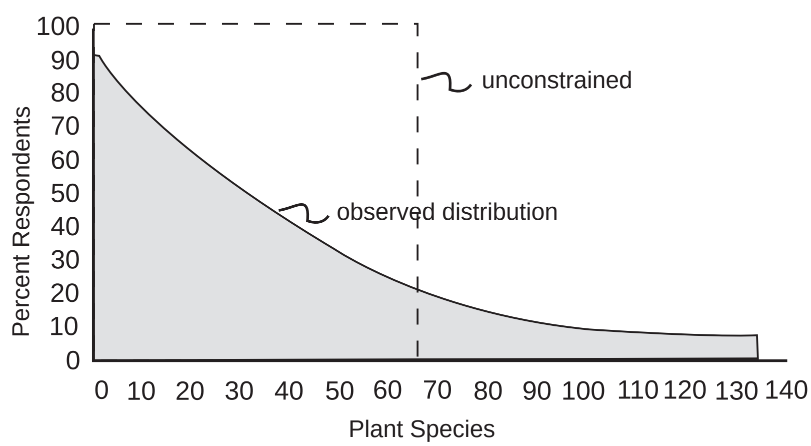

Figure 9.1c. The unconstrained scenario compared with the actual distribution observed in Nabil.

survey data, I calculated the average number of medicinal plants known by adult informants in Nabil to be 65 (SD = 15). Of course, a few informants knew well over 100 herbal remedies, while others knew as few as four, but the standard deviation shows that most people knew about 65.

Drawing on notions from information theory (Klir and Folger 1988; Shannon and Weaver 1949), Figure 9.1a shows a situation in which every individual in the population has equal access to a common knowledge pool and information is transmitted without error. Of course, this is not the case for the Tzeltal nor any other medicinal knowledge system. The most important constraint of information flow is probably the size of information networks (Boster 1985; Hewlett and Cavalli-Sforza 1986). The smaller the networks are, the fewer the links there will be in the chains of communication. Information flow will be constrained and asymmetrical because everyone does not have equal access to all information. As networks become smaller, the distribution of knowledge will tend toward total idiosyncrasy in which everyone knows something different. This is analogous to pulling the horizontal knowledge limit depicted in Figure 9.1a downward toward the *x* axis as shown in Figure 9.1b. If each person is interested in knowing as many plants as possible, and they are still capable of knowing around 65 plants, but in this case everyone knows different plants, the total number of plants is greater. The tendency will be for the horizontal shaded area of knowledge depicted in Figure 9.1b to also be pulled toward the right. Note how this resembles the asymptotic tail actually found in the Tzeltal distribution (Figure 9.1c).

Another process having the identical effect is transmission error (Cavalli-Sforza and Feldman 1981:65). Because some people will learn information incorrectly, knowledge will become more idiosyncratic, and diversity will increase; assuming again that the total amount of information in the system is held constant.

But the actual distribution observed in this study is a smooth *J*-shaped curve. That is, the proportion of individuals in the population who know the medicinal uses of plants decreases gradually as the diversity of plants increases (Figures 2.1, 2.2, and 9.1c). This is partly because the constraining forces presented above will not affect the dissemination of knowledge about each of the plant species equally.

But the shape of the curve also results from environmental influences and additional structural properties of knowledge systems. Below, I develop several notions that further explain the observed patterns. 1) Disproportionate prevalence (morbidity) and severity of the various illnesses create asymmetric opportunities for learning (Boster 1991). 2) How closely physiological symptoms of the various illnesses match cultural perceptions of each illness makes judgements of efficacy easier and more consistent—what Boster (1991) might refer to as information quality. 3) Acceptance of new information is subject to individual preference bias (Henrich 2001). In the unconstrained case presented above I assumed efficacy was the same for all plants. This, of course, is not true. Some plants are more pharmacoactive, and this influences the willingness of individuals to accept new information. 4) Conformity bias (Henrich 2001) indicates that most people are willing to adopt a new treatment only after others have already done so. 5) Prestige bias (Atran et al. 2002; Henrich 2001) indicates that more reputable members of the community are central to information flow. 6) Bias due to plant-based typicality in shared cultural models creates non-random patterns in discourse.

The aggregate effect of these processes is that the distribution of knowledge decreases with additional information in an asymmetrical, but predictable, pattern—more or less what Tainter (1988:99) has referred to as decreasing marginal returns in information due to social complexity (see Nickerson 1993 for a formal analysis specific to distributed cognition). I propose that these processes are not unique to the Tzeltal Maya medicinal plant knowledge system. And while the relative importance of each of the six processes above may vary among study populations, when combined, they ensure that the distribution of knowledge in medicinal plant systems will nearly always resemble the pattern presented in Figure 9.1c.

In the remainder of this chapter I describe these processes in more detail. The chapter is meant to be more suggestive of approaches for further research than a rigorous empirical test of these notions. But I do hope to make the point that although variables like individual cognition, plant taste, plant morphology, distribution of plants in the landscape, and humoral classification have some effects on the diffusion of knowledge, it is the structural and stochastic components of information systems and highly socialized constructions of efficacy and safety that are most essential for understanding why some plants are better known for their medicinal properties than others in the communities where I worked.

Primary pathways of knowledge diffusion

The most common ways that people in this study learn about medicinal plants are through active participation in curing events, passive observation of curing events, and discourse. Active participation can be as simple as the case of a man from Maravilla Tenejapa who told me that he cut himself with a machete while working in the field with a friend. His friend showed him how to chew the stems and leaves of *Vernonia patens* and press it onto the wound to stop the bleeding. In another case, a woman from Nabil went to a traditional curer to seek ritual treatment for *xiwel* 'fright,' where she learned that *Adiantum andicola* and *Phyllanthus niruri* are used as part of the ritual treatment.

Participation also includes more complex familial discussions and actions regarding diagnosis and treatment, especially when infants are sick with cough or diarrhea. Often, the other young children are sent out by parents to collect the plants to be used for treatment. If they return with the wrong plant, they are corrected and sent out again.

People can also learn by passively observing cures, especially while visiting other households. But it is more common to combine casual observation with discourse. For example, Juan, a man from the frontier, told me that while he was working at one of the large, privately-owned sugar plantations (*fincas*) he observed another man cutting the leaves of *ch'ich' bajt* (*Croton drago*). When Juan asked why, the man replied that he intended to use it to treat his wife's dysenteric diarrhea. On another occasion, Juan was approached at the *finca* by a man with a small child who had a case of *chamel yej alal* 'oral thrush.' The second man asked Juan if he had seen any *paj wamal* (*Arthrostema ciliatum*) in the area. When Juan asked why, the man said he intended to apply the sour juice from the stem to the child's mouth to relieve the irritating pustules.

Sharing information through discourse can also occur without being related to a particular illness event. For example, when someone sees a plant in the wild or being used for food, they might mention that it has a medicinal application.

Most often, adults learn new medicinal plants by specifically seeking new treatments for illnesses that are being experienced. These "quests" usually begin after the use of commonly known plants, biomedical options, or traditional ritual curing are perceived to have failed to improve symptoms; or, when a diagnosis yields an illness for which the immediate family knows no plant-based treatment and there is no biomedical correlate (see Chapter 3). Questing for plant-based remedies can include consultations with extended family, neighbors, friends, acquaintances, respected healers, pharmacy and herbal shop owners, biomedical professionals, books, and in cases of desperation, total strangers.

For example, a man from Maravilla Tenejapa told me that his young boy had been bitten by a fly called *mosque chiclera* (probably the new world screwworm—*Cochliomyia hominivorax*), which is known by residents of the tropical zone to cause severe infection. When locally available herbal and pharmaceutical remedies failed to stop the spread of the infection, the man traveled to San Cristóbal to consult with a consortium of professional herbalists that he heard were reputable. For a fee of 300 pesos ($33 US) one of the herbalists traveled to Maravilla Tenejapa to show the man how to use the milky latex of a species of *Ficus* to treat the bite of *mosque chiclera*. The boy's infection healed within a few weeks.

This is an example of "questing," but it also subsequently inspired a different learning process. Rather than having to pay for such information again, the man told me that he decided to buy books and take courses in order to learn as much as he could about medicinal uses of the local flora. Which brings me to the final source of knowledge—learning through books, courses, and apprenticeships. While these sources are still relatively rare, they appear to be increasing in importance as a result of the commodification of medicinal plant knowledge, especially in the frontier zone.

Most learning by the populations in this study results from the processes presented above. Particularly important are participation in illness curing events (especially for children) and questing. As discussed in Chapter 8, most learning is socially situated and is usually tied to an illness event.

Before moving on to how these learning processes structure knowledge distribution, it is important to distinguish between vertical and horizontal cultural transmission (Cavalli-Sforza and Feldman 1981:54), because these result in different patterns of knowledge distribution. Vertical transmission refers to transmission from parents to offspring. This is the primary source of learning for Tzeltal children and young adults, but parents also continue to learn from their parents. Horizontal transmission is restricted to members of the same generation; whether through relations, as in the case of siblings and cousins, or unrelated people, such as friends. This is the primary way in which information enters Tzeltal communities from external sources.

Having described the various ways that information is transmitted, I turn now to my estimation of the relative importance of the various sources of information. Among the multiple questions that I asked when showing plant specimens during structured ethnobotanical interviews in Nabil, Maravilla Tenejapa, and Salto de Agua (Appendix A), I asked how interviewees learned the medicinal use of each plant (see also Cavalli-Sforza 1988; Hewlett and Cavalli-Sforza 1986; Ohmagari and Berkes 1997)(*Bit'il la a'nop ya xpoxta ja'ini*? 'How did you learn that this cures,' or *Mach'a la yalbet ya xpoxta mene*? 'Who told you that this cures?'). Data from the 3,848 occasions that interviewees answered these questions are presented in Table 9.1.

Table 9.1. Frequencies of sources of medicinal plant knowledge reported during structured ethnobotanical interviews.

	Nabil		Maravilla Tenejapa and Salto de Agua	
Information source	No. reports	Percent	No. reports	Percent
Parents	1193	52.1	306	19.7
Other family members	530	23.2	204	13.1
Friends, neighbors, acquaintances	304	13.3	459	29.5
Traditional Tzeltal healers	31	1.4	5	0.3
Strangers	26	1.1	37	2.4
Markets, stores, traveling salesmen	26	1.1	78	5.0
Professional herbalists, midwives	24	1.0	88	5.7
Lowland plantations (*fincas*)	22	1.0	109	7.0
Books	17	0.7	82	5.2
Biomedical professionals	16	0.7	54	3.5
Courses	11	0.5	61	3.9
Self experimentation	4	0.2	5	0.3
Guatemalans	n/a	n/a	17	1.1
Don't remember	86	3.7	51	3.3
Total reports	2291	100.0	1557	100.0

The first point I want to make is that there were very few cases of learning by experimentation with plants that were not known as medicinals, or intentionally attempting to use plants known to treat one illness for another illness (Table 9.1). The general populations of all three communities acquire nearly all of their information from other people, not through experimentation. This is consistent with the major discursive themes of concern about legitimacy and safety (Chapter 8). Put simply, people are extremely wary of their local flora. Again, I want to emphasize the difference between this study, which focused on novices, and studies that have focused on experts, or specialist healers, who are more likely to experiment with new plants[1] (see Brett 1994 for experimentation by Tzeltal healers).

So who do people in Nabil learn from? Most cultural transmission in Nabil occurs within families, beginning with the basics learned as children and continuing through adulthood (Table 9.1). This makes sense when considering that family members are more likely to be trusted, people spend much of their time with family, and, most importantly, illnesses are usually dealt with as a highly participatory family process of distributed cognition.

Within families, most transmission of knowledge in Nabil is vertical—from parents to offspring (Table 9.1). Interviewees did not usually distinguish which parent they learned from, referring only to *jme'jtat* 'parents.' But in 35% of responses they did specify which parent, and the proportion who specified father (49%) was nearly the same as those citing their mother (51%). These data suggest that there is no difference in the amount of information passed on by fathers versus mothers. However, males who specified a parent were more likely to cite their fathers (71%) as the source, and females were more likely to cite their mothers (84%). (Note that I interviewed 50% female and 50% male adults in all communities.) This indicates that transmission pathways are gendered within households, which is consistent with the gendered division of time allocation (Chapter 1). These results are also consistent with Hewlett and Cavalli-Sforza's (1986) study of Aka Pygmy foraging, household, and social skills. In their study, parents were equally likely to know most skills and teach them to children (even though there were gendered differences in labor), but that most transmission was from father-to-son and mother-to-daughter.

The next most important source of information within families was grandparents. Less common sources included aunts, uncles, cousins, siblings, and in-laws. Because of migration and patrilocal residence, these sources were sometimes located in other communities.

After family, interviewees in Nabil were most likely to acquire advice about medicinal plants from friends, neighbors and acquaintances (Table 9.1). Occasionally they sought advice from other people in the community with whom they were not well acquainted, but who had reputations for being knowledgeable, but this was not common. Even more rarely they acquired medicinal plant information from traditional curers, strangers met on trails or in towns, professional herbalists, midwives, biomedical professionals, pharmacy owners, herbal shops, books, and herbal courses and workshops.

As discussed in Chapter 1, many men from Nabil have worked at the large, privately-owned *fincas* at lower elevations (sometimes accompanied by their families). The *fincas* serve as "clearinghouses" for medicinal plant knowledge because people from a variety of places share knowledge about the illnesses they experience while living in poor conditions at the *fincas*. Many of the low-elevation plants that are known as medicinals in Nabil, but do not occur in Nabil, were learned at the *fincas*.

Nabil represents a case of a deep tradition of medicinal-plant use that spans many generations. The situation in the frontier communities is quite different. The Tzeltal who live there have migrated to the area only within the last 28 years, and the tropical flora of the frontier differs from the more temperate flora found in the communities of origin. It comes as no surprise that far less information is passed from parents to offspring than in Nabil (Table 9.1). Indeed most cultural transmission in the frontier is horizontal, involving family members, friends, neighbors, and acquaintances of the same generation.

