HIGHLAND MAYA MEDICAL ETHNOBOTANY

IN ECOLOGICAL PERSPECTIVE

by

JOHN RICHARD STEPP

(Under the direction of Brent Berlin)

ABSTRACT

The Tzeltal Maya of Highland Chiapas have widespread generalized knowledge about medicinal plants and the biophysical environment. Medicinal plants play an overwhelmingly primary role in daily health care. Tzeltal self-administer treatments and rely on clinics and/or specialized healers on rare occasions for very serious conditions. Research was conducted in six communities distributed throughout the three major ecological zones in the municipality of Tenejapa to gather data regarding medicinal plant knowledge, use and procurement. Illnesses and medicinal plant treatments were tracked for 208 individuals for a period of 7 months. Data were collected regarding habitat, time allocation, distance, soil type, vegetation type, seasonality, efficacy, availability, use, treatment and admixtures. 122 plant species were utilized to treat a variety of ethnomedical conditions, with over 80 percent of the cases involving gastrointestinal and respiratory illnesses. 93 percent of medicinal plant procurement was conducted within a 2-km radius of the household, 71 percent within a 1km radius. The average time spent in procurement of medicinal plants was 16 minutes. The distribution of medicinal plants were analyzed within specific ecological zones based on land use and degree of human modification. 86 percent of medicinal plants were obtained in managed areas or areas of secondary vegetation (non-forest). 14 percent were obtained in young secondary forest. No medicinal plants were obtained in old secondary or mature forest. Tzeltal living within a 1-km radius of mature forest were also interviewed. None could recall obtaining medicinal plants in mature forest for any illness at any time yet they could recognize a set of mature forest obligate medicinal plants. Research was also conducted on the ecological distribution of 203 medicinal plants with the highest consensus as to their use. 2842 responses were recorded. Early successional stages were reported as the most common habitats for medicinal plants with distribution falling off sharply in forested areas. These findings support the main study. Explanations are presented based on evidence and theory from human ecology and biochemical ecology. Implications for general conservation, medicinal plant conservation, and the relationship between health and the biophysical environment in Chiapas, Mexico are discussed.

INDEX WORDS: Maya, Tzeltal, Mesoamerica, Mexico, Chiapas, Highlands, Ecological anthropology, Medical anthropology, Ethnobotany, Ethnoecology, Medical ethnobotany, Illness, Healing, Medicinal Plants

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CHAPTER 1

INTRODUCTION

Plants play a central role in human existence. Medicinal plants, in particular, have allowed for the continued survival of the species. Even today, the World Health Organization estimates that two-thirds of the world's population rely on plant based medicines for their primary health care (Farnsworth et al. 1985). The field of medical ethnobotany has experienced a surge of interest during the last decade (for but a few examples see Alexiades 1996; Berlin and Berlin 1996; Cox and Balick 1994; Etkin 1993; Farnsworth 1994; Iwu 1993; Lewis and Elvin-Lewis 1995; Martin 1995; Schultes and von Reis 1995, Moerman et al. 1999). Several studies have indicated that indigenous peoples have a comprehensive, empirically based knowledge of their environments (Conklin 1954; Berlin et al. 1974; Alcorn 1983; Frechione et al. 1989; Posey 1984; Moran 1982). However, there has been little research on the interaction between cultural knowledge and the use of medicinal plants in relation to the biophysical environment. Two recent studies, one by a geographer (Voeks 1996) and one by ecologists (Caniago and Siebert 1998) look at medicinal plant ecology but not from an anthropological perspective.

One reason for the increased interest in ethnobotany is due to the exotic association of medicinal plants with primary forest. This association was promoted through several popular press books and articles (e.g. Joyce 1994; Plotkin 1993).

Conservationists were quick to seize on the proposition that primary tropical rainforest contains many important medicinal plants that may hold the key to cures for diseases such as AIDS and cancer because it provides a powerful economic and medical argument for preservation of tropical rainforests. The assumption that mature forests are the most significant habitat for local peoples to obtain medicinal plants has gone almost unchallenged (with the exception of Voeks 1996). In part, this research seeks to test this assumption.

This dissertation research involves an ecological study of medicinal plants of the Highland Tzeltal Maya in Chiapas. Both the general ethnobotany (Berlin, Breedlove and Raven 1974) and the medical ethnobotany (Berlin and Berlin 1996) are well understood. This means that the Tzeltal Maya one of the few indigenous populations in the world with which a study such as this one could be undertaken without first investing significant amounts of time in obtaining baseline ethnobotanical data. Within the last few decades there has been increased environmental degradation and population growth in Chiapas, Mexico. However, the biodiversity of the state of Chiapas remains among the highest in the world, comprising more than 9000 species of vascular plants (Breedlove 1981,1986). Over 1600 of these plants are employed for medicinal uses by the Highland Maya and knowledge for approximately 600 species is widespread (Berlin and Berlin 1996). Their medical system is heavily reliant on local medicinal plant species and is integrally interwoven with the biophysical environment. By building on this previous research it becomes possible to relate this botanical knowledge (ethnobotany) to ecological knowledge (ethnoecology).

Ethnoecology is an interdisciplinary sub-field of anthropology that looks at indigenous cognitive perceptions of divisions in the biological world and how human behavior relates to these perceptions (Frechione, Posey and Da Silva 1989). As such, this research has two interrelated domains of investigation: cognitive and behavioral. This approach allows for a fuller understanding of human-environmental relations by contextualizing human behavior within local perceptions of the environments.

The affordance concept laid out by Gibson (1979) in particular, provides a useful framework to look at healing within an environmental context. "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill…It implies the complementarity of the animal and the environment (Gibson 1979: 127)." The utility of the concept lies in its emphasis on the holistic aspects of human-environment relations and the complementary nature of this relation, in this case between medicinal plants and humans. Inherent in the definition are the values and meanings attached to objects in nature. Additionally it implies not just the perceptual features of objects in the environment but biological features (in the case of medicinal plants, pharmacological and toxic aspects) and cultural features.

GENERALIZED VERSUS SPECIALIZED KNOWLEDGE

A major premise of this study is that ethnobotanical knowledge among the Tzeltal Maya is common, widespread and generalized. While this approach has been validated through numerous studies of other cultures (e.g. Conklin 1954; Alcorn 1981; Martin 1996) and especially in Chiapas (Berlin et al. 1974; Berlin and Berlin 1996) there is still resistance to such an approach by ethnobotanists that tend to work exclusively with specialized healers (cf. the discussion between Berlin, Balick, Cox, Elvin-Lewis, Lozoya, Martin, Iwu and Posey in Berlin and Berlin 1994:260-61). Much medical ethnobotany that has been done previously relied exclusively on interviews with specialized healers. Stereotypically, this approach is much more common with ethnobotanical studies done by researchers with a background in botany while those with anthropological backgrounds more often investigate generalized knowledge. The reasons for this dichotomy have much to do with the development of the field of ethnobotany within two larger disciplines that often did not communicate across disciplinary boundaries. But apart from historical aspects of ethnobotany there are other possible reasons why the ethnobotany of specialized healers has remained a popular approach. In western culture medical knowledge has become increasingly specialized and even sacred (Katz 1999). Despite efforts at objectivity, cultural patterning influences research design. Given the lack of self-treatment in western industrialized societies and the overwhelming importance assigned to specialized practitioners of medicine, it is perhaps not surprising that so much research has focused on specialized healing in other cultures.

OBJECTIVES AND HYPOTHESES

The objectives of this study are to investigate:

1) What medicinal plants are utilized by the Tzeltal Maya.

2) What the role of environmental variation is on use and selection.

3) Which habitats are preferred for medicinal plant procurement.

The overall research design is guided by several hypotheses related to the selection and procurement of medicinal plants. Selection is defined as deciding which particular plant to search for to treat a particular ailment. Procurement involves selecting a particular ethnoecological zone(s) in which to find the plant. The hypotheses are as follows: certain plants are selected more frequently for specific illnesses; medicinal plants are gathered within a short distance from the household; the distribution of medicinal plants throughout ethnoecological zones will affect selection of species used for treatment; disturbed habitat is favored over primary forest for medicinal plant procurement; weeds (defined as those plants that are successful in disturbed environments, are fast growing, and, are often but not always herbaceous) are represented in the medicinal flora at a significantly higher number than their representation in the general flora.

SIGNIFICANCE

In a general sense, ethnoecological studies can contribute to a bridging of adaptational (materialist) and ideational theroretical approaches in anthropology (cf. Hunn 1989) by looking at both knowledge and behavior. This research will add to this growing body of literature and address a significant gap by looking at traditional knowledge and use of medicinal plants within an ethnoecological framework. Despite decades of research on medical ethnobotany, to my knowledge, no one has ever systematically explored *actual* medicinal plant use over time. The study of medicinal plants as a domain in ethnobotany can provide a greater understanding of plant-human interactions and human-biophysical environments. The testing of hypotheses relating to medicinal plants and disturbed areas contributes to theoretical developments in ecological anthropology regarding human modification of environments. On a basic inventory level, besides having importance for other ethnobotanical research within Chiapas, the research potentially relates to ethnobotanical research throughout the neotropics. Many of the plants utilized by the Tzeltal, are also used by other indigenous groups (cf. Frei et al. 1998; Arvigo and Balick 1993).

There are also significant applied aspects of the research. Medicinal plant conservation is a relatively new endeavor (Sheldon, Balick and Laird 1997). Today over 20,000 plant species are endangered (Wilson 1993; Tyler 1996). This does not include the number of plants in danger of local extinction, a problem that has widespread implications for local peoples reliant on traditional plant medicine for their primary health care.

The research provides data that could be used to suggest improved management of the resource in the context of increasing human population pressures in the Highlands. It also has the potential to make recommendations to governmental and non-governmental organizations working on sustainable resource initiatives in Chiapas. Because of the overwhelming significance of plants in healing practices for the vast majority of the world's population it is crucial to understand the cultural relationships underlying these resources. This can help to ensure the continued survival of traditional peoples and their healing practices.

ORIGINS AND ORGANIZATION OF THE DISSERTATION

The proximate origins of this study lie in my participation in a trans-generational project to revive ecological anthropology in the department of anthropology at the

University of Georgia. In 1990, the department was restructured to focus on human-environmental interactions. This dissertation then, is but a small humble part of the fruition from this larger effort and, as such, bears the mark of a large group of colleagues who contributed to my intellectual development. Errors and omissions are, of course, my fault alone.

The dissertation is organized as follows:

> Chapter 2 presents the environmental context for the research. Biophysical and sociocultural environmental aspects of the research site in the Tzeltal Maya municipality of Tenejapa, Chiapas are explored.
>
> Chapter 3 describes the research design, methodology and techniques. A discussion of the techniques used in relation to more standard techniques in ethnobotany is provided.
>
> Chapter 4 provides data from the main study which investigated use, procurement and ecological distribution of medicinal plants throughout the landscape. The role of specific habitats for procurement is explored, along with patterns that appear from the data.
>
> Chapter 5 looks at medicinal plant procurement in one specific habitat, mature forest.

Chapter 6 is a botanical ethnography of the most utilized Tzeltal Maya medicinal plants. A botanical description is provided for each plant along with data on ecology, folk classification and nomenclature, medical ethnobotany and ethnopharmacology, and ethnoecological distribution. An illustration, voucher specimen, and/or photograph accompanies each description.

Chapter 7 concludes the dissertation with a discussion drawing from human ecology and biological ecology to explain the results of the study. Future directions in medical ethnobotanical research are explored.