Also, the information acquired at the *fincas* becomes much more important in the frontier communities (Table 9.1). Nearly every family I interviewed had some householders who worked at the *fincas* before migrating or during the first few years after migrating. Much of the tropical flora in the *fincas* is similar to that in the frontier communities, and much of the medicinal flora of the frontier communities was learned at the *fincas*.

Compared to Nabil, people in the frontier communities were also more likely to acquire information from friends, neighbors, and acquaintances than family. In particular, they were more willing to seek advice from local people who had reputations for being knowledgeable. Many interviewees told me that they learned about medicinal plants by asking the advice of a Ladina woman from San Cristóbal who owned a restaurant and lived in Maravilla Tenejapa center. There was also a Ladina midwife who had lived in Salto de Agua before my arrival and taught female reproductive uses of several plants to people in both communities.

People also regularly consulted the professional herbalist organizations that operated “clinics” in neighboring communities and large cities, as indicated by the story above about the boy with the *mosque chiclera* infection. In another example, community members pooled their financial resources and paid for professional herbalists to live in the community for periods of a few months and teach workshops. There has also been a plethora of government and private sponsored herbal and biomedical education programs as a result of the Zapatista uprising in 1994 and the Guatemalan refugee crisis during the 1980s when many frontier communities hosted refugee camps (see Chapter 1). In one case a medical doctor came from Europe as a volunteer and gave a month-long course in tropical herbal medicine.

Other links in the informational network included traveling salespeople, biomedical clinics, and the market and shops in Comitán. The young doctor who ran the IMSS clinic in Maravilla Tenejapa was interested in herbal remedies, and the clinic served as an important source of information (Table 9.1). I was very surprised to find that in only a few cases did people learn about medicinal plants from the Guatemalan Maya who lived in their communities as refugees during the 1980s and still serve as day laborers for the frontier Tzeltal (Table 9.1).

Finally, I should note that the Tzeltal of the frontier were as hesitant to experiment with the flora as their Highland counterparts (Table 9.1). Instead of experimenting with their new flora, they rapidly "imported" medicinal plant knowledge from sources outside of the community.

The bottom line is that the knowledge system in the frontier is more horizontal and more open than that in Nabil. These differences allow for a comparative evaluation of some of the principles of knowledge distribution that I describe below.

Information network size and transmission error

As I mentioned above, the average number of species known by novices in Nabil was 65 (SD = 15). Obviously, this average is not entirely a result of intellectual capacity. People could clearly "know" medicinal uses of more than 65 plants. But as Roberts (1964) stated in his groundbreaking work on distributed cognition, individuals in distributed knowledge systems tend not to receive as much input as they are capable of absorbing. Whatever the reason, 65 plant species appears to be the cutoff for medicinal plant knowledge for the population. As such, this number sets the overall constraint for how much information, or knowledge, the system contains.

The relative importance of transmission pathways reported in Table 9.1 allows for predictions of how knowledge will be distributed; or to be more specific, whether some information about plants will tend to be confined within information networks. For example, if new information entering from outside of a community, or generated from transmission error, is circulating amongst relatively few people, then we would expect to see knowledge about the various plant species clustered within groups of interacting people. In this case, knowledge should be mostly clustered by households (Table 9.1). Furthermore, within households knowledge should be clustered by gender, as indicated by data showing a pattern of transmission from mothers to daughters and fathers to sons (above), as well as gendered differences in time allocation and labor (Chapter 1).

Asymmetrical distributions of knowledge based on households, gender, and kinship are intuitive and well documented (Boster 1985; Cavalli-Sforza 1988). Gollin (2001:225), for example, showed that Kenyah Leppo' men were more likely to know treatments for wounds, especially from the primary forest, because of a division of labor. Boster (1985) showed that deviations from consensus in manioc classification by the Aguaruna Jívaro are patterned by sexual division of labor, individual expertise, and membership in kin and residential groups.

Following the example of Boster (1985), I produced a cluster diagram based on informant agreement among adults in Nabil about the medicinal status of plants.[2] Figure 9.2 is a segment of the cluster analysis showing how women within households (in gray boxes) tend to agree more amongst themselves about which plants have medicinal uses, while men from the same household (indicated by the curved connecting lines) tend to know different plants.

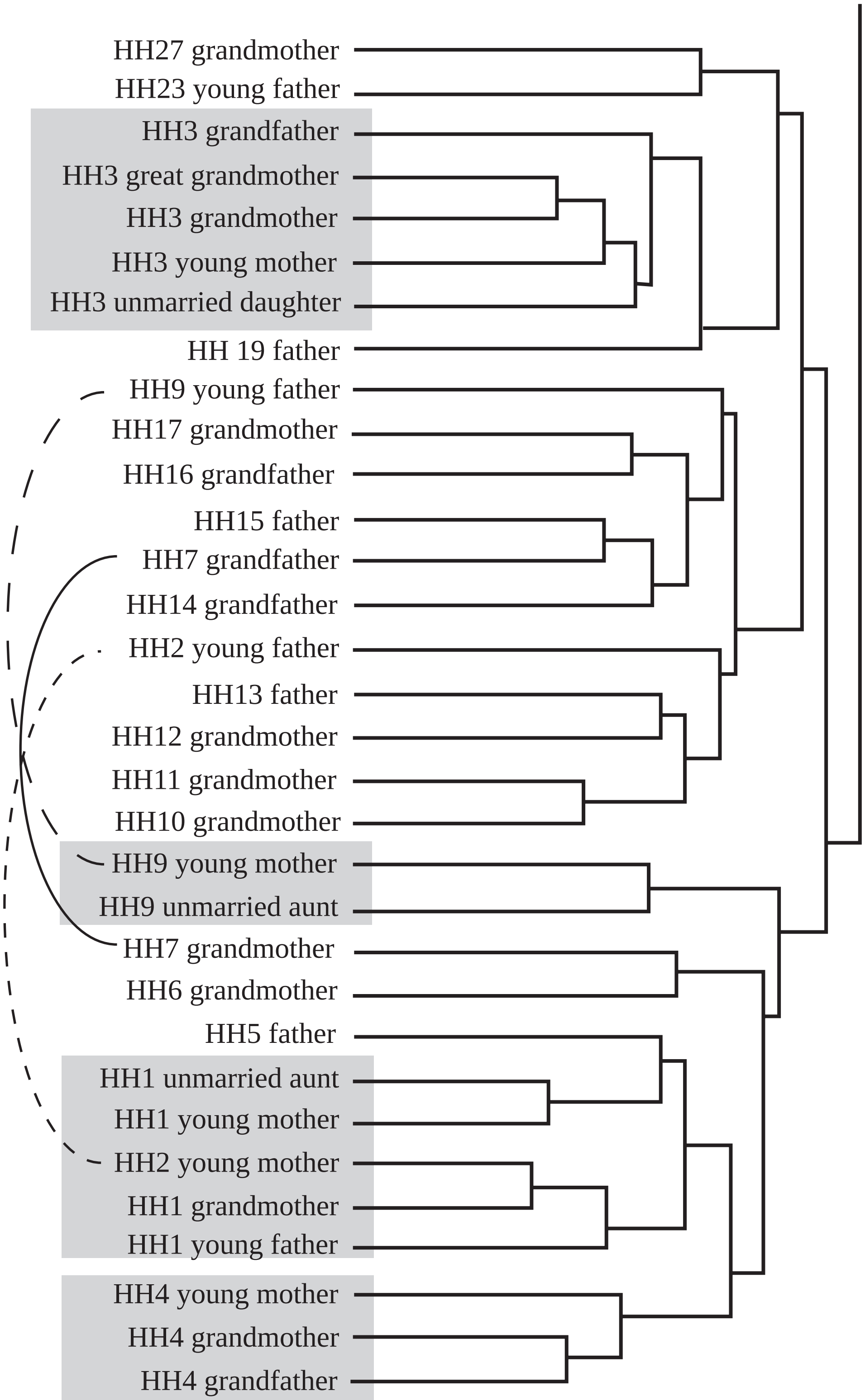

Figure 9.2. Segment of a cluster analysis of Nabil informant agreement about whether each plant species was medicinal or not. "HH" and gray boxes designate households. Men whose knowledge differs from their households are indicated by the curved lines.

At this point I want to digress briefly to distinguish between gendered differences in *amount* of knowledge and *types* of knowledge about medicinal plants. Garro (1986) claimed that women in the communities she studied were the repositories of medicinal plant knowledge. Alexiades (1999: 354-356) showed that Ese Eja women knew more medicinal plants than men. The common intuitive explanation for this pattern is that women are more likely to be caregivers of children, and thus have more experience with medicinal principles. But Gollin (2001:225) claimed that although Kenyah men tended to know different plants, overall gender differences in the total amount of plants known were "not dramatic."

My observations (see Chapter 1) did indicate that Tzeltal men were less likely to spend time talking about children's illnesses because they spend more time outside of households occupied by other interests ranging from politics to wage labor and playing basketball. Using ANTHROPAC and my data from the structured ethnobotanical interviews (Chapter 2), I performed a consensus analysis on whether interviewees considered each of the 45 most commonly known plants to have a medicinal use or not (i.e., a true/false questionnaire). The mean knowledge scores for adult males was 0.53; for adult females it was 0.58. A student's t-test showed that the difference between the male and female scores was not significantly different (df = 29; t = -1.44; $P_{\text{one-tailed}} = 0.08$). These results, combined with the cluster analysis (Figure 9.2), indicate that women did not know more medicinal plants than men, but only that men showed a tendency to know different plants, probably because they spent more time working in other communities and with men from other households.

I want to emphasize that gendered differences in knowledge within the households are minimal when compared to differences between households (Figure 9.2). This is primarily because when serious illness strikes, everyone in the household participates in the curing process. Analogous to Hutchins' (1995) cognitive division of labor, Tzeltal men know some things, women know other things, but they all cooperate to solve problems.

Another characteristic of social structure that I should mention is patrilocal residence, which is still dominant in Tenejapa and the frontier. Young wives, many of which are from other communities, bring some new medicinal information into the households of their husbands. But as Figure 9.2 illustrates, their knowledge is very similar to their new families. For example, the young mothers in households #1 and #9 are from other communities, but their knowledge is very similar to their female in-laws, who they now live with. Indeed, an adult woman is more likely to agree about medicinal plants with her mother-in-law, who she lives with, than her siblings, who live in other households. I suspect this is because although young wives learn many plants during their youth, it is only after they have children that they begin to acquire more detailed knowledge (Figure 9.3). As I will also show below, the plants learned during youth tend to be generally known throughout communities. Learning of more detailed knowledge as young caregivers takes place within their husbands' households. I point this out because it suggests a greater

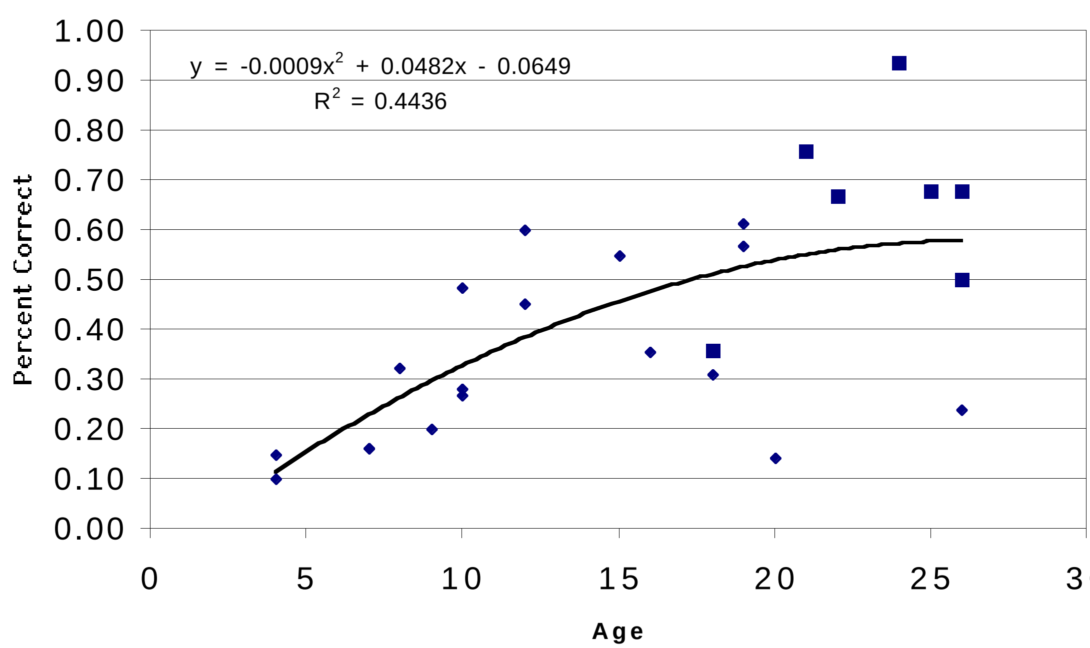

Figure 9.3. Ontogenetic trends in learning of medicinal plants in Nabil determined as the percentage of plants that children were shown for which they provided a correct medicinal use (as corroborated by their parents). Squares indicate young adults with at least one child of their own.

constraint on information sharing between households and communities than might be expected given patrilocal residence. This further contributes to idiosyncrasy (Figure 9.1b).

To reiterate, Figure 9.2 shows how knowledge tends to be clustered by households, and is further clustered by gender within households. This observation is crucial for understanding the transmission of medicinal plant knowledge in Nabil. Although people consult with friends and neighbors about health issues, much of the information that enters the community, or is otherwise passed on to subsequent generations, does not transcend the informational boundaries of the household. This is a major constraint on information flow.

Of course, each household is unique. Some families talk more amongst themselves than others. Some young adults are more eager or capable of learning than others. And, although most young married couples live with the husband's parents, in some cases they start a new household and live alone. There may be as many as four generations living in some households; in other households, there may be only one. One household where I conducted interviews was comprised only of three elderly sisters who had never married.

Although households form the core of informational networks, links in the chains of communication do extend beyond households (Table 9.1). But the number of friends, neighbors, and acquaintances that any individual can learn from is constrained by the amount of time spent outside of the household within communities and opportunities to travel to other communities (which are very few for women; see Chapter 1), and the pronounced concern for legitimacy of the source of the information and perceptions of safety (see Chapter 8).

In practice, these information networks are even smaller, because people will not always communicate with everyone in their potential network. Even though another person may be trusted, and it would be easy to visit with them, individuals may not do so if, for example, they have recently had a disagreement. Or, the other person may have been recently shamed within the community and a friend may not want to be seen socializing with them (Zarger 2002). Thus, actual networks will be even more constrained than the potential networks outlined above.

The small sizes of networks mean that even in the cases of learning from experts, who are the most important producers of new information via experimentation, the information transmitted to a member of the general population may never pass beyond an immediate circle of friends or family. Because information networks tend to be small, information is "bottled up" within households, and to some extent, within networks of friendship and trust, which results in a trend toward idiosyncratic knowledge as depicted in Figure 9.1b. But, as I will discuss below, this effect is not consistent across plant species.

Another important process in the distribution of knowledge is transmission error (Cavalli-Sforza and Feldman 1981:65). In all of the discourses, quests, and passive observations there exists a potential that some information will be transmitted erroneously. For example, the speaker may accidentally use the wrong plant name, there are also legitimate differences in plant nomenclature, some plants look alike, and sometimes people simply fail to remember the information correctly. As another example, Alcorn (1984:303) cited cases of Haustec misapplying information from herbal books. I also saw numerous cases in which people mistook plants pictured in books for local plants. In another case, a woman told me that she was told by a friend about a cure. The friend realized a few days later that she had provided the wrong plant name and came to tell the woman. But in the meantime the woman had tried the wrong plant and insisted that it worked!

If people try a plant in error, and it is perceived to correct symptoms, they may transmit this information. But also, even if the treatment isn't perceived to correct the symptom, the information may still be accepted (Etkin 1988a). It is important to note that either case is a function of *perception* of efficacy. Whether a treatment is perceived to be efficacious depends on many variables. "The person's luck/ability to diagnose the illness properly and choose the correct remedy will influence his success and therefore the knowledge deemed useful for passing on/to be remembered" (Alcorn 1984:310). Also, people may still assume that the plant is the correct cure but may be more appropriate to use for another stage in the illness process, or it may work better on one person than another, or they have prepared it incorrectly (Etkin 1988a). Although pharmacological activity influences emic judgements about efficacy, and pharmacological activity may enhance the likelihood of transmission, it cannot be assumed that observations of pharmacological activity will remove all "erroneous" knowledge from a system. The result is somewhat analogous to mutations resulting from transcription error in biological evolution. As long as the trait is not deleterious, it doesn't necessarily need to be advantageous to spread throughout the population (Kimura 1968).

But note also that the constraints of the size of information networks, the hesitancy to repeat unsuccessful treatments (Chapter 8), and/or the likelihood that other people may not obtain similar results, will all constrain the diffusion of this new information. If new information is being produced through error at a rate faster than it is removed, it will accrue among individuals. But because this information is not likely to spread across many individuals, heterogeneity and idiosyncratic knowledge in the system will increase. That is, more plants and their uses will be known by fewer and fewer people (Figure 9.1b).

At this point I want to comment on the boundedness of these information systems because this is important when comparing Nabil with the frontier communities and for explaining differences in knowledge between neighboring communities. Allen and Hoekstra (1992:25-53) provide a useful description of ecosystemic boundedness at different scales. When conceptualizing ecosystemic scales ranging from organisms to biospheres, there appear to be natural break points, or discontinuities, based on rates of chemical reactions or other interactions between physical or energetic entities. For example, the rates of chemical reactions occurring within a human body are of a greater volume and happen at a faster rate than those occurring between the body and the immediate environment. The flow of information about medicinal plants appears to also form discontinuities at the household level and the political boundary of the community. Table 9.1 and Figure 9.2 suggest that most information is circulating within households, and at a faster rate, than between households. Likewise more information is exchanged, and at a faster rate, within Nabil, than between

Nabil and other communities. Thus, the socio-political boundary of the paraje of Nabil forms a natural boundary of the medicinal plant informational system.

Because most cultural transmission is within communities, a greater potential for error exists within the community than between one community and another. This, combined with the tendency for transmission error to be a random (stochastic) process, means that knowledge between communities will gradually diverge in unpredictable ways. Thus, even though two communities like Nabil and Ch'ixaltontik are next to each other, share young wives, and have a nearly identical flora, there are surprising differences in knowledge about particular plants and illnesses (Chapter 2). Alexiades (1999:352) also found similar differences in knowledge when he compared two Ese Eja communities.

The differences in knowledge between the towns in this study (Chapter 2) can not be accounted for by differences in individual cognitive models of curing based on taste, the doctrine of signatures, plant distribution, pharmacological efficacy, or epidemiological context, because these are widely shared in both communities. Instead, it is the structural and stochastic properties of knowledge systems that probably better explain the observed patterns.

So far, this discussion has focused on the community of Nabil. The explanatory value of these concepts becomes even more apparent when comparing patterns from Nabil with the frontier communities, which have different patterns of transmission.

Most importantly, the frontier communities show less constrained patterns of diffusion. More information is entering the communities from outside of their political boundaries through courses, professional herbalists, books, and the *fincas* (Table 9.1). These are more open information systems than Nabil. Hutchins' (1995:262) work with distributed cognition led him predict that open systems are more likely to have horizontal than vertical internal structure. Indeed, there is far less cultural transmission from parents to children in the frontier communities, and more sharing of information among friends and acquaintances between households.

Thus, more information is entering the community and it is flowing more freely between households. Information is being shared among more people than would be the case with a predominantly vertical system such as that in Nabil (Hewlett and Cavalli-Sforza 1986). This allows for the prediction that there will be less of a tendency toward idiosyncratic knowledge in the frontier communities. That is, there should be less of the effect depicted in Figure 9.1b.

This appears to be the case. By plotting the knowledge distribution curves from Nabil and the frontier communities on the same graph (Figure 9.4), it becomes clear that knowledge in the frontier is more widely distributed (i.e., less constrained). Further evidence for the reduced tendency toward idiosyncrasy is provided by the observation that there are only 116 species known by two or more people in the frontier, versus 130 in Nabil (although this could also be a function of the shorter history of the frontier communities).

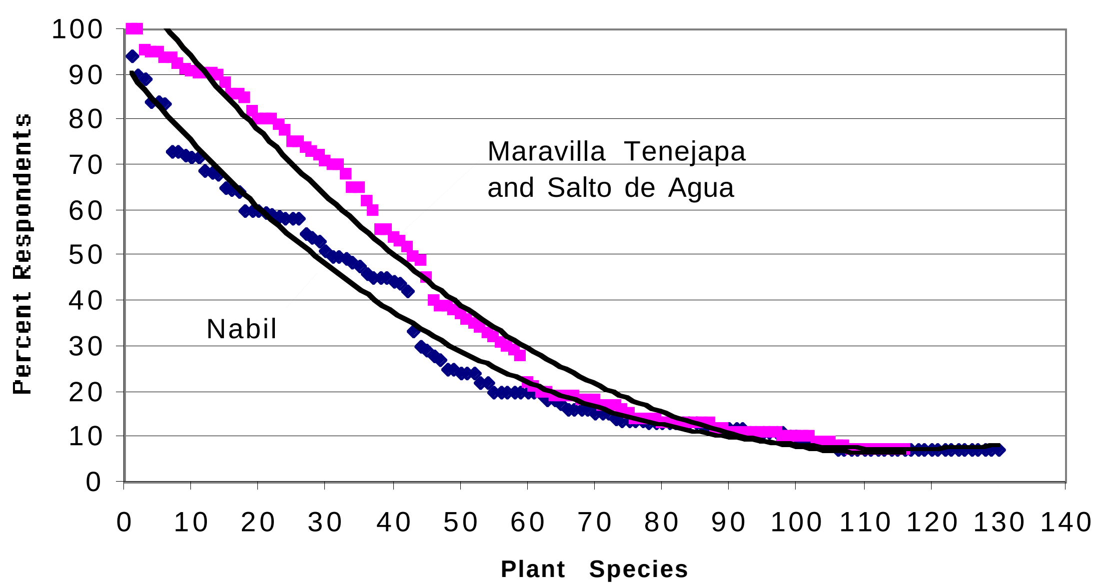

Figure 9.4. Percent of respondents in Nabil, Maravilla Tenejapa and Salto de Agua citing medicinal uses for plant species (only species known by two or more respondents are shown). Knowledge is more widely distributed in the frontier communities.

Also, frontier individuals tended to know more plants than in Nabil (mean = 71) although there is an increasing disparity between those who know many plants and those who know fewer (SD = 23). Note that the shape of both curves in Figure 9.4 is similar, suggesting that perceived efficacy, rates of transmission error, and sources of cultural bias discussed below are similar in both situations.

Thus, holding some parameters of the Nabil and frontier systems constant (e.g., language, epidemiological context, and illness nomenclature—Chapters 1 and 3), but altering the flora and structure of cultural transmission pathways, allows for a comparative experiment. The results shown in Figure 9.4 support the notion that knowledge will be more widely distributed in the frontier because of horizontal and open patterns of cultural transmission. This indicates the importance of networks and social organization for constraining information flow. I was not able to obtain such comparative predictive power using other variables like cultural interpretations of plant taste and morphology (Chapter 5), humoral classification (Chapter 6), or the distribution of plants in the landscape (Chapter 7).

Cultural bias

To further account for the shape of the curves in Figures 2.1 and 2.2, I turn next to the three forms of cultural bias in transmission described by Henrich (2001). Henrich was attempting to explain patterns in the adoption of individual innovations throughout populations. He argues that the pattern of how many people adopt an innovation over time almost always follows an *S*-shaped curve (Figure 9.5). In the beginning, there is a long period when very few people adopt the innovation, followed by a period of rapid diffusion, and then a leveling off, in which all those who are going to adopt the trait have done so. In my case, I am interested in knowing how the distribution of knowledge about the various medicinal plant species (i.e., 130 such "innovations" in the case of Nabil) can be located at various points on Henrich's adoption curve. In essence I am considering my data to represent a snapshot in time of the

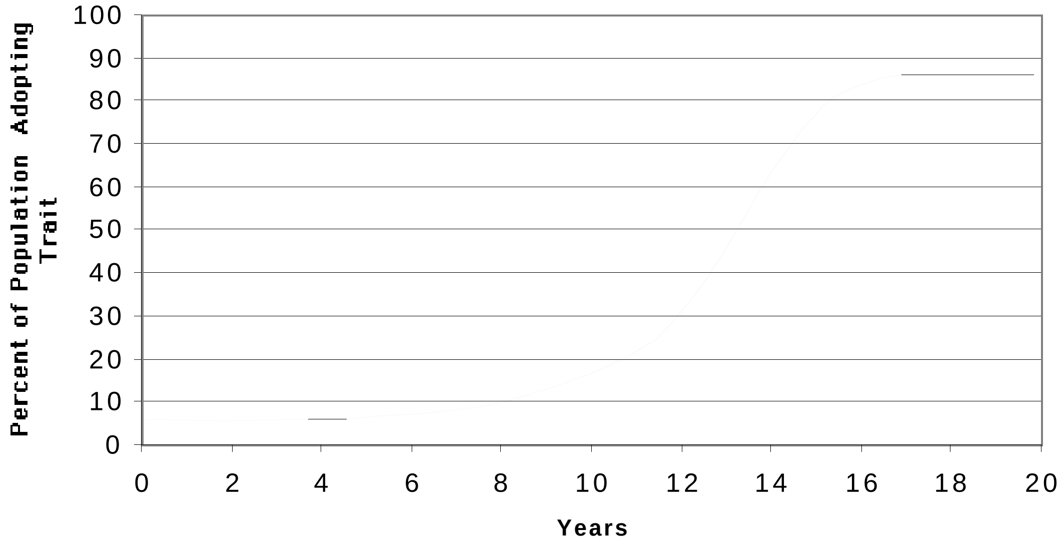

Figure 9.5. A typical innovation adoption curve (after Henrich 2001).

process of adoption (or perhaps abandonment or non-adoption) of the various medicinal applications. Yet another way to look at the Tzeltal patterns is that some knowledge gets "stuck" in the beginning of Henrich's adoption curve.

Henrich argued that a fundamental constraint on adoption is direct bias, or personal acceptance bias. As described by Henrich (p. 997):

> Direct biases result from cues that arise from the interaction of specific qualities of an idea, belief, practice, or value with our social learning psychology. The presence of these cues makes people more or less likely to acquire a particular trait.

I am applying Henrich's description to how well a new trait conforms to individual cognitive models of plant-based curing. For example, in the case of Tzeltal medicinal plant knowledge such cues might derive from cognitive models of the relationship between bitter taste and gastrointestinal illnesses. But recall from Chapters 4 and 8 that the most important criterion for guiding acceptance into the cognitive category of medicinal plants is whether a plant is considered to be efficacious, and personal observations, convincing discourse, and concerns regarding legitimacy and safety can easily override individual models of how the plants should work. I proposed an important distinction in Chapter 8 between individual models, which are primarily explanatory and rely on concepts such as taste, and shared discursive models, which rely more on social themes.

I am arguing that the personal acceptance bias results primarily from perceptions of efficacy, which to a large extent has a pharmacological basis, but also is subject to the contexts of social learning and variations in individual cognitive models. Thus, it can not be assumed that two bitter plants with equal pharmacological potential to treat the same linguistically recognized illness will be accepted by everyone in the population with equal probability. This serves to explain, to a large extent, the shape of the knowledge distribution curve (Figures 2.1 and 2.2).

Of course, some plants *are* more efficacious for treating symptoms, defined both pharmacologically and culturally, and thus are more likely to escape the constraints of transmission error and the limitations of network size. This is why perceptions of efficacy are correlated with knowledge distribution (Chapter 4). Nevertheless, although this is the overall pattern, many plants that are efficacious do not escape the constraints. The reasons can be stochastic. For example, the probability that new information enters a community via a person who is centrally located in his or her information network versus someone who is marginal may be largely random. There may also be combinations of environmental and cognitive effects. For example, knowledge will be less likely to spread about a rare disease for which there is poor agreement among explanatory models, such as *cha'lam tsots*. I discuss several more such problems below. The important point here is that knowledge about some plants may not spread, even though the plants may be efficacious by emic standards, they may fit individual models of plant-based curing, and they may be abundant in the local landscape.