CHAPTER 2

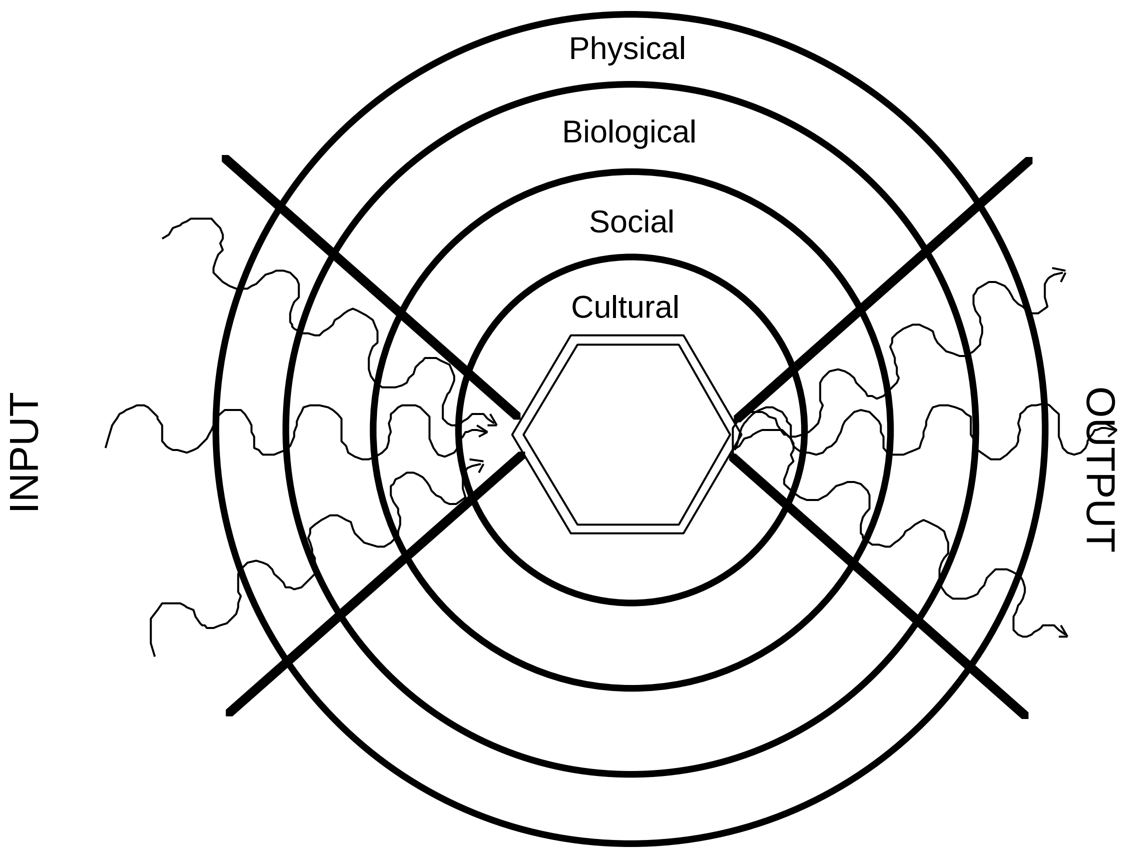
ENVIRONMENTAL CONTEXT OF THE STUDY

INTRODUCTION

In this chapter I present the environmental context for the study. The term 'environment' is often used in an imprecise and reified manner in ecological anthropology. "The environment" is taken to mean only the biophysical environment; the earth system; or in a loose colloquial sense, 'nature.' Using the term in this manner obscures the relationship between environment and agent and how this interaction forms a system or ecosystem. In the interest then, of a more precise usage of the term, I present the following distinction. Using a multiple environments approach (Stepp 1999, Kuchka 2001), 'environment' is taken to mean, at a minimum, the biological, physical, social, and cultural environments. When a more precise usage is intended one can then refer to the specific environmental domain. One way to depict the taxonomy of these multiple environments is with a model of concentric circles arranged in an evolutionary sequence as in figure 2.1. In this model, a physical environment exists prior to biological forms, some of which develop sociality and culture. Also implicit in this arrangement is the concept of a system being composed of both an input environment and a output environment (Patten 1978). The lines represent matter, energy and information flows. Ecosystems form through the dynamic coupling of one agent's output environment with another agent's input environment (cf. Patten 1979, Odum 1993).

An ecological perspective then is one that takes these environments into account and looks at the interactions between them.

Figure 2.1: A hierarchy of multiple environments (after Stepp 1999, Kuchka 2001)



Sources of Data and Accuracy

Much of the data presented in this chapter concerning demographic, economic and physiographic conditions comes from various reports provided by the Mexican federal government through the Instituto Nacional de Estadística, Geografía e Informática (INEGI). INEGI is in charge of collecting census information for the entire country along with production of maps with various themes, INEGI has become increasingly more sophisticated over the last decade and they now feature much of their data either on CD-ROM or available directly from their website (http;//www.inegi.gob.mx). INEGI also has stores in most of the capitals of Mexican states and in the Mexico City airport where one can purchase a wide range of topographical maps, satellite images and books.

The services offered by INEGI provide invaluable data for researchers. However, researchers sometimes question the validity of some of the data that INEGI provides (e.g. Berlin and Berlin 1996). At times, the level of detail that they provide for highly rural municipalities such as the ones in the Highlands of Chiapas is astounding. It seems almost impossible to collect some of this data without a legion of researchers tromping across the Highlands. During my fieldwork I have encountered numerous non-Mayans such as social service workers, other anthropologists, military personnel, peace activists, tourists, and even a few Jehovah's Witness missionaries. But I have never run into anyone from INEGI in Highland Maya communities. Because INEGI researchers are rarely, if ever seen, in the Highlands, this had led to some questions about their methodology and validity for some of their reports.

I did not set out to verify the INEGI data so I can only provide a limited report of my own experience with INEGI data. I used INEGI topographical maps extensively in my research, along with a GPS unit. I found that with regards to physical features and accurate reporting of altitude and contour lines, the maps are highly accurate. Unfortunately this does not extend to accuracy of place names and locations of communities. For example, the topographical map that contains most of the municipality of Tenejapa in the Highlands of Chiapas (the sheet is named Oxchuc,E152D52) places the community of Chixtontic over 1.5 km away from where it actually is. The location of the *cabecera* (or municipal center) of Tenejapa is listed twice: one is accurate, the other is across the highway from the *cabecera* for the municipality of Oxchuc.

Many of the areas that are noted as forested on the map are not. Two of the largest tracts of primary forest near the communities of Matzab and Achlum in Tenejapa are not noted as being forested land at all. While the major roads are accurately depicted on the map, many of the smaller ones are either not included or the course they follow deviates substantially from the topographical map. It appears that some of the lines that are marked as roads are, in fact, well used walking trails in the mountains. I have found the topographical features and locations of geological and hydrological features to be accurate when checked against a handheld GPS unit.

With the above in mind, the reader is cautioned about overly relying on data reported by INEGI absent any corroborating evidence or ground truthing.

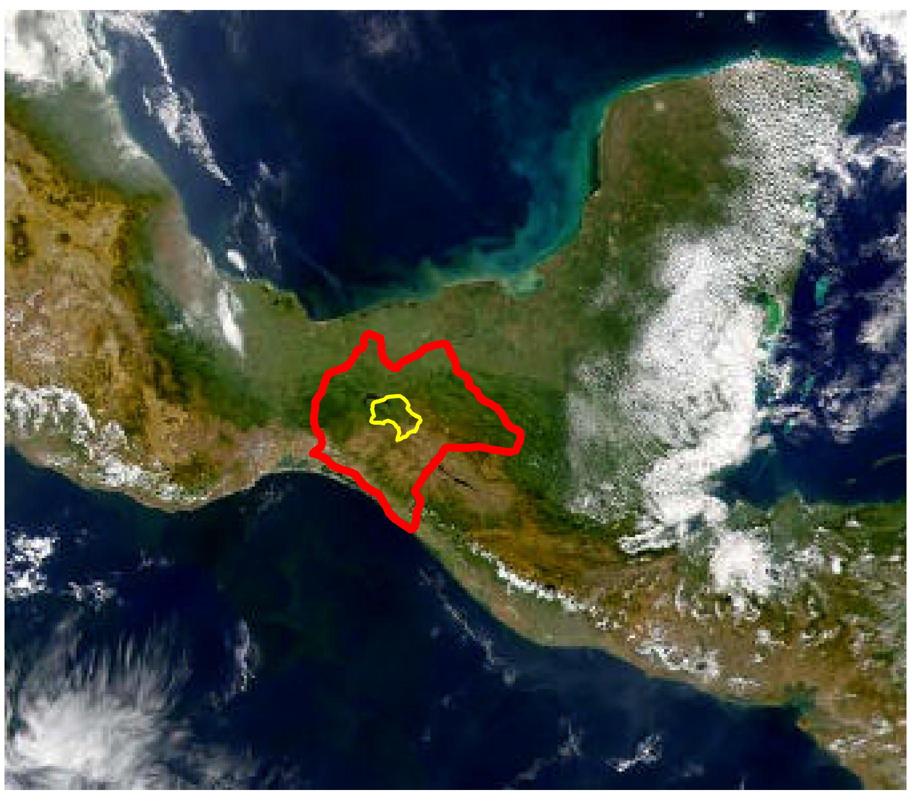
BIOCULTURAL DIVERSITY IN THE STATE OF CHIAPAS

This research took place in the Highland region of the state of Chiapas. Chiapas, with an area of 73,887 square km, lies at the southernmost extent of Mexico and borders Guatemala on its eastern/southeastern side (Figures 2.2.and 2.3). Chiapas is notable for its high biocultural diversity in a country that itself ranks very high in biocultural diversity by several measures. With regards to biological diversity, Mexico is considered to be one of the six megadiversity countries of the world. It ranks third, following Brazil and Colombia (Mittermeier 1988). Within the North American/Central American bioregion, Mexico ranks first in species richness and sixth worldwide for species endemism (Sisk et. al. 1994). More than 17 percent of Mexico's 2,500 genera and 52 percent of its 22,000 vascular species are endemic to the country (Ramamoorthy and Lorence 1987; Rzedowski 1993). There are 58 main groups of indigenous peoples speaking 240 languages and dialects in Mexico (Grimes 1996). It is ranked ninth in the world for biocultural diversity (Ryan 1993). Mexico is considered one of the three primary centers of agricultural origin (Harlan 1975).

Within this context is the state of Chiapas as one of the two most biodiverse regions of the country along with the neighboring state of Oaxaca (Toledo 1988). In the Barthlott et al. classification of the world's diversity and endemism of vascular plants, Chiapas is given a ranking of 9 (10 possible) with more than 5000 species/10,000 km^2 (Barthlott et al. 1996). Chiapas has more than 9000 species of vascular plants and more than 1150 species of vertebrates (Breedlove 1981,1986; Toledo 1988; Ramamoorthy et. al. 1993). There are four major Maya languages spoken in Chiapas (Tzeltal, Tzotzil, Ch'ol, Tojolobal). Other Mayan languages include Lacandon, Kanjobal, and Mam. There is also a sizable population of Zoque speakers. In total, there are at least 54 indigenous languages spoken in Chiapas, although of these only 11 have more than 100 speakers (INEGI 2000). Attesting to the high cultural diversity in Chiapas is the fact that half of the ethnographic literature on indigenous people in Mexico written between 1965 and 1995 deals with indigenous people in Chiapas (Köhler 2000). The two largest sociolinguistic groups are the Tzeltal and Tzotzil Maya, living in fourteen municipalities

Figure 2.2: Political Map of Mexico

Figure 2.3: OrbView-2 satellite image of Southern Mexico with the borders of Chiapas in red and the highland region in yellow (courtesy of NASA, used with permission)



in the Highlands (Figure 2.4) although outmigration beginning in the late 1960s has led to substantial populations moving to lowland regions of Chiapas and to other areas throughout Mexico. The Tzotzil municipality of Chamula in particular has experienced massive migration and I have encountered Chamulans in the city of Mérida and as far north as Chihuahua. At present, the population of the Tzeltal is 278,577 and the Tzotzil population is 291,550 (INEGI 2000). Tzeltal and Tzotzil are two of the 31 extant Maya languages spoken in Mexico and Central America and are part of the Greater Tzeltalan grouping that include Chol, Chontal, Chortí and Choltí (Campbell and Kaufman 1985).

Chiapas has experienced rapid population growth during the latter part of the 20th century. For example, the state's population has almost tripled from 1,569,000 in 1970 to 3,920,515 in 1990. This expansive growth was even greater for the indigenous populations of the state, more than tripling from 288,000 in 1970 to 809,512 in 2000 (INEGI 2000).

HIGHLANDS AND THE MUNICIPALITY OF TENEJAPA

The specific area in the Highlands where this research took place was in the Tzeltal Maya municipality of Tenejapa. This municipality, with an area of 99.4 square km, lies approximately 27 km to the north east of the colonial and now tourist town of San Cristóbal de las Casas along an all-weather road. Tenejapa has been the site of a great deal of anthropological fieldwork over the last 40 years. There have been numerous research articles, book chapters, monographs and dissertations as a result. To varying

Figure 2.4: Map of the Highland region of Chiapas, Mexico, Tzeltal communities are to the east of the dark line and Tzotzil communities lie to the west (courtesy Maya ICBG)

degree, this body of literature provides a comprehensive and accurate portrait of Tenejapa, at least up to the date in which it took place. The first published anthropological research in Tenejapa was in 1901 by Frederic Starr who made a brief visit to the municipality and collected biometric data from the population (Starr 1902). Since the late 1950's there has been a steady stream of anthropologists doing research in Tenejapa. The surge of interest in Tenejapa and other highland Maya municipalities began with the Man and Nature program under the direction of Norman McQuown at the University of Chicago. This was followed a few years later by the Harvard Chiapas Project under the direction of Evon Vogt which focused mostly on Tzotzil municipalities. McQuown wanted to place both a linguist and ethnographer in the Highland municipalities. In 1961, he recruited Brent Berlin and Andrés Medina to conduct their anthropological dissertation research in Tenejapa (Berlin 1964, Medina 1991).