Another empirically-supported principle of transmission is conformity bias (Henrich 2001). Put simply, people are more likely to accept a new idea or behavioral trait only after they see that others have done so. In adopting any innovation, some people will be pioneer experimenters, but most people will wait to see the results of the pioneers and adopt the trait only after others have. This largely explains the rapidity of diffusion at the steepest point of the *S*-shaped adoption curve (Figure 9.5). Once a critical mass is achieved, most people rapidly adopt.

This also provides another possible explanation for the shape of the Tzeltal knowledge distribution curves (Figures 2.1 and 2.2). Information about those plants that are known by only a few people is not likely to spread to other people precisely because only a few people know it. Again, this is a perceptual problem related to efficacy. Just as ethnopharmacologists assume that the most efficacious plants will be widely used, the Tzeltal may question the efficacy of a plant known by only one person. On the other hand, a person questing for a cure needs only to encounter two or three people who know a cure to assume that the cure is widely known and is therefore probably efficacious. Such systems become stable over time, with some items dominating.[3]

Of course, the effect of conformity bias will vary from case to case. As interview excerpt 8.7 above indicates, people are eager to learn a new cure from someone with a remarkable story of recovery from an illness. But again, how widely the person who was sick is known, the place of the information bearer in social networks, and decreasing trust in the legitimacy of information as social distance from the person who was sick increases will all affect the importance of conformity bias.

Another important issue in cultural transmission is prestige bias (Atran et al. 2002; Henrich 2001), in which people who hold high social status are more likely to be consulted for information, often regardless of the relevance of the topic of information to their social status. For example, Atran et al. (2002) suggested that for the Q’eqchi’ Maya, information coming from outside of the community is less likely to spread if it is introduced by socially irrelevant people. In particular, they argued that people of higher social status are more likely to be asked for their opinions about ecological concepts.

The case of Tzeltal medicinal plants is different. I found that social status was largely irrelevant.[4] As I have already discussed via the discourse analysis in Chapter 8, two of the primary concerns for the Tzeltal are the legitimacy of the source of information and the safety of the plant-based treatments. Furthermore, while interviewing people about how they learned plants, they never indicated that they learned plants from politically powerful or wealthy individuals, which would have been a logical way of presenting legitimacy to me had that been important to them. Instead, in those rare cases when they ventured outside of the immediate circle of friends and family (Table 9.1), they almost always consulted with someone who they trusted. In particular, people with reputations to be both knowledgeable and *cautious* about medicinal plants.

In the Tzeltal case this concept may be better described as “expertise bias” or “safety bias,” than “prestige bias.” But the effect on knowledge distribution is similar to that described by Henrich (2001) and Atran et al. (2002). There are probably very few people serving as key sources of new information, and people in the population will vary in their ability to access these key sources. Thus, the distribution of information will be asymmetrical. Also, if these key informants remember the treatment incorrectly, deviate from standard nomenclature, or learned the treatment incorrectly, they become critical loci for stochastic effects.

Asymmetrical opportunities for learning

As expressed by Boster (1991), learning opportunities may either be ubiquitous or rare, they may vary in quality, and they will not be evenly distributed among individuals. Here, I briefly discuss these issues to further explain why the total information in Tzeltal medicinal knowledge systems is constrained, and why information tends not to be distributed evenly.

An individual's position in an information network, the extent and structure of that network, and the quality of the information in the network will all affect a person's ability to learn about medicinal plants. An interesting example is provided by two frontier families who were close friends and neighbors in their *paraje* of origin in Tenejapa, and who agreed to migrate to the frontier together (24 people spanning three generations migrated together). My structured ethnobotanical interviews quickly revealed that none of these people knew even the most common medicinal flora of the Highlands or the frontier. Subsequent conversations indicated that key individuals in the network were never interested in learning medicinal plants. They specifically mentioned that one reason for migrating was to earn more money in order to access biomedical resources. A young woman from another frontier community who had married into one of the families, and who was interested in learning medicinal plants, told me that she was frustrated by her inability to acquire information within her new network. As far as medicinal plants were concerned, these families had transported their low-quality, closed network to their new environment. As a result, the young woman had a very low potential for learning.

Another overall constraint in the flow of information about medicinal plants is time. Put simply, there is only so much time that people can dedicate to talking about medicinal plants or searching for specific cures. Furthermore, the amount of time will vary among individuals. As I discuss above, and in Chapter 1, women appear to dedicate more time to the topic of children's illnesses, while men may share more information about wounds encountered while at work.

The type of men's employment will also have an effect. Men who work alone cutting timber have less opportunity to learn from others than men working in groups picking coffee at the *fincas*. Men working on construction have even less opportunity to learn about plants, since most construction materials are now manufactured.

Finally, I want to mention the variable frequencies with which illnesses are encountered. Since most information appears to be transmitted during illness episodes, there are probably fewer opportunities to communicate about less prevalent illnesses. Recall from Chapter 7 that the frequency with which plants were used was nearly correlated with knowledge distribution. This is partially a function of some illnesses being more prevalent and because the plants used to treat these illnesses are used more frequently.

Boster (1991) proposed that a population who has less opportunity to experience a concept or item directly will rely more on verbal communication for learning. In such cases there would be more of an influence of social networks and the information would be more patchy. Boster also discusses "information quality," or how well structured the domain of information is. I alter this concept slightly to refer to congruency among individual Tzeltal explanatory models and clarity of symptomatologies for the various illnesses. Per Boster's reasoning it should be easier to learn about treatments for illnesses that are common, show clear and simple symptoms, and for which individual explanatory models are similar.

This notion appears to be supported by my data. The most widely shared plant-based treatments are for diarrhea and cough. These are the most common illnesses, which also tend to have the clearest symptomatologies. The highest variation about plant treatments is associated with rare illnesses that have unclear symptomatology and explanatory models like *cha'lam tsots* (Appendices B and C).

I doubt there would be a correlation between knowledge distribution and these variables, if indeed they were quantifiable. But the point that I hope to make again is that although efficacy is generally predictive of knowledge distribution, the distribution of knowledge about any particular plant is confounded by a variety of processes unrelated to efficacy.

Ontogenetic learning bias

The *J*-shaped Tzeltal knowledge distribution curve (Figure 9.1c) is also a result of ontogenetic bias—the patterned order in which children learn plants. Tzeltal children start learning to name plants at age two, and learning continues at a rapid pace until about age 12 when most plants are known by name (Stross 1973). Most knowledge about the uses of plants (or similar ethnoecological knowledge) is learned by about age 14 (Ohmagari and Berkes 1997; Stross 1973; Zarger 2002:209). But the order in which plants are learned is not random—some plants are more likely to be learned first (Stross 1973; Zarger 2002:179). As I will show below, some children do not learn as many plants as others, and some young adults stop learning medicinal plants in their teens, while others continue to accumulate more detailed knowledge. Because the plants known by those who learn the least will be included in the set of plants known by more knowledgeable adults, any sample of the population's knowledge will show that the plants that are learned first will be included with higher frequency than plants learned later in life. This contributes to the *J*-like shape of the knowledge distribution curve.

To determine if this was indeed the case for the Tzeltal knowledge distribution, I interviewed 16 children and young adults between the ages of 10 and 25 using dried specimens of the 45 most widely known plants asking for plant names and medicinal uses for each. Children younger than 10 are less likely to be able to identify dried specimens out of context, and very unlikely to know plants from habitats other than their immediate houseyards. Therefore, I interviewed six children between the ages of four and nine using a subset of 15 species that grew in yards. The children under 10 were interviewed by walking around their own yards with a parent and asking if they knew each of the 15 species' names and medicinal uses. Results were then normalized across the entire population as the percentage of the plants shown to each participant for which they could correctly identify a medicinal use. I considered any answer that was later verified by each child's parents as a legitimate medicinal use to be a "correct" answer.

I produced a Guttman scale using ANTHROPAC (Borgatti 1996b) and determined that there is a rough order in which medicinal plants are learned by children (Figure 9.6). The species that tend to be learned first are those that grow abundantly around houseyards and are used most frequently for the most common illnesses (Chapter 7). They also tend to be the species that dominate household discourses (Chapter 8).

Age	*Verbena litoralis*	*Erigeron karwinskianus*	*Baccharis vaccinioides*	*Sambucus mexicana*	*Foeniculum vulgare*	*Aloe vulgaris*	*Satureja brownei*	*Salvia lavanduloides*	*Sedum praealtum*	*Mentha citrata*	*Nicotiana tabacum*	*Matricaria recutita*	*Litsea glaucescens*	*Brugmansia candida*	*Solanum lanceifolium*	*Prunus persica*	*Oenothera rosea*	*Myrica cerifera*	*Rhus terebinthifolia*	*Borreria laevis*	*Pinus* sp.	*Adiantum andicola*	*Gaultheria odorata*	*Quercus* sp.	*Pinaropappus spathulatus*	*Psidium* sp.	*Chenopodium ambrosioides*	*Cupressus lusitanica*	*Prunella vulgaris*	*Castilleja arvensis*	*Cornus disciflora*
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-		+
21	1	1	1	1	1	-	-	1	1	1	1	1	-	1	1	-	1	-	1	-	-	1	+	+		+	+	+		+	+
25	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	-	-	1	1	1	-	+		+					+	+	
22	1	1	1	1	1	1	-	1	-	-	1	1	-	1	-	1	1	-	1	1	+	+				+		+		+	+
19	1	1	1	1	1	1	1	1	1	1	-	1	1	-	-	1	-	1	-	+		+		+			+		+		
19	1	1	1	-	1	-	-	1	1	-	1	-	1	1	1	1	1						+	+	+		+	+			
15	1	1	1	1	1	-	1	1	1	1	1	-	-	-	1	-	1	+	+	+			+						+		
12	1	1	1	1	1	1	1	1	-	1	-	1	-	-	-	+	+						+		+	+					
10	1	1	1	1	1	1	1	-	1	1	-	-	1	1	1					+	+	+									
12	1	1	-	1	-	1	1	-	1	1	1	1	1	1	+	+					+										
16	1	-	1	1	-	-	1	-	1	1	1		+		+			+	+												
18	1	1	1	-	1	-	-	1	-	-	+			+	+				+				+								
8	1	-	-	1	-	1	1	-	1	1		+		+				+			+										
18	1	1	-	-	1	1	1	1	1								+	+													
10	-	1	1	1	1	1	-	-			+	+				+															
10	1	1	-	-	-	1	-	+				+				+									+						
7	-	1	1	-	1	+	+																								
7	1	-	-	1	-						+		+								+										
20	1	1	-	-	+			+																							
9	-	-	-	1			+			+			+																		
4	-	-	1			+			+																						
4	-	-					+					+																			

Figure 9.6. A Guttman scale showing the approximate order in which plants are learned by children from age 4 to 25 in Nabil. This Guttman scale was produced using ANTHROPAC (Borgatti 1996b:131). The species to the left of the table are most likely to be learned first. "1"s indicate that the participant cited a medicinal use that agrees with the majority of adults (i.e., is "correct"), and which fits the overall Guttman scale. "+" indicates that the participant cited a medicinal use that agrees with the majority of adults, but shouldn't have according to the Guttman scale. "-" indicates that the participant provided an "incorrect" answer or no answer when they "should have" according to the Guttman scale. The Coefficient of Reproducibility was 0.765; marginal error was 217; Coefficient of Scalability after sorting was 0.263.

The trend in ontogenetic learning (Figure 9.3) shows that some young adults never learn more than the basic children's knowledge. The low R^2 value and the spread of the points in Figure 9.3 indicate a clear divergence in competency with age. In other words, some children learn no more than a few medicinal plants, while others continue to accumulate knowledge well into adulthood. Furthermore, it appears that young adults who have children of their own learn more medicinal plants. Zarger (2002:217) also noted that Q'eqchi' adolescents tended to learn more detailed knowledge as a result of "being held accountable" by the community for their knowledge. These results differ from those of Ohmagari and Berkes (1997) and Hewlett and Cavalli-Sforza (1986) who claim that most ethnoecological and social skills are learned by the time children reach their mid-teens. In contrast, Zarger (2002:207-209) found that the Q'eqchi' continued to learn additional information about plants well into adulthood.

While it is true that most Tzeltal children learn the basic medicinal plants and principles by their teen years, there is a good deal of variation in knowledge at that age, and some will continue to learn significant amounts of detailed knowledge after having children of their own. As indicated by the Guttman scale, if a young adult knows only a few plants, the species they know are likely to be those that tend to be learned first. Thus, any sample of knowledge drawn from the adult population will show that the plants that are learned first will be represented more frequently. The *J*-like shape of the curves in Figures 2.1 and 2.2 can be at least partially explained by the tendency for species that are learned first to be more widely known throughout the population. Differences in the number of plants learned are mostly the result of the quality of the information networks to which the children belong, other asymmetrical opportunities for learning, and the efficacy and accessibility of plants. Although children are undoubtedly developing intuitions about why plants cure that are based on plant taste, smell, or morphology, these intuitions are probably not contributing to the ontogenetic bias of knowledge distribution.

Typicality and discursive bias

Before ending this discussion of cultural transmission, I want to introduce the idea that the effects of prototypicality in discourse may also bias cultural transmission. This is based on my observation that individuals ground discourses by using the few plant species that are most typical of the category 'medicinal plants' to construct discourse frames. These frames are necessary to initiate meaningful discourse, but they also bound the potential trajectories for subsequent dialogue, and therefore may bias or constrain patterns of cultural transmission.

Given the widespread concern for safety of the information being transmitted and the legitimacy of speakers, there would seem to be a communication problem between individuals with widely divergent models of medicinal plant curing. Either speaker might not be inclined to trust the other speaker's knowledge if it appears that the other speaker has the facts wrong. In the previous chapters I showed that discrepancies in individual models of curing illnesses are common throughout the communities in which I worked. Nevertheless, information is routinely transmitted. This is partly because people strive to construct some "common ground" in their conversations (Mingers 1997; Rolfe 1996; Schwarz 1996:7). Prototypical plants and events appear to play an important role in the process of bridging divergent models by establishing that two people have a common understanding of how at least the obvious things should work, and that they may only disagree on more complex details. If trust in the other speaker is sufficient, one may be convinced to revise his or her model of a particular cure, or open themselves to accepting new and unfamiliar models, as in the case of the AIDS discourse (interview excerpt 8.4). Starting discourses by talking about prototypical plants appears to bridge divergent models and build common ground early in the discourse.

For example, while collecting plants or conducting vegetation surveys, my assistant and I often met people on the trails. We were always questioned about what I was doing.

Here is a typical conversation recorded on one such occasion:

Excerpt 9.1 (from Nabil Tape 22)

Assistant: Tatik, bi xi.
Friend, what do you say.

Other: Bi xi, binti spas?
What do you say. What is he up to? (referring to me)

Assistant: Ya snop poxil wamaletik.
He's studying medicinal plants.

Other: Ja'mene, poxil.
Really, medicinals.

Assistant: Jich'.
Yep.

Other: Banti lijkem?
Where is he from?

Assistant: Lijkem tal ta Estados Unidos.
He's from the United States.

Other: Aaah ta estados unidos, melel.
Aaah, the United States, really.

Assistant: Jich'.
Yep.

Other: Poxil . . . ya snop poxil . . . Ay bayel poxil li'i. Ay te yakan k'ulube . . . ya bal a'na yakan?
Medicinals . . . he studies medicinals . . . There are a lot of medicinals here. There's *Verbena litoralis* . . . Do you know it? (asking me)

Casagrande: Yak. Ya spoxta tza'nel xi.
Yes, it cures diarrhea they say.

Other: Ja'mene, ya spoxta tza'nel. Jich' ya sna te poxiletik.
That's right, it cures diarrhea. He does know medicinals.

Assistant: Yak. Ya sna bayel.
Yes, he knows many.

Other: Ay bayel poxil. Ay te . . . te. . . ja'ini . . . te tujkulum ch'ixe.
There are lot's of medicinals. There's . . . there's . . . this . . . *Solanum lanceifolium.*

Assistant: Ja'mene. Tujkulum ch'ixe.
That's right, *Solanum lanceifolium.*

Other: Ya spoxta ik'.
It cures body aches.

Assistant: Ja'mene, ya spoxta ik'.
That's right, it cures body aches.

Other: Ya spoxta ik'. Ay bayel . . .
It cures body pains. There's lots . . .

Assistant: Bayel te poxil . . .
There are lots of medicinals . . .

Other: Ya bal a'na ja'ini . . . ja'ini . . . binti spil . . . Ay tul ants la yalben ya spoxta . . .

Do you know this . . . this . . . what's it called . . . Some woman told me it cures . . .

Assistant: Binti ya xpoxta?

What does it cure?

Other: Ja' . . . ya spoxta . . . ch'ay ta k'otan, pero jich' ya xpoxta tsin. Ay yan. Ja' te . . . binti spil . . . Ya spoxta sak obal. Ya spoxta sak obal xi. Ya jpaytik sok . . . ja'ini ni ni, sak ji spil.

Well . . . it cures . . . I forgot. But it cures. There's another, it's . . . what's it called . . .it cures dry itchy cough. It cures dry itchy cough they say. You boil it with . . . it's . . . *Cornus disciflora* it's called.

Assistant: Je'mene. Sak ji.

That's right, *Cornus disciflora*.

Other: Ya bal a'na te sak ji'e?

Do you know *Cornus disciflora*?

Assistant: Yak. Ya jna. Pero ma ba k'ayoj ya spoxta . . .

Yes, I know it, but I hadn't heard that it cures . . .

Other: Ya spoxta sak obal xi. Ay yan. Te 'kujye ya spoxta cha'lam tsots.

It cures dry itchy cough they say. There's another, a snail, it cures 'second hair illness.'

This conversation follows a very typical pattern. After the initial greetings and the standard "what is he doing here?" the people we encountered were always eager to talk about medicinal plants. They began by steering the conversation toward a plant that everyone was sure to know. If we hadn't known that plant, the conversation would have probably moved on to a different topic (like whether there are jobs in the United States). Thus, a plant that best represents the category was used to establish the discourse frame—an understanding that we all have some knowledge in common that makes any subsequent meaningful exchange possible. In five out of the seven such spontaneous "trail" conversations that I was able to record, the initial plant discussed was either *Verbena Litoralis* (n = 3) or *Baccharis vaccinioides* (n = 2)—two of the plants that I identified as prototypical category items. These are the plants for which it is most likely that anyone in the community will know the "appropriate" medicinal use, including children beginning at age four or five (Figure 9.6). In the other two cases the "introductory" plants were also widely known (*Erigeron* *karwinskianus* and *Solanum lanceifolium*). They were also in our line of sight and had probably been seen by the speaker.

As the excerpt above exemplifies, the next conversational phase appeared to serve to further solidify the discourse frame by talking about other common and well known plants, usually by looking around for visual cues—almost as if we started talking at the top of the curve in Figure 2.1 and proceeded down the slope. Only after the first two phases of frame instantiation, usually consisting of about three or four plants, did conversations turn to other more idiosyncratic knowledge. In the case above, the speaker segues to the use of *Cornus disciflora* to treat cough. Then, he mentions the even more esoteric use of a local snail to treat *cha'lam tsots* 'second-hair illness'—a very serious but poorly understood Tzeltal illness for which there is little agreement about cures (Luber 2002), although most people are interested in finding a cure. This appears to be a phase in which other speakers tried to impress us with their knowledge, probably because they knew before we met on the trail that I was in town paying people for interviews about medicinal plants.

The first important point of this observation is that interlocutors cannot begin conversations with idiosyncratic information. In other words, two people can not begin to communicate by instantiating radically different individual models. Instead, there is a beginning phase in which the shared schematic model is presented and the first details are filled in with prototypical features that everyone is expected to understand. Reconciling (or mediating) individual and shared models thus appears to be an important role of prototypicality in Tzeltal communication.

The second important point is that the plant species that follow the initial prototypical plants are not likely to be randomly produced from memory, but will be cued by some characteristic of the previous plant. This reasoning roughly follows the concept of "polysemous chaining" (Lakoff 1987; Palmer 1996). The same principle can be seen in the Tzeltal freelists of medicinal plants, in which respondents almost always started with one of the three most typical plants (Chapter 8). The plants that followed would share some characteristic—usually they would be plants used to treat the same illness, but also they could have a similar taste or grow in the same habitat. Quite often when these "chains" were exhausted the interviewee would go back to the original typical plant or begin anew with another of the three most typical plants. In the cases of freelists and discourses, typicality appears to provide a starting point from which individuals will pursue various cognitive or discursive trajectories (Kronenfeld et al. 1985).

If these two important processes are almost always primed by a limited number of plants, as my data suggest, the implication is that the diversity of potential trajectories that follow will be limited, as opposed to always starting with a random plant, which would allow for a potentially limitless diversity of trajectories. The discursive benefit of typicality is the creation of a frame that potentiates meaningful exchanges, but the cost is that the diversity of such frames is limited by a few plants.

The important implication is that the extreme saliency of the few plants at the top of the curves in Figures 2.1 and 2.2 becomes another possible explanation for the *J*-like shape of the curve. Because some plants are more widely known and dominate shared models, the potential for disseminating knowledge about other plants is constrained. How similar the other plants are to the prototypical plant determines how likely they are to appear in discourse. Thus, the potential for dissemination of knowledge decreases as plants are added to the knowledge pool.

Conclusion

The concepts presented in this chapter are important for understanding why the Tzeltal in the communities I studied know some plants as medicinals, but do not know others. Results of this study, combined with observations from other studies, indicate that there is a limit to the amount of information about medicinal plants that can be disseminated in any pre-literate community, and that the processes that affect patterns of distribution within communities are common across study populations

Because of social organization, political organization, and historical processes, the communities that I studied exhibit properties of bounded information systems in which more information circulates within the *paraje* and *ejido*, and at a faster rate, than it does with sources outside of the political and social boundaries. Within communities knowledge tends to be clustered by households, and is further clustered within households by gender. Because everyone does not have equal access to all information, the amount of information that persists within communities is constrained by the size, number, and quality of information networks. Furthermore, information in systems that are dominated by vertical transmission (like Nabil) is more constrained than that of horizontal systems (like the frontier).

Because there is little experimentation among the novice populations that I studied, there is little opportunity for independent discoveries of the same cures. This indicates that similar information can not appear spontaneously throughout the population. New information is either imported or results from transmission error, and tends not to spread due to the constraint of network size.

These factors, when combined with each other and with the constraint of how much time is available for sharing information about medicinal plants, define the limits of how much medicinal plant knowledge can be disseminated within the communities. There is widespread agreement about the use of less than 60 plants, both in this study as well as numerous other studies (Barrett 1995; Berlin et al. 1990; Friedman et al. 1986; Johns et al. 1990; Stepp 1998). Because information that is imported or arises from transmission error does not circulate widely, and because of the asymmetrical distribution of learning opportunities, there is a large amount of idiosyncratic knowledge as mentioned in the other studies cited above and represented by the asymptotic tails of the curves in this study .

The limits of information flow also help explain the “missing” information about important illnesses that I documented in Chapter 2. Again, the explanation for this phenomenon is not that emically-defined efficacious plants don’t occur in the communities, nor that the information hasn’t entered the community, nor that there is a lack of impetus for dissemination of that information, nor is it a function of individual long-term memory. The likely explanation is that there are structural limits on the total amount of information that can be widely disseminated throughout the communities.

Which information is excluded is partly due to illness prevalence (i.e., how frequently diarrhea, cough, and oral thrush are experienced versus rare illnesses like ‘second hair’), information quality (i.e., the consistency of cognitive models and clarity of symptoms), and differences in perceptions of efficacy—all of which contribute to radically asymmetrical and unpredictable opportunities for learning. There are also stochastic effects, such as the size and quality of the information network and perceived legitimacy of the bearer of information through which transmission errors or external information are introduced. The cumulative effect of these processes is manifest by such observations as widespread ignorance of dermatological treatments in Nabil that are well known in neighboring communities.

These processes not only help explain why information is “missing,” but also the *J*-like shape of the knowledge distribution curves in Figures 2.1 and 2.2. Emic perceptions of efficacy and individual preference bias are important for understanding this pattern. Other effects that likely influence knowledge distribution, in addition to the processes mentioned above, include conformity bias, the quality of one’s network, type of employment for males, ontogenetic bias, and bias due to plant-based typicality in discourse.

Finally, significant differences in knowledge between neighboring towns (Chapter 2) result from constraints of information flow at the social and political boundaries of these communities. This, combined with stochastic effects, such as the randomness of transmission error or whether information is brought in by well-connected or marginal individuals, suggests that knowledge shared between communities will tend to drift apart over time.

A comparison between knowledge distribution in Nabil and the frontier provides for a preliminary test of some of these notions. It appears that the more horizontal and open properties of the frontier system do result in a wider distribution of knowledge. Other variables presented in this dissertation, such as cultural interpretations of organoleptic, morphological, or humoral properties of plants, did not yield any such predictive capacity. For example, the association of specific tastes with cough treatments in the Highlands might lead one to predict that knowledge about new cough treatments in the frontier that have the same taste would rapidly diffuse throughout the frontier communities, and would at least partially explain the *J*-shaped knowledge distribution in the frontier. This was not the case. Instead, individual models of taste were adjusted to fit new and different knowledge that was accepted mostly along the lines of perceived efficacy (Chapter 5) and the processes described in this chapter.

In summary, there are limits to the amount of knowledge that can circulate in any community that are a result of the structure of informational networks, time, and the nature of communicative processes—resulting in a diminishing return of knowledge distribution with increasing complexity and diversity of knowledge. But these processes do not affect the distribution of all information consistently or, to a large extent, predictably.

Notes

[1] In his study of the Amazonian Ese Eja, Alexiades (1999:343) also found that experimentation was the exclusive province of specialist healers. Nonspecialists did not experiment with plants, but rather learned their information from other people. I suspect that additional studies comparing the knowledge acquisition of experts and novices would find a similar pattern.

[2] For the cluster analysis, 48 interviewees were shown the 45 most commonly known medicinal plants in Nabil and were asked if the specimen had a medicinal use or not. I performed consensus analysis on these true/false data using ANTHROPAC to derive measures of informant agreement. I then imported the informant agreement matrix into SYSTAT to perform a single-linked cluster analysis based on Euclidean distances. The length of the links between nodes shown in the figure reflects the amount of agreement between groups. “HH” designates households. Note that the young mother from household 2 clustered within household 1 is actually a daughter from household 1 who still lives next door. Her husband (connected by the dashed line) knows different plants as medicinals.

[3] This is an example of a stochastic mechanism leading to drift (Cavalli-Sforza and Feldman 1981:67). Similar to the concept of drift in population genetics, the statistical effect of repeated random selection from a limited pool of information results in a tendency toward a limited number of traits. Thus the tendency is toward homogeneity in the population.

[4] Although social status within the community didn’t appear be a major influence on cultural transmission, there may have been effects at broader scales of class and ethnicity. The Tzeltal clearly learned many plants from Ladino sources who they perceived as better educated, wealthier, and healthier. But they appeared to have learned very little from Guatemalan refugees, who were perceived by the Tzeltal to be worse off than they were.

Chapter 10
Conclusion: Major Findings and Significance for Ethnopharmacology and Ecological Anthropology

Summary of major findings

The goal of this dissertation is to explain why some plants are more likely to be known as medicinals than others. The approach I used was to document and explain patterns in distribution of knowledge about the various plant species among Tzeltal Maya who have lived in the temperate Chiapas Highlands for many generations and other Tzeltal who have migrated from the Highlands to the tropical Lowland rainforest frontier within the last 30 years. The overall method was to test for correlations between knowledge distribution and a series of variables, and to contextualize the quantification of variables and interpretation of results using discourse analyses, participant observation, and epidemiological data.