Anthropologists returned many times in the ensuing years for their doctoral fieldwork. For example, Stross (1970) on childhood acquisition of botanical knowledge; Branstetter (1974) on the social significance of clothing; Hunn (1977) on Tzeltal folk zoology; Brown (1979) on politeness and gender roles; Haehl (1980) on Tzeltal kinship analysis; and Rostas (1986) on change, identity and religious practices. The most recent dissertation research undertaken in Tenejapa prior to this study is that of Maffi (1994) on ethnosymptomatology and Castille (1996) on mental illness. Maffi, in particular, provides a detailed description of Tenejapa that concentrates on political features, linguistics, health aspects and belief systems in Tenejapa.

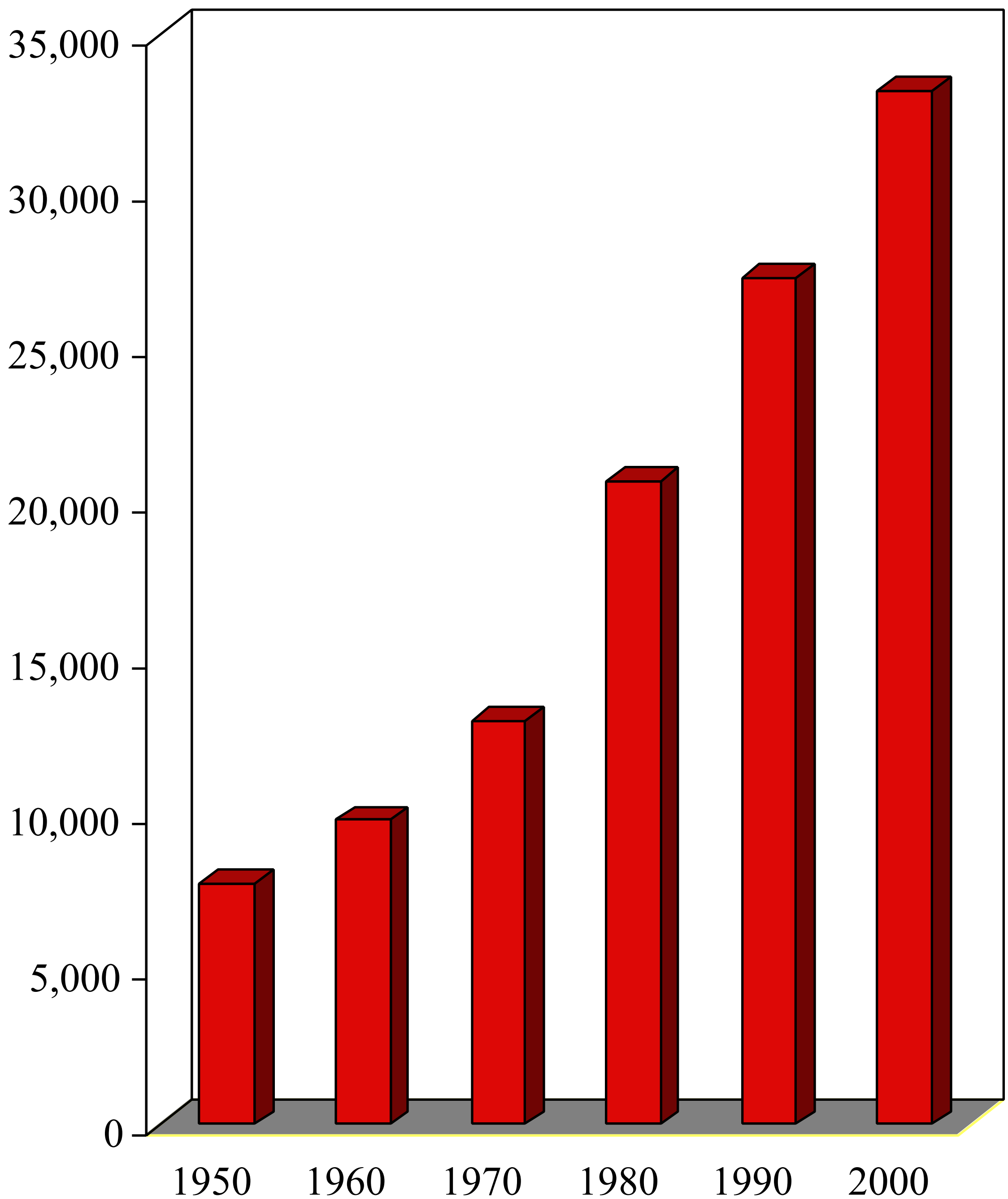
Rather than attempt to duplicate the work of others then, this chapter provides a description of characteristics that 1) are particular relevant to this study 2) update previous ethnographic and ecological description and 3) have not been mentioned in previous work. I might add that during 2001, Tenejapa was the site for doctoral fieldwork in anthropology by David Casagrande on cognitive prototypes and medicinal plants, Aaron Lampman on ethnomycology and George Luber on an illness known as *chalam ts'ots*. It is expected that their research will continue to provide updated ethnographic details and further address any overlooked aspects. Moreover, this chapter does not seek to place Tenejapa within that fictive time frame known as the "ethnographic present" but rather portrays Tenejapa during the time I worked there from 1996 to the end of 1999. Use of the present tense in this discussion then is a matter of convenience and not an attempt at what has been termed 'discursive distancing' (Fabian 1983).

Population and Sociopolitical Organization

The population of Tenejapa has grown dramatically in the last 50 years (Figure 2.5) and currently numbers 33,271 (INEGI 2000). The municipality is almost entirely Tzeltal Maya with only 200 non-indigenous people, who live mostly in the Tenejapa town center, *lum* (literally 'land') in Tzeltal or *cabecera* (literally 'head') in Spanish. Among the population aged 5 years and older, 55 percent of males speak Tzeltal and Spanish, and 26 percent of females speak Tzeltal and Spanish. Overall, 58 percent of Tenejapans are monolingual Tzeltal speakers. There are 5,643 households in Tenejapa with an average of 5.89 people per household (INEGI 2000).

The economic and political heart of Tenejapa lies in the Tenejapa town center, a remnant of the 'vacant town' described by Tax (1937). In this model, settlement

Figure 2.5: Population of Tenejapa, Chiapas 1950-2000 (INEGI 2001)



is dispersed into outlying hamlets or *parajes* and the center is occupied temporarily by cargo holders and political leaders who regularly rotate out of living in the center back to their home communities. Tenejapa never quite fit this model however because there has long been a substantial presence of non-indigenous people (known in Chiapas as *ladinos*) living permanently in Tenejapa center. During the last thirty years the number of *ladinos* in Tenejapa center has declined due to a trend towards moving to San Cristóbal. However the loss of *ladinos* living in Tenejapa center has been offset by a trend towards more Tzeltal choosing to live permanently in Tenejapa center. Overall, the population of Tenejapa center has increased in the last few decades. This is exemplified in two photographs: one taken in the early 1960s by Brent Berlin (Figure 2.6) and the other taken in 1998 by the author (Figure 2.7). The streets have approximately doubled in length and houses have cropped up surrounding the town. In the 1960s, Tzeltal lived on the edge of town in traditional houses with mud walls and thatch roofs (Figure 2.8) while *ladinos* lived along the main streets in concrete houses. This distinction has all but disappeared and no one lives in traditional houses anymore in the town center. Throughout the municipality traditional houses are becoming extremely rare and it is more common to find a house with wood plank walls and tin roofs (Figure 2.7).

Outside of the town center, people continue to live in dispersed settlements organized around small communities (*parajes*). These *parajes* range in populations from 50 to upwards of 2,000 and usually contain some sort of civic complex including a school, administrative buildings and a basketball court. The number of *parajes* has grown from 21 in the late 1960s (Berlin et al. 1974) to 42 in the 1990's (INEGI 1991) and probably numbers over 50 today. The aftermath of the Zapatista uprising in 1994 has likely exacerbated this fissioning process due to conflict between supporters of the *organizacíon* (as the EZLN is called by Tenejapans) and those Tzeltal opposed to the EZLN. The exact processes by which *parajes* are formed and boundaries are delineated is unclear and ethnographic research is sorely needed.

Like many Highland municipalities, political tensions run high among the population and there is frequent conflict. During my fieldwork in 1999, the state police occupied Tenejapa center on three occasions and stayed for a few weeks each time. There is general mistrust in the office of the municipal presidency and it is not uncommon to find a president being removed from office well before his elected term expires. Although the PRI party has traditionally dominated politics in Tenejapa (and the rest of the country) their hold appears to be slipping. It is common to see signs and slogans for opposition parties in Tenejapa center and during the most recent elections for governor in 2000, the majority of Tenejapans (4,464 votes) voted for a coalition of opposition groups over the PRI party (3,721 votes). Votes for or against PRI in these elections did not break down by specific precincts but rather most precincts recorded significant support for opposition groups (Instituto Estatal Electoral de Chiapas 2000). Despite conflict and political violence there do not appear to be paramilitary groups operating in Tenejapa although their presence is well documented in neighboring municipalities. The Acteal massacre on December 22, 1997 where 45 Tzotzil Maya were killed by *Paz y Justicia* paramilitaries took place only a few kilometers from the community of Majosik' in Northern Tenejapa (Figure 2.10). Tenejapa also does not appear to have communities involved in autonomy movements, unlike other neighboring

Figure 2.6: Tenejapa center in the early 1960s (photograph by Brent Berlin)

Figure 2.7: Tenejapa center in 1998

Figure 2.8: Traditional style of housing in Tenejapa, community of Winik Ton 1986 (photo courtesy of Brent Berlin and Elois Ann Berlin)

Figure 2.9: Contemporary style of housing in Tenejapa

Figure 2.10: Memorial along main road in Chenalhó for Tzotzil Maya slain during the Acteal massacre

municipalities such as Chenalho (Figure 2.11). The underlying causes for political conflict in the Highlands are unequal distribution of resources and a shortage of arable land. It is unlikely that these conditions will improve in the near future and conflict will likely continue.

Figure 2.11: Sign for autonomous community of Polho

Economy

Despite the widespread change that has occurred in Tenejapa over the last 40 years, the vast majority of Tenejapans are still engaged in the same economic activity that they have been doing for millennia: subsistence farming. The major crop is maize, supplemented by several types of beans and squashes and a variety of other crops depending on the altitude. There is limited animal husbandry, mainly chickens and pigs. A small minority engages in other occupations, most notably taxi driving, weaving and teaching. Some Tenejapans have migrated to San Cristóbal and found work there in the service or construction industry while others engage in seasonal migration beyond Chiapas to work in a variety of manual labors. However this labor migration is much smaller than what has occurred in other highland municipalities such as Zinacatán.

The basic practice of subsistence farming is much the same as it was 40 years ago with a significant exception. Land shortages have meant that less land is put into fallow at any given time. In order to maintain productivity the Highland Maya have become increasingly reliant on chemical fertilizers (Collier 1994). In the short term this has been beneficial in increasing yields and providing food for a increasingly larger population. The long-term sustainability of this system is questionable and it has also made the Highland Maya subservient to a cash economy over which they have little control (Collier 1994). The implementation of the North American Free Trade Agreement in 1994 has meant that imported maize grown in the United States with high fossil fuel inputs is cheaper than maize grown by less intensive methods within Mexico (Barry 1995). The impact of this in Highland Chiapas has been less severe than in other parts of Mexico simply due to the fact that most of the maize produced in the Highlands is for subsistence and local markets and not exported. In 1991, 47% of the maize was grown for subsistence (INEGI 1997).

The ownership of land in Tenejapa is divided between 70 percent as communal property, 20 percent as *ejido*, and 10 percent as private property (Anon 1988). There are 4,418 agricultural units in production over an area of 14 square km (out of a total of 99.4 square km). The average size of a production unit is 3.17 hectares (INEGI 1996b).

A major crop at elevations below 1800 meters is coffee, comprising at least 3,132 hectares or 22% of the total land in production for the whole municipality (INEGI 1996b). In 1991 there were 7,985 tons produced (INEGI 1996b). There is often conflict with the coffee growers and the *coyotes*, or middlemen, that take the coffee from the highlands to regional processing centers. Coffee prices in Tenejapa in 1999 ranged from 7 to 9 pesos per kilogram or approximately 70 to 90 cents per kilogram. The third most significant crop is probably bananas with at least 298 hectares in production (INEGI 1996b).

There is an increasing interconnection between Tenejapa and the larger regional, national and international contexts. While these interconnections are nothing new and a case could be made that they began with the Spanish invasion of the Highlands in the 16^{th} century, the level of interconnectedness is certainly increasing. Collier (1974) did the first detailed study of this phenomenon with the Tzotzil and the process has continued unabated since then. I was surprised to learn, for example, that Guatemalan immigrants (mostly Mayan themselves although obviously from a different sociolinguistic group) are sometimes employed to pick coffee and for other agricultural labor in communities at lower elevations.

Ecology

This section presents some relevant biophysical, geographical, and ecological characteristics of Tenejapa; *ethno*-ecological classification is discussed in detail in Chapter 4. The highland region of Chiapas presents a vast array of ecological zones and microenvironments and Tenejapa is no exception. Elevations range from 900 meters to 2500 meters, with a few peaks reaching 2800 meters. The municipality is almost equally divided in area between the three major ecological zones based on altitudinal and climatic variation: hot or *k'ixin k'inal* (900 meters-1500 meters), temperate (1500meters-1800 meters) and cold or *sikil k'inal* (1800 meters-2800 meters). There is a general trend towards a downward slope moving from the south to the north of the municipality. Tenejapa lies along a seafloor uplift plateau of cretaceous limestone with a shallow soil profile punctuated by steep ravines and occasional karstic sinkholes, especially in the west central area (Figure 2.12; Müllerried 1957). Soil is mainly nitosols with a high clay content which are susceptible to erosion and acrisols which are acidic and nutrient poor (Anon 1988). There is a pronounced rainy season from late May to December. Annual precipitation ranges from 1500 millimeters to 2000 millimeters and is higher in the northern, lower elevation parts of the municipality. The climate of Tenejapa is considered to be subhumid temperate, climatic formula $C(w_2)(w)$ in the Köppen climate classification as modified by García (1988). The central location of the municipality within the Highlands means there is flora represented from both the Selva Lacandon lowlands to the east and the Sierra Madre Mountains to the west. In general, the municipality is characterized by a patchy mosaic of land in cultivation and in various

Figure 2.12: The patchy karstic landscape of Tenejapa as seen from a ridge in the community of Nabil facing southeast towards the primary forested peaks of Matzab

successional stages. Vegetational formations vary depending on the altitude and degree of human disturbance. In the lower elevations there is seasonal evergreen forest, tropical deciduous forest and pine-oak-liquidambar forest. At higher elevations lies pine-oak forest (although as oaks are selectively removed it is increasingly more common to find only pine forest, González-Espinosa et al. 1991) and evergreen cloud forest on the highest peaks where agriculture is impractical (Breedlove 1981). There are at least 2200 vascular plant species in Tenejapa (Berlin et al. 1974). Large animals have been hunted out of Tenejapa and it is rare to find even small mammals today, although Tzeltal will sometimes go to extraordinary lengths to hunt them despite the minimal return on their efforts (a potentially vexing issue for proponents of optimal foraging theory!). Deforestation is a serious problem as more and more land is brought under cultivation.

RESEARCH COMMUNITIES IN TENEJAPA

Given the range of ecological variation present in Tenejapa it is necessary to conduct research in multiple communities in order to gain an accurate understanding of human-environment interactions. Research was conducted in six communities in Tenejapa (Figure 2.13). Two communities in each major ecological zone (six total) along a range of altitude were selected for the study (Fig 2.14). They are Balum Kanal and Nabil (cold country); Kul ak'tik and Sibanilja' (temperate country); Majosik' and Jomanichim (hot country).

Fig 2.13: Topographical map of approximate boundaries of Tenejapa with study communities: A=Balum Kanal, B=Nabil, C=Kul ak'tik, D=Sibinilja, E= Jomanichim, F=Majosik', *=Tenejapa Center (after INEGI 1990)

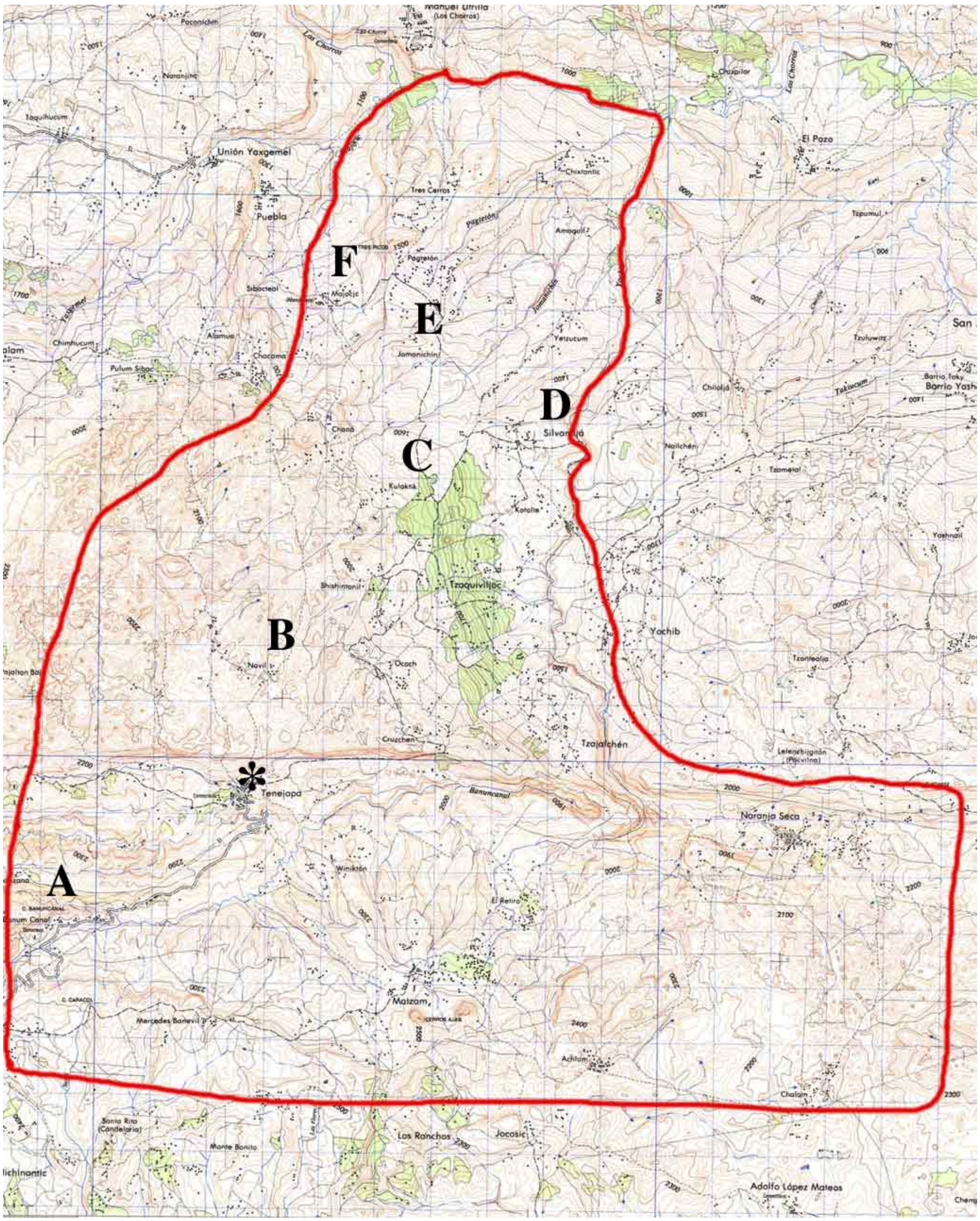
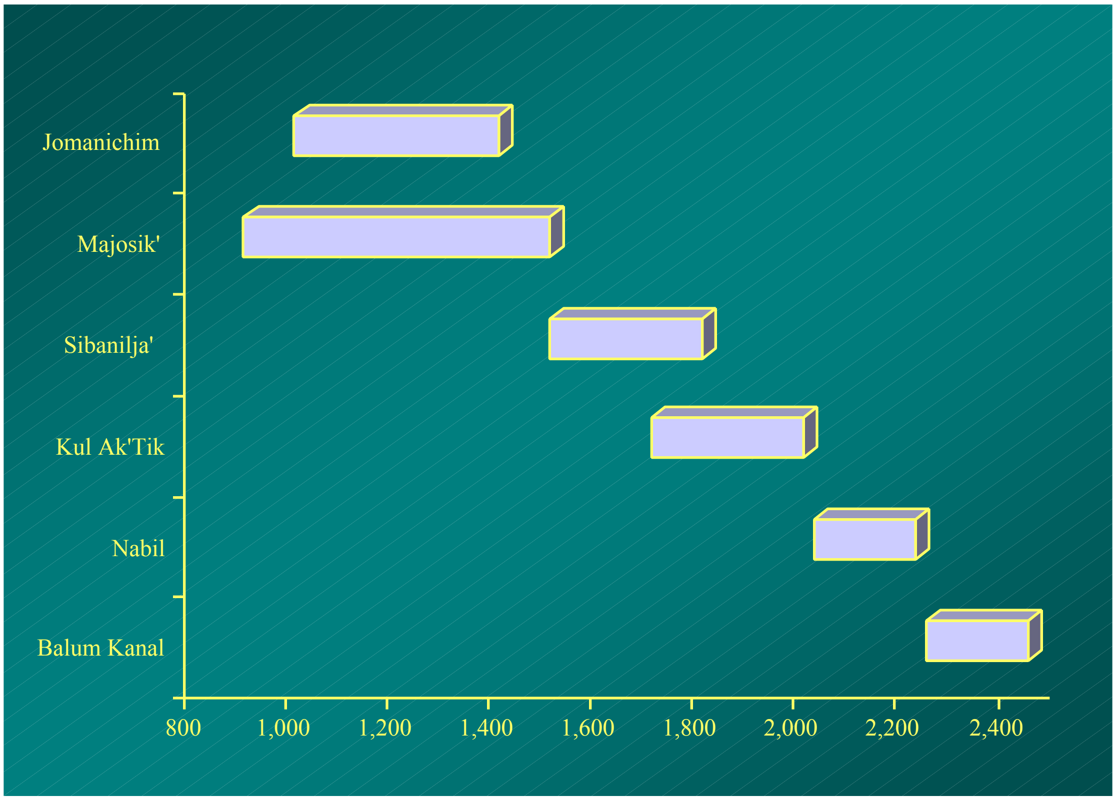


Figure 2.14: Elevation range of study communities (in meters)



Cold Country (*Sikil K'inal*) Communities

Balum Kanal

Balum Kanal (gloss 'nine levels', referring to the nine mythological levels that one ascents to the top of the mountain in this community (Berlin pers. comm.) although Becerra (1932) claims 'new houses up high') lies at 2240 meters (16º 46' 49" North, 92º 32' 12" West) along the all weather paved road from San Cristóbal to Tenejapa center. This location makes it one of the most accessible communities in Tenejapa. Houses lie mostly along the road itself and the terrain is very steep. There is no clinic in Balum Kanal but there is access to the clinics in Tenejapa center. In 1990, 19 percent of houses did not have piped-in water, None of the houses had indoor plumbing and 31 percent did not have electricity (INEGI 1991).

Nabil

Nabil lies at an altitude of 2220 meters (16º 50’ 17” North, 92º 30’ 25” West) along an all weather dirt road a few kilometers west of the main highway from Tenejapa to Oxchuc and just to the north from the box canyon where Tenejapa center lies (Figure 2.15). Nabil contains some of the most karstic landscape in Tenejapa with numerous sinkholes. Despite the steep slopes of some of the sinkholes they are readily utilized for milpa. In 1990, 38 percent of houses did not have piped-in water and none of the houses had indoor plumbing (INEGI 1991). It appears that most houses in Nabil have electricity and there is a clinic.

Temperate Country (***Sikil Htebuk K’inal/K’ixin Htebuk K’inal***) Communities

Kul ak’tik

Kul ak’tik lies a short distance off the main paved highway from Tenejapa to Oxchuc at an altitude of 1800 meters (16º 51’ 52”North, 92º 29’ 12” West; Figure 2.16). There are more than 604 people in more than 95 households (INEGI 1991). The community lies in the transition zone between cold and hot country and is the first area where coffee cultivation appears coming from the higher altitudes of the southern part of

Figure 2.15: Community of Nabil

Figure 2.16: Community of Kul ak'tik

the municipality. There is no clinic. In 1990, 73 percent of houses did not have piped-in water, None of the houses had indoor plumbing and 12 percent did not have electricity (INEGI 1991).