Botanical collecting and structured ethnobotanical surveys revealed that at least 130 plants were known by two or more people in the Highland community Nabil, and 116 were known by two or more people in the frontier communities Maravilla Tenejapa and Salto de Agua. In all cases, the distribution of knowledge follows a pattern in which a few plants are known by almost everyone, distribution of knowledge decreases as the diversity of plants increases, and most knowledge is idiosyncratic. Plotting these data results in a *J*-shaped knowledge distribution curve (Figures 2.1 and 2.2). This pattern has been described as "consensus within diversity" (Barrett 1995). A review of the literature indicates that this pattern, including the number of plants, appears to be widespread. These results indicate that there is an overall limit to the amount of medicinal plant knowledge that can be distributed throughout pre-literate communities. Also, there were clear differences in knowledge between neighboring towns in this study, which indicates that the exchange of information between socio-political boundaries is limited.

Table 10.1. Spearman ranked correlation matrix of the study variables for Nabil.

	Knowledge distribution	Emic efficacy	Frequency of use	Category typicality	Agreement for hot/cold	Taste strength
Emic efficacy	0.49 **					
Frequency of use	0.31 *	-0.03				
Category typicality	0.26	0.13	0.71 **			
Agreement for hot/cold	0.10	0.01	-0.43	-0.48		
Taste strength	-0.14	0.27	0.24	0.20	-0.43	
Abundance	-0.23	-0.13	0.34 **	0.42 **	-0.54	0.23

** indicates significance at the 0.05 level.
* indicates significance at the 0.10 level.

Emic perception of each plant's efficacy was the variable most strongly correlated with the distribution of knowledge about each plant species (Table 10.1). Illness classification is based on symptoms, and efficacy is judged primarily by the perception of a plant's ability to correct deleterious symptoms. These perceptions are based on firsthand experiences and have pharmacological bases, but discursive themes indicated that perceptions are also heavily influenced by socially-situated persuasion. Overall, plants that were ranked by participants as more efficacious were more likely to be known throughout the population for their medicinal use. But salient exceptions to this pattern indicate that there are constraints on the dissemination of knowledge about efficacious plant species. In particular, information about some plants known to be efficacious in neighboring communities is almost completely unknown within the study communities, even though there is an expressed need for that information.

Agreement about humoral (hot versus cold) properties of medicinal plant species was not correlated with the distribution of knowledge (Table 10.1). Inter-informant and intra-informant humoral classification were highly variable. Also, humoral classification did not facilitate recall of medicinal uses for plants, and therefore can not be said to serve as a cultural or individual mnemonic. Rather than guiding the dissemination of knowledge or facilitating recall of medicinal uses, humoral classification appears to serve as one of several *post hoc* explanations among the novice populations for the ability of plants to alter symptoms. However, humoral principles may be more important for expert curers who are more likely to experiment with new plants and who hold more detailed knowledge about medicinal plants.

Although linguistically labeled plant tastes showed clear patterns of affiliation with specific illnesses, taste intensity (as ranked by interviewees) was not correlated with knowledge distribution (Table 10.1). A comparison of Highland and frontier medicinal flora indicates that cultural interpretations of taste have not significantly influenced knowledge acquisition for the Tzeltal migrants. Medicinal plant knowledge in the frontier has been "imported" from a variety of sources as a result of the residents migrating to an area with an unfamiliar flora and their reluctance to experiment with plants. Comparison of the affiliations between plant tastes and illness categories in the Highlands with those of the tropical frontier showed that taste-based models of curing were adjusted to fit new affiliations rather than to have guided the acquisition of new knowledge into traditional Highland patterns.

Cultural interpretations of plant taste and morphology are very important in individual cognitive models, but they lose importance at the scale of shared discursive models where social and pragmatic themes, such as safety and legitimacy, also influence dissemination of knowledge. As with humoral classification, cultural interpretations of taste and morphology appear to be *post hoc* explanatory mechanisms that do not significantly affect the dissemination of knowledge throughout the population of novices.

The frequency with which plant species are used appears to affect the distribution of knowledge, but this correlation is weak (Table 10.1). In other words, plants that are used more often are likely to be more widely known throughout the population, but only for a subset of the total pharmacopoeia. There are many plants the are well known even though they are used rarely and are difficult to find.

Abundance was correlated with use, which indicated that plants that are easier to find are more likely to be used. Discursive data indicate that people will usually begin treating symptoms with accessible plants (not necessarily the most efficacious plants), but will search for plants known to be more efficacious if the first treatments fail to produce results. Abundance was not correlated with emic perceptions of efficacy, suggesting that the reason for frequency of use is that plants are more accessible, not because plants from disturbed habitats are more likely to be pharmacoactive.

These relationships between abundance, frequency of use, and knowledge distribution were the same in the tropical frontier communities as in the Highlands. The replication of these patterns in the new migrant communities indicates their resilience.

My analysis of the goal-derived cognitive category *poxil wamaletik* 'medicinal plants' showed that the definitional criterion for category inclusion among individuals was the perception that a plant had the ability to alter some illness symptom or suite of symptoms (i.e., its efficacy). Typicality within the category was primarily a function of how frequently items were instantiated as members of the category. Attributes associated with the most typical plants (e.g., their taste, humoral property, or habitat) do come to dominate individual explanatory models, but this did not appear to guide acceptance of items into the category. Typicality in categorization and discourse appears to explain the extreme salience of the three or four most widely-known plants, but generally fails to explain the distribution of knowledge about the remaining plant species. This is primarily because typicality and the shared-model features associated with typicality, such as taste or humoral property, are subordinate to efficacy, and efficacy can be conveyed so convincingly through firsthand experience and social discourse that items can be accepted for category membership even if they are in conflict with the typical features of an individual's explanatory curing model.

The results of this research indicate that emic perceptions of efficacy and, to a more limited extent, frequency of use are the variables most responsible for the distribution of knowledge about medicinal plants. But patterns and processes of cultural transmission also constrain dissemination of information in unpredictable ways. The communities that I studied exhibit properties of bounded information systems in which more information circulates within the *paraje* and *ejido*, and at a faster rate, than it does with sources outside of the political and social boundaries. Within communities, knowledge tends to be clustered by households, and is further clustered within households by gender. Because everyone does not have equal access to all information, the amount of information that persists within communities is constrained by the size, number, and quality of information networks. The constraints of information networks, when combined with personal acceptance and conformity bias, form a limit to the amount of information about medicinal plants that can be disseminated in any pre-literate situation. New information brought into the communities or produced by transmission error becomes idiosyncratic in a pattern of diminishing returns of additional information.

Random processes like transmission error, the possibility that information will be imported by a person who is well connected versus one who is marginal, and asymmetrical learning opportunities inherent in the quality of the information create a situation in which it is difficult to predict which particular information will be constrained and which will be disseminated more widely. Thus, frequency of use and perceptions of efficacy alone are inadequate for predicting which knowledge about treatments will be distributed. A community like Nabil may be "missing" knowledge about dermatological and female reproductive treatments, while the neighboring community Ch'ixaltontik may be "missing" treatments for toothaches.

In sum, emic perception of efficacy and the frequency of plant use are the most important catalysts for the distribution of knowledge. But social organization, individual and distributed cognition, and structured and random processes in cultural transmission shape the flow of all information, and knowledge about some species that may fit emic definitions of efficacy will not necessarily circulate throughout the population.

These findings suggest that optimally-adapted medicinal systems are probably not maintained amongst these novice populations. Instead, consensus about medicinal plant treatments will focus around a few of the most common illness categories and plants, but the distribution of knowledge will otherwise be somewhat random, or at least unpredictable. This is not to say that the plants that people know are not efficacious, but rather that patterns in the distribution of knowledge do not represent an optimal fit between illness-based needs and all of the available phytochemicals. Knowledge about many potentially efficacious plants appears to be inaccessible to large segments of the population.

Significance for ethnopharmacology

An implicit assumption of most ethnopharmacological studies that use indigenous knowledge as a guide for screening for pharmacological activity is that frequency of use, distribution of knowledge, and/or consensus about medicinal uses of plants correlate with shared emic perceptions of efficacy (e.g., Adu-Tutu et al. 1979; Ankli et al. 1999b; Friedman et al. 1986; Heinrich et al. 1992; Johns et al. 1995; Trotter and Logan 1986). The results of this research raise serious questions about this approach.

First, the widespread assumption that frequency of use, knowledge distribution, and efficacy are correlated with each other is problematic (Chapters 4 and 7). This research clearly shows that frequency of use is not a function of emic efficacy (Table 10.1). Most people in this study are likely to begin treating illnesses with plants that are more accessible, not necessarily more efficacious, and they resort to more efficacious plants only if the original treatments fail to produce the desired effects. Symptoms usually diminish on their own or as a response to preliminary treatments, and so the most efficacious treatments (that are not also easily accessible) will be used less frequently.

Stepp and Moerman (2001) have argued that plants from disturbed habitats are more likely to contain bioactive phytochemicals. Thus, the tendency to use accessible plants might correlate with pharmacological activity. But plant abundance in this study was not correlated with emic perceptions of efficacy, suggesting that the primary reason for frequency of use of plants from disturbed habitats is that those plants are more easily accessible, not necessarily because they are more likely to be pharmacoactive.

A second important consideration for pharmacological studies that are based on indigenous knowledge is that although consensus, or the distribution of knowledge throughout a population, is probably a function of efficacy, in many cases it may be severely biased. In this study, much of the information about efficacious plants was shown to not circulate widely throughout the populations.

In sum, only a direct measure of emic efficacy can guarantee that emic efficacy is indeed the variable being analyzed. But this research also shows that even direct measures of emic efficacy may not reflect pharmacological potential if local variation in knowledge distribution is not accounted for, because information varies between communities. Attempts to identify pharmacologically important constituents should also be based on regional data, or at least data from several communities.

Theoretical significance for ecological anthropology

The overall goal of ecological anthropology is to explain human thought, behavior, and social organization by situating the study of populations or individuals in interaction with their biophysical or social environments. Within this broad rubric I include the traditional approaches of cultural ecology (Sanders and Nichols 1988; Steward 1949), cybernetic modeling and ecosystems theory (Blount 1999; Moran 1991; Rappaport 1984), ethnoecology (Fowler 1977; Hunn 1989), and human behavioral ecology (Smith 1992; Winterhalder 2002). There are five central questions, or persistent problems, that I see as cutting across all of these approaches and that I have attempted to address with this research. The first, which is common to most of anthropological inquiry, is the need to reconcile individual agency with social or group behavior or cultural knowledge. Second, is the need to integrate cognition and beliefs with behavior. Third, is the historical debate over environmental determinism versus possibilism, which now exists mostly as a debate over "where the adaptation is." Fourth, and bound tightly with the previous, is the persistent problem of appropriately identifying functionalism, including a general hesitancy and methodological inability to accept or explain traits that have no apparent adaptation or function (Hallpike 1988). Finally, critiques of ecology and ecological anthropology indicate a need to consider non-equilibrium dynamics and spatial and temporal variability (Scoones 1999).

One possible explanation for these shortcomings is that subdisciplines within anthropology have more or less followed trajectories defined by the intellectual traditions from which their basic methods and theory have been borrowed, thus precluding the possibility of synthetic holism (Kuchka 2001). Human behavioral ecologists claim that reductionist models must be developed before modeling complexity (Winterhalder 2002), while others argue that these can never account for complexity because they are too reductionist at the expense of socio-cultural context (Joseph 2000; Vayda 1995). Meanwhile, ethnoecological approaches continue to struggle to identify the points where cognition becomes synonymous with behavior (Hunn 1989).

At least one result of these problems is a failure to fully explicate the relationships between beliefs and interactions with the biophysical environment in ways that allow for the explanation of flexibility, change, variability, and asymmetrical relationships. We can not yet explain behavior in contradiction to personal or emic ecological beliefs, cases of cooperation that yield less than optimal or even maladaptive interactions with the nonhuman environment, or the ubiquitous observation that what people say is quite often different from what they do.

What unifies the shortcomings of both ecosystem and behavioral ecologies is the inability to model information—mostly because the methodological tools of these approaches were designed to study nonhuman phenomena for which information is more difficult, if not impossible, to conceptualize (Kuchka 2001). Meanwhile, other disciplines, such as ethnoecology, information systems science, and cognitive science offer robust explanations of informational patterns, but they usually do not include behavioral variables in their research, and they also remain mired in their own failure to reconcile concepts across scale—for example, individual versus distributed cognition and categorization versus cultural models.

What is needed in ecological anthropology in general, and specifically for me to answer questions about medicinal plant knowledge, is a synthesis of analytical tools that specifically allow for the study of asymmetrical patterns in information (including cognition), biophysical variables, and behavior *across scales of analysis*. This dissertation research was conceptualized and designed specifically as an attempt to address these issues by adopting the following methodological approaches. 1) Explanatory notions and analytical tools (Pickett et al. 1994:28) were carefully chosen so as not to violate the assumptions inherent to each of the tools. For example, optimization theory was not deemed appropriate because adaptation and fitness could not be assumed. Inheritance of cultural traits and system boundedness, however, were applicable to these shared systems of medicinal plant knowledge. 2) Patterns and processes in the distribution of *information* formed the bases of the analyses. 3) I bounded the scale of analysis in a way that was appropriate to the fundamental question by studying communities of individuals situated within a broader cultural context of other similar communities, which allowed for comparison and contrast. I also tried to elucidate the effects of scale for each of the analytical variables, including a thorough treatment of cognition at different scales of analysis. 4) I included both behavior and cognition and attempted to clearly discriminate which nonhuman environmental variables were operating at which scales in order to strike a middle ground between reductionism and complexity. 5) I used non-equilibrium and stochastic evolutionary principles of cultural transmission to incorporate complexity and explain non-optimal, non-adaptive observations. 6) Most importantly, I used a comparison between Highland and tropical frontier migrant communities in an attempt to test the explanatory notions derived from these approaches.