Sibanilja'

Sibanilja' lies at 1500 meters (16º 52' 28"North, 92º 27' 40" West) close to the border with Oxchuc. There is a clinic available that is shared with the community of Pocolum (Figure 2.17). In 1990, 67 percent of houses did not have piped-in water, None of the houses had indoor plumbing and 26 percent did not have electricity (INEGI 1991).

Figure 2.17: Sibanilja'/Pocolum clinic

Hot Country (*K'ixin K'inal*) Communities

Jomanichim

Jomanichim (gloss 'place of the flower') lies at the intersection of an unpaved road off the main highway and a turnoff for the far northern part of the municipality at an altitude of 1420 meters (the center lies at 16º 53' 12"North, 92º 28' 41" West). At times the road is not accessible during the rainy season. There are over 789 people in the community with over 136 households (INEGI 1991). Almost all of the households have electricity and 85 percent have piped in water (INEGI 1991). In 2001, the community suffered major political violence as a result of conflicts between the dominant PRI political party and the opposition PRD political party.

Majosik'

Majosik' (gloss 'where the swallow was hit', Becerra (1932) claims 'hiding place of five swallows') is the largest community in the study, comprising over 868 people (INEGI 1991). It is located in the northwestern section of the municipality (the center lies at 16º 53' 48"North, 92º 29' 32" West) and ranges from 1500 m to 900 m along a mountain slope that ends at the Majosik' river which forms the border between Tenejapa and the Tzotzil municipality of Chenalho. It is accessed off the main road via a 30 minute drive along an unpaved all-weather road. Majosik' was the site of Brian Stross' dissertation research in 1968 and 1969 on childhood acquisition of botanical terminology (Stross 1970). A thirty year follow-up study found, surprisingly, that children are continuing to acquire botanical knowledge at the same rate and levels (Zarger and Stepp in prep.). Being in hot country, a range of agriculture is available, although coffee and maize predominate. Although Stross (1970) claims that at the time of his research there was only one maize harvest a year, during my research there were two harvests throughout the year. It is not uncommon to see houses with large trucks parked in front, attesting to the greater economic opportunities afforded by hot country agriculture. Most houses have cement courtyards that provide an area for drying coffee beans and sometimes other crops as well (Figure 2.18). Majosik' in some respects serves as a de facto *cabecera* for hot country Tenejapa. A variety of market and government services are available in Majosik', including a library, a guesthouse and a clinic. In 1990, 35 percent of houses did not have piped-in water, None of the houses had indoor plumbing and 3 percent did not have electricity (INEGI 1991).

Figure 2.18: Courtyard in Majosik'

CHAPTER 3

RESEARCH DESIGN, METHODOLOGY AND TECHNIQUES

FIELD STAYS AND SPONSORSHIP

While this research in many ways began in 1996 with my first field visit to the Highlands, the major portion of this research was conducted during most of the year 1999. Prior to this time, I spent three previous summers in Chiapas conducting preliminary research and language training. During all of my field visits I received a great deal of assistance from El Colegio de la Frontera Sur (ECOSUR), a Mexican federally sponsored graduate teaching and research center.

My first entry into the municipality of Tenejapa took place in the summer of 1997 where I undertook a pilot study of the reported ethnoecological distribution of medicinal plants with funding from the National Science Foundation Ethnographic Research Training Grant (Stepp 1998). During this time I was fortunate to become acquainted with Antonio Girón Ramírez from the paraje Ch'ixaltontik, who collaborated with me and introduced me to Tzeltal Maya medical ethnobotany. Antonio's assistance allowed me to rapidly gain a working familiarity with the most utilized medicinal flora of Tenejapa, a knowledge that later proved invaluable in making botanical determinations of specimens that were often sterile, lacking fruit or flowering parts that aid in identification. The botanical determinations referred to in this dissertation were made either by myself (JRS) and confirmed by Carmelino Sántis Ruíz (CSR) of the ECOSUR herbarium in San

Cristóbal de las Casas, Chiapas (ECO-SC-CH). In some instances CSR made the primary determinations which I then cross-checked with a comparative collection of medicinal flora housed at ECO-SC-CH.

I returned the following summer in 1998 and began to venture further afield from the municipal center and gained a real appreciation for the diversity of Tenejapa. At this point I realized that any detailed study of Tzeltal Maya medical ethnobotany would require serious consideration of ecological variability and the affordances (Gibson 1979, for a full discussion see Chapter 1) and constraints that this variability presents on daily healing practices.

In 1999, I initiated an almost year long stay in the Highlands with the financial support of a Robert Borens NSEP fellowship for the first part of the year which was followed by an EPA-STAR fellowship that provided generous assistance with the remaining fieldwork and the subsequent write-up.

RESEARCH DESIGN, METHODOLOGY AND TECHNIQUES

This study is based primarily on ethnographic research involving extended fieldwork (in this case a total of approximately 15 months over a period of 4 years) and direct interaction and observation. Multiple methods, both quantitative and qualitative, were utilized and are elaborated on below. The research design is systematic as opposed to interpretive and for the most part involves an explanatory (hypothesis testing) approach. "Explanatory approaches generally involve testing elements of theory that may already have been proposed in the literature or that have been informed by exploratory research. Research designs in this mode are determined *a priori* and their primary purpose is to eliminate threats to validity, where validity is concerned with whether things are what they appear to be or are the best approximation to the truth. In this enterprise, explanation can involve a general search for causality or prediction (Johnson 1998:139)."

The research consisted of a primary study that tracked medicinal plant use for 208 individuals in six communities in Tenejapa, along with other complementary studies involving various aspects of ethnoecological knowledge and use of medicinal plants. The specific methodologies for these complementary studies are addressed in those chapters where the study is fully explained. In this chapter I address the more general methodological aspects of the overall research, along with the specific research techniques used in the primary study.

Finding a Principal Collaborator

Prior to initiating the main research in Tenejapa I took part in a series of workshops, held at ECOSUR and led by Brent Berlin and Elois Ann Berlin, to train Highland Maya collaborators in various aspects of linguistic, ethnobotanical, ecological, and anthropological research (Figure 3.1). One of the participants in these workshops was Alonso Mesa Guzmán (hereafter AMG), who was to become my principal collaborator (Figure 3.2). AMG was born in the paraje of Nabil, Tenejapa but had long since moved into the municipal center. He was working as a taxi driver prior to this research. However, he had previous experience in field research: in the summer of 1998 he worked with anthropologist David Casagrande on a ethnobotanical survey of the primary forest in the hills of Matzab in Tenejapa. AMG proved to be an adept parataxonomist and an astute observer of the biophysical environment and his own culture. Together we worked out a protocol for research in Tenejapa that was culturally sensitive and ensured not only prior informed consent but also ensured that communities that participated did so in a grassroots democratic process of agreement.

Figure 3.1: Training workshop for Tzeltal and Tzotzil collaborators (left to right: Juan Gómez Gómez, municipality of Chamula; the author; Amalia Girón Meza, municipality of Tenejepa; Manuel Díaz Hernández, municipalaity of Larráinzar)

Figure 3.2: Alonso Meza Guzmán interviewing a healer in the paraje of Iwiltik, municipality of Cancuc

Prior Informed Consent Procedures

The process of prior informed consent (PIC) is crucial in all research involving human participants. It is also a process fraught with difficulty for a variety of reasons. Chief among them are defining what it means to give informed consent and determining at which levels it is necessary to obtain consent and from whom. Federally funded research institutions in the U.S. now mandate that an institutional review board or human “subjects” committee approves all research that involves humans. While in principle this should provide a mechanism to ensure proper procedures for PIC, the purpose for such oversight is primarily to shield the research institution from legal responsibility for unethical research. While well-intentioned individuals make up such boards, standards and definitions of PIC vary widely and are often unsatisfactory within the context of anthropological research. Ultimately, the responsibility lies with the researcher to ensure that the well being of the people participating in the study takes precedence over any other concerns.

I outline below the steps that I took in this research to obtain PIC. The first step in the process was to obtain written permission from the municipal authorities to conduct research in the municipality. A presentation of the research to be carried out was made to the municipal president at his home in Tenejapa center. The president provided us with a letter of agreement which granted us permission to conduct research in the municipality at large. In actuality, this letter only gave us permission to *ask permission* because it was at the community level were real consent was obtained. Individual communities have a great deal of autonomy in controlling who conducts research within their boundaries and are in no way bound to permit research simply because an investigator has permission at the municipality level.

At the community level the permission process varied slightly from community to community. After identifying potential communities where I wanted to work (based on criteria explained in Chapter 2) AMG and I would visit the community. This was usually done in the late afternoon when we were most likely to find community authorities at home, having often just returned from working in their milpas or coffee groves. I would ask around and find a *comité* (literally "committee" but in the Spanish spoken by the Highland Maya in Chiapas it also refers to the head of the committee; oftentimes the various committees would consist of but a single individual). *Comités* in Highland Maya communities serve a variety of political and cultural functions. There are committees devoted to education, health, municipal relations, agriculture, cargoes, etc. Committees can be formed *ad hoc* depending on the needs of the community.

After identifying a committee member, I would describe the project in some detail and AMG would translate in Tzeltal. I would ask when we could meet with the entire assembly of *comités* to further explain the project. Sometimes the *comité* would tell us to come back (a matter of asking permission to ask permission) or we would be given a date and time where we could make our case before the *comités*.

At this next meeting I would fully describe the project (in Spanish, with AMG providing a translation into Tzeltal) explaining our goals, how the knowledge obtained would be utilized, how the participants would be compensated and that the community could at any time terminate our presence. This process of explanation often went on for more than an hour as the *comites* were keen to ask questions in order to understand the project fully. Because so much anthropological fieldwork has been conducted in Tenejapa, people are generally knowledgeable about the nature of anthropological fieldwork and dissertation research. Also ECOSUR has had several projects in Tenejapa that were well received and so many Tenejapans are familiar with the institution.

At this point, if approval were obtained we would then be invited to present the project once again at a full assembly of the community. These *asembleas generales*, despite the somewhat marginalized position afforded to women at them, are highly democratic and consensus oriented. While the process seems somewhat straightforward, if not a little laborious, there were sometimes additional steps needed before the full community was presented with the project. Like much of fieldwork there was a lot of waiting around to talk to this person or that which added to the overall time required to obtain permission in all six communities. In all I spent eight weeks working almost every day to obtain consent to work in the communities.

Research Techniques

Once permission was granted by the community, I began the process of identifying households within the community that would be asked to participate in the project. In each community I selected five households. A baseline interview was conducted with each household where once again the research was explained in the same manner and detail as the earlier presentations to the general assembly. I asked that all of the household members participate and basic census data was recorded at this time. A total of 208 individuals participated in the use recall interviews, which are described in detail below. Participants were provided a rudimentary plant press and asked to collect and press a voucher specimen of every plant used to treat illnesses that occurred in the period between my visits. They were also told that if no illnesses occurred in the household in a given period then that was of interest as well. They were also asked to make a mental note about various ecological aspects about where the plant was obtained (habitat, soil type, abundance of plant) and the amount of time required to find the plant. Subsequent visits to the household involved a semi-structured interview process where informants were asked about all of the illness they treated in the week prior and the plants used to treat them.

A variety of use, management, selection, time allocation and ecological data were provided through these interviews. The following questions were asked in Tzeltal (but I provide below the English translations as well):

1) *¿sbil chamel*?

What is the name of the illness?

2) *¿sbil te mach'a ay yich'o chamel?*

What is the name of the person with the illness?

3) *¿Binti poxilil la sle?*

How was the illness treated? While this almost always involved medicinal plants, occasionally they would report the use of patent medicines or injections.

4) *¿Binti jejchuk la stuntes be te wamale?*

If medicinal plants were utilized, what part of the plant was used?

5) *¿Te' bal, wamal bal, ak' bal, binti?*

Which of the three major plant life form categories the plant was in (*te'*–tree or woody shrub, *wamal*–herbaceous plant, *ak'*–grass)?

6) *¿yip?*

What was the strength of the plant utilized?

7) *¿ay bal yorail te bit'il k'alal ay yip te wamale?*

Is there a particular hour or season during which the plant was more effective?

8) *¿ay bal yawil ya xch'i te wamal te k'alal ay yipe?*

Is there a particular place to collect the plant where the plant would be more effective?

9) *¿te ' nax bal la yich' tael ta comunidad te wamale?*

Did you find the plant in the same community that you live in? If not, where?

10) *¿jayeb ora ya xbeben ta sleel te wamal te banti ay snae?*

How long did it take you to find this plant walking from your house?

11) *¿ay bal yorail te k'alal ya yich' leele?*

Are there special conditions to gather or harvest this plant?

12) *¿banti ya x'chi? (ak'beya yejtal te banti ya xch'i te wamale)*
*k'altik*___ *k'ajbenal*____ *wank'altik*___ *unin k'inal*____
*k'inal*_____*te'tikil*____*tojol k'inal*____*ja'mal*_______*pat na*_____
*kajpetal*_____ *akil*_____ *ts'unbil*____*otro* ____________
What habitat did you find the plant in?

13) *¿binti sbil lumilal banti ya xch'i?*

What type of soil did it grow in?

13) *jich yipal (+++++ ya sk'an yal lom toyol, + ya sk'an yal lom alan)*

How abundant is the plant (on a scale of 1-5)?

The voucher specimen collected by household members served as a prompt for the interview and the use of such visual stimuli followed protocols set out in Whyte (1984), Boster (1987), Johnson and Griffith (1998), and Berlin and Berlin (1996). The protocol established by Berlin and Berlin was of particular importance for my study.

They developed what they referred to as an *hebario viajero* or 'traveling herbarium' that consisted of dried herbarium vouchers with the labels removed of the 203 most common medicinal plants as determined in their long-term studies on Highland Maya medical ethnobotany (Berlin and Berlin 1996:81-2). This enabled them to collect a wide range of ethnomedical and ethnoliguistic data throughout the Highlands. The success of this methodology influenced me to use a similar protocol in the primary study. In one of the secondary studies that I discuss in Chapters 4 and 6, I recollected most of the same species used in the Berlin and Berlin travelling herbarium in order to elicit data regarding the ecological distribution of the 203 most common medicinal plants.

The voucher specimen collected by informants, while often sterile, was usually easy to determine. Because of Alonso's good working knowledge of the common flora of Tenejapa, of which a substantial subset is the medicinal flora, and my rapidly growing familiarity with the most utilized medicinal flora, we were usually able to provide botanical determinations of plants that were similar in appearance when sterile. On the rare occasion when we were unable to make a determination based on a voucher collected by a participant, we would seek out the actual location where the plant was collected and try to make another collection for determination. If this still proved unsuccessful we noted the plant population with GIS coordinates and attempted to return to collect a fertile specimen. In many cases I had already collected a fertile specimen in preparation for the ecological distribution study described in Chapters 4 and 6. While collection of sterile specimens is usually to be avoided, it was necessary in a study such as this one. Moreover previous research in Tenejapa and the Highlands on medical ethnobotany by

Berlin and Berlin had resulted in over 7000 collections. A reference collection was readily available at the ECOSUR herbarium to cross check our determinations.

Contextualized interviews were also conducted at irregular intervals and involved traveling to the particular ethnoecological zone where the plant was found and discussing salient features of the zone with the informant. This allowed for a control on informant's reports of their behavior versus their actual behavior.

INFORMANT RECALL AND ACCURACY

As noted above, the primary study relied heavily on aided informant recall to collect data. I would like to further discuss this technique because it is important to address questions of accuracy and validity in any empirical undertaking. Wilson (1952) states " A measurement whose accuracy is completely unknown has no use whatever." Informant recall of past events and behavior is a research technique that has been widely utilized in anthropology and the social sciences, although not as much in ethnobotany. While much of the research that has utilized informant recall has done so uncritically, there are some studies that have sought to test the validity of the approach, especially with regards to informant recall of health related activities and behavior. Informant accuracy is of major importance for anthropology as fieldwork often relies heavily on interviews with informants in addition to that most venerable anthropological research technique: participant observation (see Bernard et al., 1984 for a full literature review on informant accuracy). Failure to address these issues leads to less rigorous research.

The results of research that have addressed informant accuracy in recall is, quite frankly, discouraging. For example, Cannell (1977) found that 26 percent of hospitalizations in the United States went unreported in subsequent interviews. If accidents without personal injury occurred 9-12 months prior to the interview then 37 percent went unreported. If more than a year had lapsed after the last doctor visit to treat the condition then 59 percent of chronic conditions went unreported.

Significantly, Cannell found that the time since the event occurred was a major factor in whether a health event went unreported. If illnesses had occurred within the last week then 100 percent were reported. This percentage dropped to 86 percent for a two week time frame and if the illness did not require medical attention or in some way limit the person's behavior then the figure was only 48 percent.

The use of aided recall, where patients were presented with a checklist of possible conditions improves the accuracy of reporting, although it does not eliminate underreporting of conditions. Cannell found that without aided recall, 84% of visits to clinics that had taken place more than 4 months ago were unreported. Aided recall improved this figure to 66%, an improvement to be sure but still a serious source of error.

Gray (1955) looked at sick leave records for federal employees in Great Britain. Of the 228 employees that had taken some time off of work for illness, only 74 correctly reported that they had been absent during the previous 4 and a half months.

What then are the implications of these earlier studies for this research? It appears that decay of memory is very much a function of time (Sudman and Bradburn 1973). Obviously then, the more frequent that interviews take place, the better. For this reason, every attempt was made to contact participants in the study weekly, although at times practical field concerns made this impossible, in which case a two-week period lapsed.

Another way to improve informant accuracy is through aided recall. Visual stimuli have often been utilized in ethnobiological studies as a way of prompting informants and ensuring that the taxon being discussed is the same one that the researcher thinks it is (e.g. Boster, 1987; Berlin and Berlin 1996). Within ethnobotany the use of herbarium vouchers as a basis for interviewing is quite common, although the way they were utilized in this study is perhaps novel. By having informants collect voucher specimens every time they collected a plant for a treatment, a prompt was readily available to jog the memory of the informant during the interview. Rather than have to remember all illness events that occurred since the previous interview, an informant simply had to work through a stack of dried plant specimens they had collected in order to recount their illnesses and treatments, along with other information that was collected during the interviews. While I would not claim that this technique allowed for 100 percent accuracy in reporting, it does allow for a high degree of confidence that underreporting of illness and treatment was kept to a bare minimum.

COMPARISON OF STANDARD ETHNOBOTANICAL METHODS WITH THE METHODS USED IN THIS STUDY

Within ethnobotany, systematic studies of actual plant use as opposed to contextualized interviews on plant use are uncommon because of time and methodological constraints that they impose. To my knowledge, this is the first systematic study to look at *actual* medicinal plant use by a traditional culture over a period of time.

This section then presents a comparison between what I will term a traditional ethnobotanical methodology, and the one used in this study. It is hoped that the strengths and weakness of both approaches can be illuminated in the interest of developing appropriate research design in ethnobotany that takes into account the specific contexts in which the research is being conducted.

Standard ethnobotanical collection procedures usually involve walking along transects (random or otherwise) with knowledgeable informants and collecting all voucher specimens of fertile plants encountered of ethnobotanical significance. At the time of collection a variety of ethnobotanical and ecological information is recorded along with the specimen. Table 3.1 compares the types of data collected with the two methodologies.

TABLE 3.1: A comparison of types of data collected between the two approaches

TYPES OF DATA COLLECTED	USE RECALL	STANDARD
Medicinal plant species and their uses	Yes	Yes
Frequency of use	Yes	No
Admixtures/formulary	Yes	Usually requires follow-up interview
Seasonal variability in use	Yes	No
Actual medical use/ epidemiology	Yes	No
Field observation of efficacy	Yes	No
Ecological variation in use	Yes	No

With the use recall methodology it becomes possible to collect a broad range of additional data that come from knowing the actual frequency of use. For example, seasonal variability in the use of a plant; field observation of efficacy of the plant on the person using it; ecological variation in the use of a plant (e.g. which ethnoecological zones people were obtaining plants from, differences in use strategies depending on altitudinal gradient); other plants that are used in combination with the main plant.

Despite these advantages a use recall methodology is best seen as a secondary methodology to be used only after a standard ethnobotanical inventory has been conducted. Table 3.2 notes some of the methodological and practical concerns with the two methodologies and demonstrates potential weakness in the use recall methodology.

TABLE 3.2: Methodological and practical concerns with the two methodologies

METHODOLOGICAL AND PRACTICAL CONCERNS	USE RECALL	STANDARD
Collection of plants with low cultural saliency	Unlikely	More likely
Quality of voucher specimens	Potentially Low	High
Number of species collected	Low	High
Time expenditure in relation to data collected	High	Low
Appropriateness of utilization in research	Secondary	Primary

A use recall methodology does perhaps make it less likely that plants with low cultural saliency will be collected, while in the standard methodology if a person recognizes a medicinal plant, even if its saliency is low, it will be collected. This means that, on average and over a similar period of time, many more species will be noted in a standard methodology than in the use recall methodology. Also, the standard methodology provides superior vouchers since only fertile specimens are collected. The use recall methodology usually requires subsequent and time-consuming recollection in order to have a fertile specimen. On the other hand, supplemental voucher material that demonstrates the plant part actually utilized such as roots and bark is easily obtained with the use recall approach since the treatment had been recently prepared. Field collection of supplementary voucher material with the standard approach is a little more difficult and usually not practical at the time of initial collection.

Perhaps the biggest concern with the use recall approach is that it is time intensive. Sometimes a visit to a household would yield no ethnobotanical data because no one fell ill during the time period. However, the unfortunate truth is that this is not all that common in Highland Chiapas. People are often ill for a variety of reasons, chief among them are lack of potable water, poor sanitation and malnutrition. In fact, this type of approach is only possible in a setting like Highland Chiapas with widespread health problems where plants are regularly utilized.

Obviously the use recall methodology is not appropriate for initial ethnobotanical research. However as a secondary or subsequent methodology it can complement a standard approach. Both approaches should be utilized to develop a full understanding of a socio-linguistic group's medicinal plant knowledge and utilization. It comes down to a matter of breadth versus depth.

CHAPTER 4

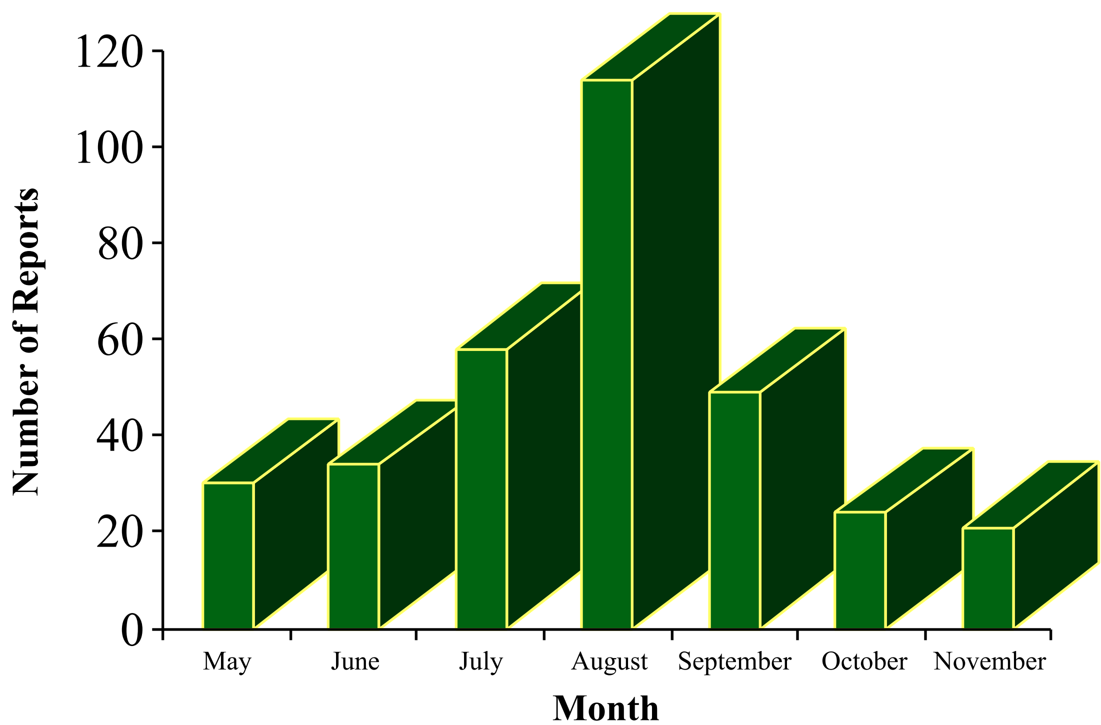
USE, PROCUREMENT AND ECOLOGICAL DISTRIBUTION OF MEDICINAL PLANTS

ILLNESS IN TENEJAPA

One of the most striking, unfortunate and sad aspects of life in Tenejapa is the tremendous amount of illness that occurs. During this study it was uncommon to visit a household and find that someone had not experienced some form of illness in the previous week. On average, households were free of illness for only four weeks out of the 28 weeks during which the main study took place. This was always a welcome event and allowed for interviews regarding why everyone in the household had remained healthy since my previous visit. This was usually attributed to good fortune and people did not articulate reasons beyond this. The types of illnesses encountered in Tenejapa are familiar to anyone who has worked in marginalized tropical communities. The most common illnesses are gastrointestinal diseases (including general diarrhea, bloody and mucoid diarrhea, abdominal pain, epigastric pain, and intestinal parasites) and respiratory diseases (coughs, chronic cough such as croup, tuberculosis, inflammations of the nose, ears, and throat) (cf. Berlin and Berlin 1996). These two categories accounted for 87 percent of illnesses. Fever, eye infections, and mouth infections accounted for another 10 percent. The remaining 3 percent of illnesses involved skin infections, headaches, breaks and sprains, injuries from accidents and violence, teeth and mouth infections, mental illness, snakebites and illnesses with supernatural etiologies. Despite an inordinate amount of attention paid by researchers in Chiapas (e.g. Fabrega and Silver 1973, Holland 1963) to the treatment of illnesses with supernatural etiologies, there were only five reported during the study. It is possible that this category was underreported due to the sensitive nature since witchcraft and evil spirits are the usual causes. However, it is very clear that the vast majority of illnesses in Tenejapa are naturalistic in etiology (cf. Foster 1976), empirically diagnosed and at least initially, self treated. Only two visits to specialized healers occurred among the 208 individuals in the study. This was to treat the aforementioned illnesses with personalistic etiologies. Despite fairly widespread access to clinics, there were only three visits made by the study population. These were treated in all three instances with modern pharmaceuticals.