The first finding of theoretical importance is that individual cognitive models are not necessarily guiding the dissemination of knowledge or behavior, nor should the contents of individual models be *necessarily* assumed to represent cultural importance, adaptation, or functionality. Cultural interpretations of plant taste and morphology are very important in individual cognitive models, but their importance diminishes at the scale of shared discursive models where social and pragmatic themes, such as safety and legitimacy, also influence the dissemination of knowledge. The expectation of shared themes is probably more important than agreement about the details within those themes. I have also shown that category typicality is not guiding acceptance of plants into the category 'medicinal plants.' This serves as one of several explanations of *why* very schematic social themes can override features of models that appear *prima facie* to be most important at the scale of individuals (see Chapter 8 for other explanations).[1]

If this dissertation research was limited to analyses of individual models, the results could have led to the erroneous conclusion that cultural perceptions of organoleptic or humoral properties significantly influence knowledge acquisition and behavior. But the features associated with typicality, such as taste or humoral property, are subordinate to efficacy, and efficacy can be conveyed so convincingly through firsthand experience and social discourse that items can be accepted for category membership even if they are in obvious conflict with the typical features of individual explanatory models.

As the adoption of new *post hoc* explanatory models in the frontier suggests, models are malleable and are altered to reflect compelling experience. Explanatory models do not necessarily *function* to proscribe behavior or acceptance of new information. In this case, any reliable explanation of why some people know or use certain plants is simply not possible without also analyzing how individual models are reconciled in discourse, how social organization affects information flow, and how plants are distributed in the landscape. The ethnoecological literature, on the other hand, is replete with studies that assume individual classification or cognitive models can serve as surrogates for knowledge, cultural importance, meaning, and behavior.

Rigorous analysis of individual models with the specific intent of predicting behavior may also be inadequate. For example, my data indicated that plant accessibility and efficacy were important for deciding what plant to use. But I was only able to determine *which* of these variables was more important for short-term goals by also documenting the frequency of plant use.

Results of this study also contribute to methodological and theoretical issues regarding the causal relationships between culture and the biophysical environment—in particular, the way in which environmental information is interpreted, shared, and ultimately transformed into behavior. It is clear that empirical observations of the effects of plants on symptoms and subsequent perceptions of efficacy are very important for knowledge distribution. Thus, the phytochemical environment, along with disease prevalence and the distribution of plants in the landscape, form core environmental determinants. Also, most people generally agree how plants taste and they tend to associate taste and morphological characteristics with certain illnesses. Meanwhile, humoral classification is only weakly linked to biophysical phenomena, and is more subject to interpretation. Of the various environmental stimuli, it shows the most variation in informant agreement.

This scenario is reminiscent of Steward's "cultural core" (1949), in which cultural features that most closely interact with the biophysical environment should show the least variability within and between cultures. Are cultural interpretations of taste and morphology more empirically important than humoral classification for Tzeltal interactions with their phytochemical environment? The informant agreement data would suggest so. But other interview data suggest that humoral classification is also very important to the Tzeltal, even though they often do not agree about the details of humoral classification.

The first temptation when addressing this problem is to consider the possible functions of these cultural interpretations. I showed that humoral classification was not facilitating recall, and perceptions of taste and visual characteristics of plants were not guiding behavior. I have argued throughout this dissertation that the Tzeltal I studied will use a plant because it is considered efficacious, not because it has a specific taste. This is supported by my attempt to correlate taste with knowledge distribution, and also the discursive and comparative frontier data, which showed individual models about taste were altered to fit new information instead of guiding the acquisition of new information.

Neither perceptions of plant characteristics nor humoral classification appear to guide behavior more than the other. Instead, these cultural interpretations appear to serve as *post hoc* explanatory mechanisms that do not influence behavior.

The case of humoral classification especially points out the need to consider scale. It appears to serve no function for individuals, but may be more important as a general interface between Tzeltal and Ladino medicine. Again, it is probably more important to agree about the general principle of humoral classification than to agree about details.

The comparison between the Highlands and the tropical frontier also led to insights regarding the relationships between ritual and cosmological beliefs, novice empiricism, and knowledge about the plants. Many authors have argued that ritual and cosmology are integral to beliefs about medicinal plants (Alcorn 1984; Nigh 2002). My ethnographic data from the frontier communities suggest that most traditions and accompanying cosmologies have been abandoned there. Nevertheless, the frontier Tzeltal have acquired new information based primarily on the same symptomatological models and illness classifications of the Highlands, with the exception of the illnesses of supernatural etiology. This strongly suggests that much of novice empiricism is naturalistic and is not *necessarily* linked to supernatural beliefs.

This may also apply to other types of human-environmental relationships. Toward the end of his career Rappaport (1984:338) was trying to more fully integrate symbolism into ecological studies. This approach is obviously important, but as Rappaport noted, and this study indicates, the details of any such integration should be studied, never assumed.

Related to this are the notions of adaptation and functionalism, the final topics I will address in this dissertation. As I have already noted above, the functional role of cultural interpretations of plant characteristics and humoral classification are questionable at best. Equally problematic is any assumption about adaptation or fitness of medicinal plant use in general. Although it is implicitly assumed that using medicinal plants enhances individual fitness, this notion remains untested.

Also, while it appears that the Tzeltal tend to know and use plants that are efficacious, it also appears that a sufficient amount of information about efficacious plants is missing from populations to conclude that these knowledge systems are not optimal. There is an overall limit to the amount of medicinal plant knowledge that can be distributed throughout pre-literate communities that may often be insufficient to allow for all illness conditions to be treated. Furthermore, knowledge is not distributed evenly or optimally since many people do not have access to critical information. This suggests that any notion of a group adaptation is untenable. Indeed, it appears that structural components that limit information flow within communities negate any advantage of increasing overall knowledge.

Without resorting to unjustifiable assumptions of adaptation or fitness, I have attempted to show how knowledge about medicinal plants is distributed in these communities, why there are differences between communities, and how knowledge can change. I am not arguing against the use of adaptation, fitness, or optimality per se, but simply pointing out that these concepts make poor tools for answering the question asked in this dissertation.

Where might adaptation apply in my construction? It most probably applies to the protohuman evolution of intuitive ontology of cause-and-effect, which *may* have been influenced by allelochemicals in plants. Another important human trait is the dominance of sociality in cognition (Donald 1991; Dunbar 1998). This may explain why information presented in a social context can sometimes overrule individual explanatory models, which allows for flexibility in learning.

The notions of fitness and adaptation appear less suitable, in this case, for explaining the role of social organization in the sharing of information or the importance of cultural perceptions of plant taste, morphology or humoral classification in optimizing interaction with phytochemicals.

By using tools from a variety of disciplines, carefully explicating the effects of scale, and *relaxing* the constraints of functionality and adaptation, I have been able to suggest where the nonhuman environment has influenced human thought and behavior, and where it has not in the case of how knowledge about medicinal plants becomes distributed among novice Tzeltal Maya.

Notes

[1] The only author I know of who has explicated this conundrum is Hunn (1989), although he stopped short of proposing an empirical explanation as I have attempted here.

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Appendix A
Questions Asked During Structured Ethnobotanical Interviews

The following biographical questions were asked at the beginning of each interview with a new person:

1. *Binti a'bil?* 'What is your name?'

2. *Banti p'ejkajat?* 'Where were you born?'

3. *Jayeb ja'wil a'wich'oj?* 'How old are you?'

The following questions were asked about each ethnobotanical specimen:

1. *Binti sbil ja'mene?* 'What do you call this?'

2. *Ay bal chamelil ya spoxta mene?* 'Is there an illness that this cures?'

3. *Bit'il ta pasel?* 'How is it prepared?'

4. *Ay bal skap?* 'Is it mixed with anything else?'

5. *Bi yu'un ya xpoxta?* ' Why does it cure?'

6. *Sik labal mak k'ixin labal ta poxta?* 'Does it cure because it's cold or hot?'

7. *A'tuntesoj bal swenta ____?* 'Have you used it for (illness name)?'

8. *Bit'il la a'nop? Mach'a la yalbet ya spoxta ____?* 'How did you learn this? Who told you it cures (illness name)?'

9. *Ay bal yan chamelil ya spoxta?* 'Is there another illness that it cures?' (Repeating questions 3 through 7 if another illness was mentioned.)

10. *Bi ya'el sbuts'?* 'What is it's taste?'

11. *Banti ya xch'i? Banti ta ta'el?* 'Where does it grow? Where do you find it?'

12. *Ya bal xch'i li'i ta ______?* 'Does it grow here in (town's name)?'

13. *Ay bal awu'un ta a'pat na?* 'Do you have it here in your yard?'

Appendix B. Plants Reported as Medicinal by two or more Interviewees from Nabil.

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Verbena litoralis H.B.K.	Verbenaceae	94	diarrhea
Foeniculum vulgare Miller	Umbelliferae	90	gastritis
Baccharis vaccinioides H.B.K.	Asteraceae	89	common cough, diarrhea
Erigeron karwinskianus DC.	Asteraceae	84	common cough
Salvia lavanduloides H.B.K.	Labiatae	84	common cough
Sedum praealtum A.DC.	Crassulaceae	83	topical burns, fever
Satureja brownei (Sw.) Briq.	Labiatae	73	fever, headache, cough
Sambucus mexicana Presl	Caprifoliaceae	73	common cough, pertussis
Brugmansia candida Pers.	Solanaceae	72	sprains, aches and pains
Rhus terebinthifolia S. & C.	Anacardiaceae	72	oral thrush
Aloe vulgaris Lam.	Asphodelaceae	72	topical burns, wounds
Solanum lanceifolium Jacq.	Solanaceae	69	toothache, general pain relief
Nicotiana tabacum L.	Solanaceae	68	abdominal distension and pain
Matricaria recutita L.	Asteraceae	68	abdominal pain, common cough, diarrhea

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Gaultheria odorata Willd.	Ericaceae	65	common cough, tuberculosis
Myrica cerifera L.	Myricaceae	65	toothache, common cough, diarrhea
Ricinus communis L.	Euphorbiaceae	64	dog poison, rabies
Allium sativum L.	Alliaceae	60	abdominal pain, scares away the devil
Equisetum myriochaetum S. & C.	Sphenopsida	60	urinary, kidney, and general pain
Zingiber officinale Roscoe	Zingiberaceae	60	infertility, cough
Prunus persica (L.) Batsch	Rosaceae	59	common cough, diarrhea, dysentery
Mentha citrata Ehrh.	Labiatae	59	abdominal pain, diarrhea
Adiantum andicola Liebm.	Pteropsida	59	‘fright’
Fuchsia microphylla H.B.K.	Onagraceae	58	fever, boils
Litsea glaucescens H.B.K.	Lauraceae	58	cold and flu
Psidium guineense Sw.	Myrtaceae	58	oral thrush, diarrhea, dysentery
Oenothera rosea L’Her. ex Aiton	Onagraceae	55	diarrhea, dysentery
Quercus sp.	Fagaceae	54	toothache, diarrhea, dysentery

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Pinus sp.	Pinaceae	53	aches and pains
Rumex obtusifolius L.	Polygalaceae	51	diarrhea, oral thrush, scabies
Cuphea aequipetala Cav.	Lythraceae	50	diarrhea, dysentery
Eucalyptus camaldulensis Dehnh.	Myrtaceae	50	fever, diarrhea
Chenopodium ambrosioides L.	Chenopodiaceae	49	abdominal pain, intestinal worms
Cornus disciflora DC.	Cornaceae	48	tuberculosis, common cough, pertussis
Borreria laevis (Lam.) Griseb.	Rubiaceae	48	diarrhea, dysentery, common cough
Prunella vulgaris L.	Labiatae	46	headache, fever, 'second hair'
Zea mays L.	Gramineae	45	urinary pain
Musa sp.	Musaceae	45	oral thrush, bleeding
Citrus limon L.	Rutaceae	45	fever, cough
Cupressus lusitanica Mill.	Cupressaceae	44	common cough, pertussis
Pinaropappus spathulatus Brandeg.	Asteraceae	44	common cough, diarrhea, topical wounds and burns
Ocimum basilicum L.	Labiatae	42	abdominal pain, aches and pains
Rapanea myricoides (Schlecht.) Lundell	Myrsinaceae	33	common cough, abdominal pain, 'second hair'

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Cucurbita ficifolia Bouché	Cucurbitaceae	30	(variable)
Ageratina ligustrina (DC.) King & H. Rob.	Asteraceae	29	common cough
Epidendrum radicans Pavon.	Orchidaceae	28	(variable)
Dahlia imperialis Roezl ex Ortgies	Asteraceae	27	diarrhea, emotional disturbance
Salvia cinnabarina M. & G.	Labiatae	25	fever, headache, body aches
Malvaviscus arboreus Cav.	Malvaceae	25	common cough, pertussis
Castilleja arvensis C. & S.	Scrophulariaceae	24	toothache
Gnaphalium sp.	Asteraceae	24	wounds, pertussis, tuberculosis
Zanthoxylum foliolosum J.D. Smith	Rubiaceae	24	toothache, medicine for sick chickens
Lobelia laxiflora H.B.K.	Campanulaceae	22	lactation stimulant, abdominal pain
Acacia angustissima (Mill.) Kuntze	Leguminosae	22	diarrhea
Mangifera indica L.	Anacardiaceae	20	dysentery
Smallanthus maculatus (Cav.) H. Robinson	Asteraceae	20	diarrhea

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Calliandra grandiflora (LHer.) Benth.	Leguminosae	20	eye infection, nosebleed
Calliandra houstoniana (Mill.) Kuntze	Leguminosae	20	eye infection, topical wound
Lopezia racemosa Jacq.	Onagraceae	20	common cough
Citrus sinensis (L.) Osbeck	Rutaceae	20	common cough
Valeriana scandens L.	Valerianaceae	20	boils, aches and pains
Byrsonima crassifolia (L.) H.B.K.	Malpighiaceae	19	diarrhea, dysentery
Phyllanthus niruri L.	Euphorbiaceae	18	‘fright’
Plantago australis Lam.	Plantaginaceae	18	diarrhea
Monnina xalapensis H.B.K.	Polygalaceae	17	eye infections
Montanoa hexagona Rob. & Greenm.	Asteraceae	16	cough, toothache, scabies
Acalypha botteriana Muell. Arg.	Euphorbiaceae	16	aches and pains, diarrhea
Desmodium sp.	Leguminosae	16	diarrhea, headache
Sageretia elegans (H.B.K.) Brongn.	Rhamnaceae	16	(variable)
Heliocarpus sp.	Tiliaceae	15	earache
Urera sp.	Urticaceae	15	aches and pains