Illness in Tenejapa does not occur with equal distribution throughout the year but appears to be influenced by the shift in seasons. Illness increased during the month of July and peaked in August (Figure 4.1). This coincides with the start of the rainy season at the end of June/beginning of July. One possible explanation may be that there is increased contamination of the water supply at the onset of the rainy season. Sewage and septic system are virtually non-existent in Tenejapa outside of Tenejapa center. The most common place to defecate is in the milpa fields. During the dry season fecal matter stays relatively isolated in the milpa but with the onset of the rains it is flushed into the water supply and across the landscape. People may become exposed to gastrointestinal pathogens either by drinking contaminated water or by walking in contaminated soils and

Figure 4.1: Illness in Tenejapa 1999



being exposed to mud mixed with feces. One of the results of environmental disturbance is the increase of water running across the landscape. In cases where the topsoil is eroded water is less likely to soak into the ground but instead runs over hard clay and limestone surfaces.

An increase in respiratory illnesses may also related to the onset of the rainy season. Especially at higher elevations, the rainy season is marked by cloudy days, cold nights and perpetually damp surroundings. Apart from the general tendency of these environmental conditions to foster respiratory illnesses, people's daily household activities may be contributing as well. Most house complexes have a kitchen area where a lot of time is spent around an open hearth fire with poor ventilation. During cold and rainy periods, people probably spend more time close to the fire and are exposed to more smoke.

PROCUREMENT AND USE OF MEDICINAL PLANTS

For all other cases of illnesses besides the ones reported above that involved clinic visits or visits to specialized healers, people self treated themselves with medicinal plants. In all there were 289 discrete illness cases treated with medicinal plants. 327 plants were used in treatments, comprising 122 species. These species are shown in Table 4.1, which provides the scientific name; the three-letter abbreviation for the plant family based on Weber (1982); the Tenejapa Tzeltal name; and the number of times the plant was utilized. In 63 percent of the treatments only one medicinal plant was used. In 32 percent of the treatments an admixture was made of a medicinal plant with at least one other medicinal plant.

In 5 percent of the treatments three medicinal plants were used together. More than three medicinal plants were never used in an admixture during the study. However, Tzeltal Maya healers who specialize in herbal medicine often add more than three plants together (E.A. Berlin pers. comm.). In 4 percent of the treatments an admixture was made of one medicinal plant with a non-plant substance. The most common was salt, although horse feces was used once and cane liquor (*pox*) was used once.

Table 4.1: Medicinal plants utilized in Tenejapa

Scientific Name	Fam.	Tenejapa Tzeltal Name	Times Used
Abelmoschus moschatus Medik.	MLV	kaxlan tunim	5
Ageratina ligustrina (DC.)	AST	cha' te'	1
Allium sativum L.	ALL	axux	1
Aloe vera (L.) Burm. f.	LIL	sabila	3
Ambrosia cumanensis Kunth	AST	altamixa	5
Apium leptophyllum (DC.) F. Muell. Arg. ex Benth.	API	kulantu chitam	1
Artemisia absinthium L.	AST	ajeno	6
Baccharis confertoides Nesom	AST	mes te'	13
Baccharis trinervis (Lam.) Pers.	AST	sakil xijch wamal	4
Begonia heracleifolia Schltdl. & Cham.	BEG	majben wamal	2
Bidens pilosa L.	AST	majtas	1
Boehmeria ulmifolia Wedd.	URT	poxil tsa'nel	1
Borreria laevis (Lam.) Griseb.	RUB	buluk' sit wamal	3
Botrychium decompositum Mart. & Gol.	OPH	tsajal akan tsib	2
Bougainvillea glabra Choisy	NYC	bugambilla	2
Bouvardia leiantha Benth.	RUB	tsajal nich wamal	4
Brugmansia candida Pers.	SOL	kampana nichim	3
Bryophyllum pinnatum (Lam) Kurz	CRA	poxil majben	1
Buddleia crotonoides A. Gray	LOG	bak te'	2
Bunchosia lanceolata Turcz.	MLP	sak ji'te	1
Byrsonima crassifolia (L.) H.B.K.	MLP	lancin	3
Canavalia ensiformis (L.) DC.	FAB	sakil chenek'	2
Castilleja arvensis C. & S.	SCR	tzajal nich wamal	1
Cestrum noctrum L.	SOL	ch'opak te'	1
Chenopodium ambrosioides L.	CHN	kajk'an	1
Cissampelos pareira L.	MEN	chin ak'	9
Citrus limetta Risso	RUT	elomonex	3
Citrus limonia Osbeck	RUT	lima	2
Citrus sinensis (L.) Osbeck	RUT	alchax	3
Clethra suaveolens Turcz.	CLE	k'ak'et te'	1
Cuphea aequipetala Cav.	LYT	tsajal nich wamal	6
Cupressus benthamii Endl.	CUP	nukujpat	5
Cymbopogon citratus (DC.) Stapf	POA	limón ak	3
Drimys granadensis L. f.	WIN	tsajal on te'	1
Equisetum hyemale L.	EQU	tujt	1
Equisetum myriochaetum S. & C.	EQU	tujt	2
Erechtites hieraciifolius (L.) Raf. ex DC.	AST	cha'lam tsots wamal	1
Erigeron karwinskianus (DC.)	AST	sakil nich wamal	4

Eucalyptus globulus Labill.	MRT	kampor	4
Euphorbia hypericifolia L.	EUP	antun wamal	2
Fleischmanniopsis leucocephala (Benth.) King & H. Rob.	AST	sakil chixal nich wamal	1
Foeniculum vulgare L.	API	inojo	10
Gnaphalium purpureum L.	AST	sakil wamal	2
Hamelia patens Jacq.	RUB	tsajal nich wamal	1
Hedychium coronarium Koenig	ZIN	ja'ben	5
Iostephane trilobata Hernsley	AST	poxil me'winik wamal	1
Kearnemalvastrum lacteum (Aiton) Bates	MLV	mal wax wamal	1
Lagascea helianthifolia H.B.K.	AST	jos wamal	1
Lantana camara L.	VRB	ch'il wet	8
Lepidium virginicum L.	BRA	poxil pumel	1
Liquidambar styraciflua L.	HAM	sok te'	1
Litsea glaucescens H.B.K.	LAU	tsiltsil ujch	2
Mangifera indica L.	ANA	manko	1
Matricaria courrantiana DC.	AST	manzanilla	1
Mentha citrata Ehrh.	LAM	wena	5
Mentha spicata L.	LAM	wena	2
Monnina xalapensis H.B.K.	PLG	sts'ots' te'	1
Montanoa leucantha (Lag.) Blake	AST	xakrix te'	1
Musa paradisiaca L.	MUS	manzana lobal	1
Myrica cerifera L.	MYR	ch'aj kolol te'	2
Nama dichotomum (R. & P.) Choisy	HYD	sansira ak'	2
Nemastylis silvestris Loes.	IRI	pech'ech ak'	1
Nicotiana tabacum L.	SOL	bankilal	3
Ocimum selloi Benth.	LAM	san miguel wamal	1
Oenothera rosea L'Her. ex Aiton	ONA	tsajal nich wamal	6
Opuntia sp.	CAC	pejtak	1
Passiflora edulis Sims.	PAS	karanato	1
Persea americana Mill.	LAU	bak' on	1
Petiveria alliacea L.	PHT	pay te'	1
Phenax mexicanus Wedd.	URT	tsots wamal	1
Phyllanthus lathyroides H.B.K.	EUP	poxil xiwel wamal	1
Pinaropappus spathulatus var. *chiapensis* McVaugh	AST	tsis kojtom wamal	1
Plantago major L.	PLA	poxil bejts'em	1
Pluchea odorata (L.) Cass.	AST	sitit	1
Polygala costaricencis Chodat	PGL	poxil ea'l	1
Polygala floribunda Benth.	PGL	ch'opak te'	2
Polygala paniculata L.	PGL	poxil eal wamal	1
Priva aspera H.B.K.	VRB	jolom ik' wamal	1
Prunus persica (L.) Batsch	ROS	turesna	7
Prunus serotina Ehrh.	ROS	chichoj te'	1

Psidium guajava L.	MRT	pataj	2
Psidium guineense Sw.	MRT	pajchak'	5
Rapanea juergensenii Mez	MRS	xyax te'	1
Ricinus communis L.	EUP	ch'opak te'	1
Rumex crispus L.	PLG	yak' tsi' wamal	1
Rumex obtusifolius L.	PLG	yak' ts'i' wamal	1
Salmea scandens (L.) DC.	AST	ijk'al wamal	2
Salvia cacaliaefolia Benth.	LAM	jolom ik' wamal	1
Salvia cinnabarina M. & G.	LAM	sabal ts'unun	1
Salvia lavanduloides H.B.K.	LAM	ch'abakal	15
Sambucus mexicana C. Presl ex DC.	CAP	chijil te'	1
Sanicula liberta C. & S.	API	yax wamal	1
Smallanthus maculatus (Cav.) H. Robinson	AST	balan k'in	6
Solanum americanum Miller	SOL	moen	1
Solanum lanceifolium Jacq.	SOL	tujkulum ch'ix	4
Stevia ovata Willd.	AST	ch'aal wamal	1
Struthanthus quercicola (C. & S.) Naud.	LOR	yijkats te'	1
Symplocos breedlovei Lundell	SYM	pay te'	6
Taraxacum officinale Webb.	AST	lantsin pox	1
Tithonia diversifolia (Hemsl.) A. Gray	AST	ch'ajkil	12
Trichilia havanensis Jacq.	MEL	xenel pox wamal	1
undetermined #1	?	poxil obal	2
undetermined #2	?	poxil tsa'nel	2
undetermined #3	?	wale' pox	1
undetermined #4	?	tsa'tuluk' te'	1
undetermined #5	?	xyax k'an te'	1
undetermined #6	?	ch'oliw	1
undetermined #7	?	yax ak'	1
undetermined #8	?	ch'ix k'an te'	1
undetermined Asteraceae #1	AST	tsajal nich wamal	2
undetermined Asteraceae #2	AST	sak tan wamal	1
undetermined Asteraceae#3	AST	sakil nich wamal	2
undetermined Orchidaceae #1	ORC	ts'irin wamal	2
Valeriana scandens L.	VAL	alambre ch'ox	1
Verbena carolina L.	VRB	sakil yakan k'ulub wamal	6
Verbena litoralis H.B.K.	VRB	yakan k'ulub wamal	33
Vernonia leiocarpa DC.	AST	bak te' wamal	1
Vernonia patens H.B.K.	AST	sitit	1
Viburnum hartwegii Benth.	CPR	tsop te'	1
Vitis bourgaeana Planchon	VIT	ts'usub	1
Zanthosylum foliolosum J.D. Smith	RUB	elomonex	1
Zea mays L.	POA	ixim	1

Parts of Plants Utilized

The Tzeltal Maya do not generally use dried medicinal plant material but instead gather fresh material as needed. The Tzeltal have an in-depth understanding of plant morphology and recognize at least 116 distinct plant parts (Berlin, Breedlove and Raven 1974). The most important plant parts utilized for medicinal purposes are *y'abenal* (leaves),accounting for 74 percent of uses. This is followed by *y'isim* (roots) which accounts for 5 percent of uses. The remaining 20 percent is accounted by the following parts in order of importance: *sni'* (tip of plant leaves or flowers), *sit* (fruit), *ste'el* (stems), *ye'tal* (bulb or tubers), *spat* (tough non-leathery bark), *snich* (flowers), *sbak'* (seeds), *ya'lel* (juice of fruit).