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Lippia substrigosa Turcz.	Verbenaceae	15	common cough
Bidens pilosa L.	Asteraceae	14	headache
Saurauia scabrida Hemsl.	Actinidiaceae	13	aches and pains
Tagetes filifolia Lag.	Asteraceae	13	epigastric pain
Mimosa albida H. & B. ex Willd.	Leguminosae	13	emotional disorder
Solanum americanum Miller	Solanaceae	13	weakness
Piptothrix areolaris (DC.) King & H. Rob.	Asteraceae	13	diarrhea
Salvia holwayi Blake	Labiatae	13	common cough
Gossypium hirsutum L.	Malvaceae	13	rabies
Fuchsia paniculata Lindley	Onagraceae	13	soar throat
Crataegus pubescens (H.B.K.) Steudel	Rosaceae	13	diarrhea
Rubus coriifolius Liebm.	Rosaceae	13	common cough
Vitis tiliifolia Humb. & Bonpl. ex Roem. & Schult.	Vitaceae	13	fever

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Eryngium sp.	Umbelliferae	13	infertility
Baccharis serraefolia DC.	Asteraceae	13	diarrhea
Conyza sp.	Asteraceae	12	common cough, tuberculosis
Clethra suaveolens Turcz.	Chlethraceae	12	headache
Cavendishia crassifolia (Benth.) Hemsl.	Ericaceae	12	common cold
Garrya laurifolia Hartweg ex Benth.	Garryaceae	12	abdominal pain
Phytolacca icosandra L.	Phytolaccaceae	12	dandruff
Ranunculus petiolaris H.B.K. ex DC.	Ranunculaceae	12	topical infection
Tagetes lucida Cav.	Asteraceae	11	headache, depression
Cecropia peltata L.	Cecropiaceae	11	common cough, pertussis
Bryophyllum pinnatum (Lam.) Kurz	Crassulaceae	11	fever
Salvia purpurea Cav.	Labiatae	11	common cough, fever, diarrhea
Salvia rubiginosa Benth.	Labiatae	11	common cough
Persea americana L.	Lauraceae	11	diarrhea

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Cornus excelsa Kunth	Cornaceae	10	oral thrush
Hibiscus sp.	Malvaceae	10	common cough
Bougainvillea sp.	Nyctaginaceae	9	common cough
Ruta chalapensis L.	Rutaceae	9	epigastric pain
Smilax domingensis Willd.	Smilacaceae	9	topical wounds
Sonchus oleraceus L.	Asteraceae	8	common cough, weakness
Hibiscus sabdariffa L.	Malvaceae	8	common cough
Annona cherimola Miller	Annonaceae	7	diarrhea
Apium leptophyllum (DC.) F. Muell. Arg. ex Benth.	Umbelliferae	7	diarrhea
Asclepias curassavica L.	Asclepiadaceae	7	common cough
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	7	diarrhea
Erechtites hieraciifolia (L.) Raf.	Asteraceae	7	scabies
Piqueria pilosa Kunth	Asteraceae	7	gastritis, common cough

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Alnus acuminata Kunth	Betulaceae	7	common cough
Pimenta dioica (L.) Merr.	Myrtaceae	7	abdominal pain, siezures
Bocconia arborea S. Watson	Papaveraceae	7	tuberculosis
Rumex crispus L.	Polygalaceae	7	diarrhea, scabies
Thalictrum guatemalense C. DC. & Rose	Ranunculaceae	7	'second hair,' 'fright,' aches and pains
Peperomia sp.	Piperaceae	7	fever
Vernonia patens H.B.K.	Asteraceae	7	topical wounds
Cosmos crithmifolius H.B.K.	Asteraceae	7	diarrhea
Croton drago Schlecht.	Euphorbiaceae	7	topical wounds
Euphorbia graminea Jacq.	Euphorbiaceae	7	lactation stimulant
Liquidambar styraciflua L.	Hamamelidaceae	7	aches and pains, common cough
Struthanthus quercicola (C. & S.) Naud.	Loranthaceae	7	(variable)

Appendix B (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Hibiscus uncinellus DC.	Malvaceae	7	common cough
Fuchsia splendens Zucc.	Onagraceae	7	common cold
Prunus serotina Ehrh.	Rosaceae	7	diarrhea
Ruta graveolens L.	Rubiaceae	7	epigastric pain
Castilleja integrifolia L.	Scrophulariaceae	7	fever
Cassia sp.	Leguminosae	7	(variable)
Cymbopogon citratus (DC.) Stapf	Gramineae	7	common cough

Appendix C. Plants Reported as Medicinal by two or more Interviewees from Maravilla Tenejapa and Salto de Agua.

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Musa sp.	Musaceae	100	oral thrush, bleeding
Verbena litoralis H.B.K.	Verbenaceae	100	diarrhea
Foeniculum vulgare Miller	Umbelliferae	95	gastritis
Citrus limon L.	Rutaceae	95	fever, cough, diarrhea, vomiting
Solanum lanceifolium Jacq.	Solanaceae	95	general pain relief, scabies, topical fungi
Allium sativum L.	Alliaceae	94	abdominal pain, worms, scares away the devil
Zingiber officinale Roscoe	Zingiberaceae	94	infertility, cough, abdominal pain
Byrsonima crassifolia (L.) H.B.K.	Malpighiaceae	92	dysentery, common diarrhea
Neurolaena lobata (L.) R. Br.	Asteraceae	91	common diarrhea
Matricaria recutita L.	Asteraceae	91	abdominal pain, cough, diarrhea
Brugmansia candida Pers.	Solanaceae	90	sprains, aches and pains
Chenopodium ambrosioides L.	Chenopodiaceae	90	intestinal worms, diarrhea
Gossypium hirsutum L.	Malvaceae	90	emotional disorder, rabies, abdominal pain, headache
Nicotiana tabacum L.	Solanaceae	90	abdominal distension and pain, scares away the devil
Vernonia patens H.B.K.	Asteraceae	88	topical wounds, diarrhea

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Psidium guineense Sw.	Myrtaceae	86	diarrhea, dysentery
Zea mays L.	Gramineae	86	urinary pain
Citrus sinensis (L.) Osbeck	Rutaceae	85	cough, diarrhea
Sambucus mexicana Presl	Caprifoliaceae	82	pertussis, fever, headache, aches and pains
Bryophyllum pinnatum (Lam.) Kurz	Crassulaceae	80	fever
Hibiscus uncinellus DC.	Malvaceae	80	emotional disorder, pertussis
Hyptis verticillata Jacq.	Labiatae	80	birth inducement, abortifacient
Begonia heracleifolia Schlecht. & Cham.	Begoniaceae	79	fever, heat stroke
Chaptalia nutans (L.) Polak	Asteraceae	78	diarrhea, abdominal pain
Aspidosperma cruentum Woodson	Apocynaceae	75	dysentery, common diarrhea
Eucalyptus camaldulensis Dehnh.	Myrtaceae	75	abdominal pain
Mentha citrata Ehrh.	Labiatae	71	diarrhea, fever
Aloe vulgaris Lam.	Asphodelaceae	70	topical burns, wounds
Cymbopogon citratus (DC.) Stapf	Gramineae	70	common cough

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Ruta chalapensis L.	Rutaceae	70	epigastric pain, fever, abdominal pain
Cecropia peltata L.	Cecropiaceae	68	common cough, tuberculosis, pertussis
Ocimum basilicum L.	Labiatae	68	fever, heatstroke
Hibiscus sp.	Malvaceae	64	common cough, pertussis
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	62	diarrhea, common cough
Urera sp.	Urticaceae	61	aches and pains
Lippia sp.	Verbenaceae	60	diarrhea, menstrual complications
Pimenta dioica (L.) Merr.	Myrtaceae	56	abdominal pain, agitated or upset infants
Baccharis trinervis (Lam.) Pers.	Asteraceae	56	fever, headache, hair loss
Mirabilis sp.	Nyctaginaceae	56	scabies, wounds
Crotalaria longirostra H. & A.	Leguminosae	50	malaria, fever
Mangifera indica L.	Anacardiaceae	48	dysentery
Persea americana L.	Lauraceae	47	dysentery
Lantana trifolia L.	Verbenaceae	44	diarrhea

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Salvia lavanduloides H.B.K.	Labiatae	40	common cough
Baccharis vaccinioides H.B.K.	Asteraceae	40	diarrhea, common cough
Eupatorium schultzii Schnittsp.	Asteraceae	35	sprains, aches, and pains
(unidentified)	Aracaceae	35	hearing loss
Cissampelos sp.	Menispermaceae	32	diarrhea, dysentery
Sida sp.	Malvaceae	30	common cough, greying hair
Passiflora sexflora Juss.	Passifloraceae	30	earache, hearing loss
Parthenium hysterophorus L.	Asteraceae	29	diarrhea
Borreria laevis (Lam.) Griseb.	Rubiaceae	29	diarrhea
Sedum praealtum A. DC.	Crassulaceae	28	topical burns, fever
Smilax domingensis Willd.	Smilacaceae	27	gastritis, hair loss
Euphorbia hirta L.	Euphorbiaceae	27	scabies, topical wounds
Bougainvillea sp.	Nyctaginaceae	24	common cough
Salmea scandens (L.) DC.	Asteraceae	24	toothache
Ricinus communis L.	Euphorbiaceae	22	rabies, dog poison

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Gnaphalium sp.	Asteraceae	22	common cold
Prunus persica (L.) Batsch	Rosaceae	20	diarrhea, dysentery
Cuphea carthagenensis (Jacq.) Macbr.	Lythraceae	18	diarrhea, fever
Blechum brownei Juss.	Acanthaceae	17	sty (on the eyelid)
Equisetum myriochaetum S. & C.	Sphenopsida	15	urinary pain
Pouteria mammosa (L.) Cronq.	Sapotaceae	15	dysentery, toothache
Erechtites hieracifolia (L.) Raf.	Asteraceae	15	acne, scabies, warts
Adiantum andicola Liebm.	Pteropsida	15	'fright'
Carica cauliflora Jacq.	Caricaceae	14	tumorous growths
Coffea arabica L.	Rubiaceae	14	sleepiness
Cucurbita ficifolia Bouché	Cucurbitaceae	14	lactation stimulant, urinary pain
Siparuna andina (Tul.) A. DC.	Monimieceae	13	aches and pains, headache
Tripogandra cumanensis (Kunth) Woodson	Commelinaceae	13	(variable)
Solanum americanum Miller	Solanaceae	13	eye infection, weakness

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Salvia sp.	Labiatae	13	common cough
Arrabidaea patellifera (Schltdl.) Sandwith	Bignoneaceae	13	(variable)
Asclepias curassavica L.	Asclepiadaceae	11	topical wounds
Jatrophia curcas L.	Euphorbiaceae	11	eye infection
Pinus sp.	Pinaceae	11	oral thrush
Ficus sp.	Moraceae	11	topical wounds
Bixa orellana L.	Bixaceae	11	measles, earache
Costus pulverulentus C. Presl	Zingiberaceae	11	(variable)
Phytolacca icosandra L.	Phytolaceae	11	eye infection
Pinaropappus spathulatus Brandeg.	Asteraceae	11	(variable)
Solanum erianthum D. Don	Solanaceae	11	topical wounds
Quercus sp.	Fagaceae	11	(variable)
Aster exilis Ell.	Asteraceae	10	(variable)
Bursera simaruba (L.) Sarg.	Burseraceae	10	(variable)

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Gaultheria odorata Willd.	Ericaceae	10	common cough
Litsea glaucescens H.B.K.	Lauraceae	10	cold and flu
Vitis tiliifolia Humb. & Bonpl. ex Roem. & Schult.	Vitaceae	9	(variable)
Erechtites valerianifolia (Wolf) DC.	Asteraceae	9	(variable)
Calophyllum brasiliense Camb.	Guttiferae	9	scabies, topical wounds
Ficus sp.	Moraceae	9	topical wounds
Buddleia americana L.	Loganiaceae	9	common cough
(unidentified)	Aracaceae	9	aches and pains
Phoradendron sp.	Viscaceae	9	(variable)
Bidens pilosa L.	Ranunculaceae	8	(variable)
Parathesis chiapensis Fernald	Myrsinaceae	8	diarrhea
Senna foetidissima (G. Don) I. & B.	Leguminosae	8	(variable)
Castilleja arvensis C. & S.	Scrophulariaceae	8	(variable)
Thevetia ahouai (L.) A. DC.	Apocynaceae	8	(variable)

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Borreria sp.	Rubiaceae	8	(variable)
Myriocarpa sp.	Urticaceae	8	(variable)
Satureja brownei (Sw.) Briq.	Labiatae	8	(variable)
Desmodium sp.	Leguminosae	8	(variable)
Heliocarpus sp.	Tiliaceae	7	(variable)
Cojoba arborea (L.) Britton & Rose	Leguminosae	7	(variable)
Cornus disciflora DC.	Cornaceae	7	(variable)
Smallanthus maculatus (Cav.) H. Robinson	Asteraceae	7	diarrhea
Cupressus lusitanica Mill.	Cupressaceae	7	common cough
Lagenaria siceraria (Mol.) Standl.	Cucurbitaceae	7	(variable)
Spondius mombin L.	Anacardiaceae	7	(variable)
Acacia angustissima (Mill.) Kuntze	Leguminosae	7	diarrhea
Euphorbia heterophylla L.	Euphorbiaceae	7	scabies
Schizaea sp.	Schizaeaceae	7	snakebite

Appendix C (continued).

Botanical species	Botanical family	% of interviewees citing a use	Primary medicinal uses (in order of frequency reported)
Swietenia macrophylla King	Meliaceae	7	topical infection
Myrica cerifera L.	Myricaceae	7	diarrhea