Medicinal Plants and Life Forms

The Tzeltal Maya recognize four major life form taxa: *te'* (trees and shrubs), *ak'* (vines), *ak* (grasses), *wamal* (herbaceous non-woody plants). The most significant category that medicinal plants utilized in the study were placed in was *wamal* accounting for 63 percent. The next category was *te'* accounting for 25 percent. This category was subdivided into *ch'in te'* (small tree or shrub) 43 percent of the time. The last category was *ak'*, representing 4 percent of medicinal plants utilized. There was no use reported of plants in the *ak* (grass) taxon.

Reported Strength of Medicinal Plants

In order to describe the strength or efficacy of a medicinal plant, the term *yip* (lit. strength) is employed. A relative scale of one to five (one lowest, five highest) was used in interviews to elicit *yip*. The usefulness of this question frame is debatable. On one hand, medicinal plants are always considered to have some amount of *yip*, or they would not be used. The translation of the term is context dependent. While it appears that *yip* does relate to efficacy, it is polysemous and can also refer to a strong taste or pungency. Thus, a plant could be relatively ineffective in treating an illness but by virtue of its strong effects on the senses, still be considered to have high *yip*. The average *yip* of the medicinal plants was 4.18 for plants used as primary treatments; 4.32 for plants used as secondary treatments in admixtures; and 3.90 for plants used as tertiary treatments in admixtures. There does not appear to be a pattern regarding a particular species as high or low *yip*. All of the plants that received a low (one or two) *yip* score by a particular informant were also considered to be high *yip* (four or five) by at least one other informant on at least one other occasion.

Medicinal Plants and Soil Types

While the Highland Maya have a refined soil taxonomy based on color, texture and organic content (Cervantes 1997) and employ it in agricultural activities, it appears to be little utilized in the procurement of medicinal plants. The response 99 percent of the time when questioned about what kind of soil a particular medicinal plant grew in was *ijk'al lumilal* (black soil). In two instances participants replied *tsajal lumilal* (red soil).

Reported Abundance of Medicinal Plants

A relative scale of one to five (one lowest, five highest) was used in interviews to elicit the abundance of a plant when it was collected. Participants were asked to estimate the relative abundance of the plant resource in general, not just in the specific location where it was collected. The average abundance was 4.11 for plants used as primary treatments; 4.08 for plants used as secondary treatments in admixtures; and 3.89 for plants used as tertiary treatments in admixtures. This question frame was useful in identifying plants with low reported abundance. The following plants had a high degree of consensus as to their low (score of one or two) relative abundance: *Abelmoschus moschatus*, *Ambrosia cumanensis*, *Botrychium decompositum*, *Hedychium coronarium*, *Castilleja arvensis Liquidambar styraciflua*.

Seasonality and Time of Collection

There is abundant literature in biochemical ecology noting that secondary defense compounds are not distributed evenly in a given species or in a given population but are subject to a wide range of fluctuation depending on genetic variability, location, resource availability, seasonality, and time of day (Harborne 1993). These last two factors are responsible for tremendous variation even in the same plant. For example, a study of the content and composition of alkaloids in hemlock (*Conium maculatum*) found that at certain times of the day alkaloids were non-existent, while at other times of the day their levels reached levels that would be highly toxic to a person who consumed the plant (Fairbairn and Suwal 1961). They also noted variation in composition and content of alkaloids based on seasonality (wet season versus dry season). This has major implications for medical ethnobotany if these findings are generalizable to other medicinal plants. Curious to find out if the Tzeltal had discovered that the bioactivity of medicinal plants fluctuated I asked if for a given plant, there was a time of day or night, or particular season where the plant was more or less effective at healing. None of the participants responded affirmatively to this question. This does not conclusively rule out that the Tzeltal can identify fluctuations in plant biochemistry but it does suggest that if they do, it is for a limited subset of medicinal plants and that the knowledge is not widespread.

Time Allocation

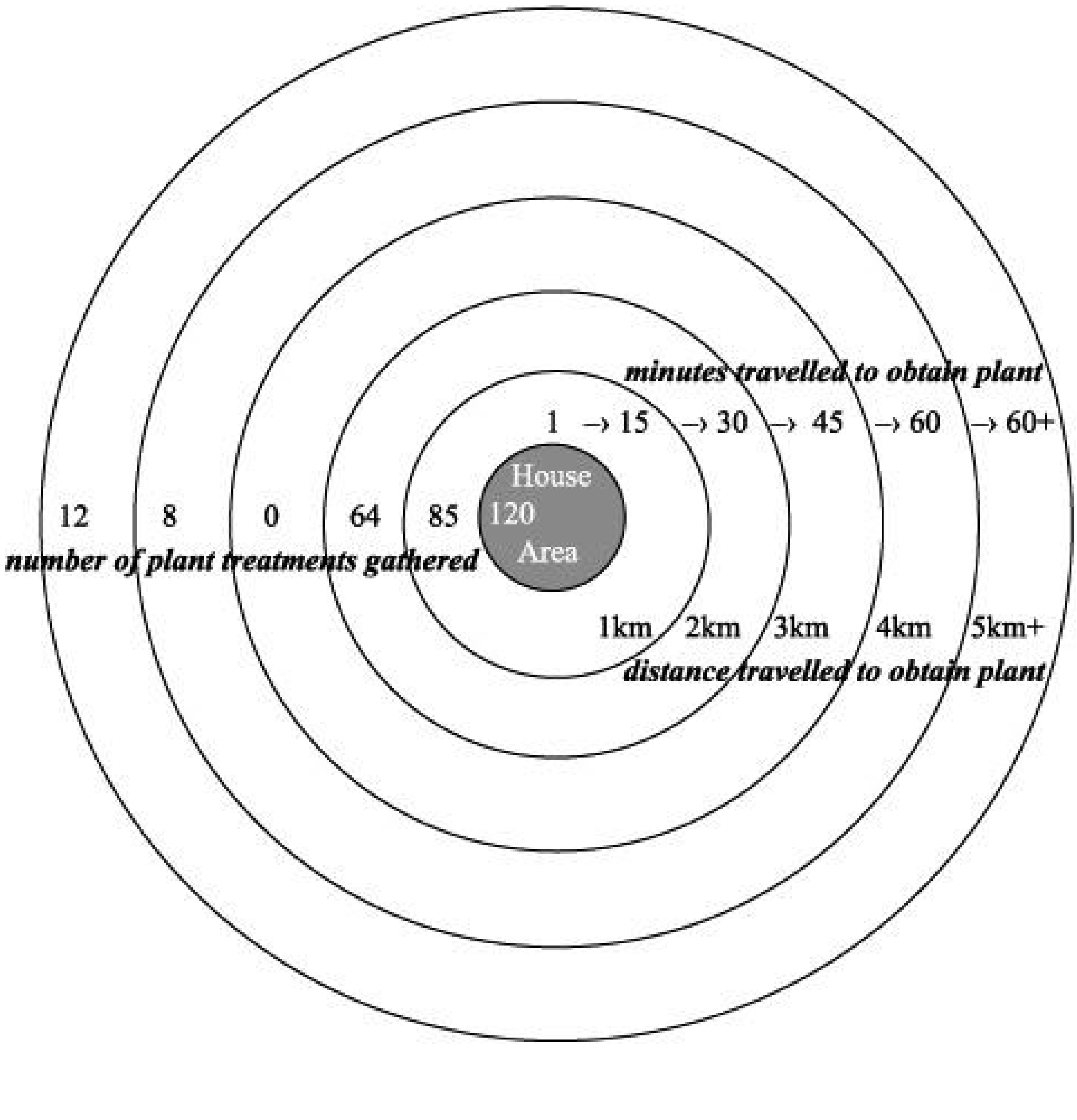
For each medicinal plant treatment, participants were asked how long it took (one way) to gather the plant when walking from their household. This time data was then correlated with distance traveled by estimating the amount of time one can walk in an hour across the hilly terrain of Tenejapa. I did this by taking GPS measurements whenever I walked for a long distance with participants. I found that, on average, people walk 4 km an hour. Thus 15 minutes corresponds to one km, 30 minutes to two km, etc.

The average amount of time spent to find a specific plant for a treatment was 16 minutes (Figure 4.2). A one km radius accounted for 71 percent of all medicinal plant procurement. 93 percent of medicinal plant procurement was conducted within a 2-km radius around each household On very rare occasions people traveled to other communities to obtain medicinal plants. The most time spent procuring a medicinal plant was six hours.

This time was spent to obtain *Equisetum myriochaetum*, a plant that only grows in marshy areas, an uncommon habitat in Tenejapa. Other instances where someone spent more than an hour procuring a plant involved travelling to areas at lower or higher elevations to find a particular plant. Thus it appears that the ‘living pharmacy’ of the

Tzeltal lies in the 2 km vicinity of the community. There was no purchasing of medicinal plants at markets, either in Tenejapa or at the regional markets of San Cristóbal.

Figure 4.2: Time and distance traveled to obtain medicinal plant treatments



Medicinal Plant Habitats

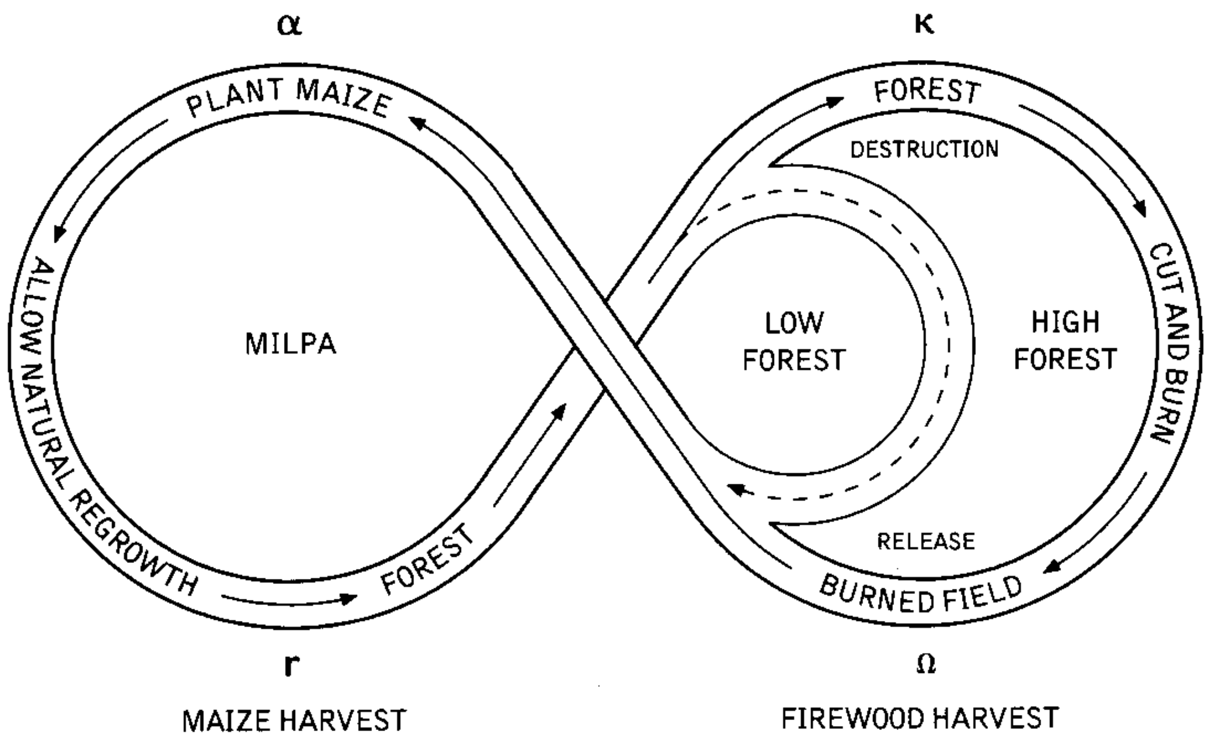
The Tzeltal Maya like many other indigenous and traditional groups, have a detailed understanding of ecological variation and this is exemplified in their ethnoecological classification system (see as examples Martin 1993, Hunn 1990; Meilleur 1986). Recent studies have found that the number of named habitats by indigenous peoples can exceed that of the scientific literature (Shepard 2001, Fleck and Harder 2000).

Perceptions of the biophysical environment *vis a vis* botanical knowledge can be divided into five domains: soils, climates, vegetation types, land use and stages of ecological succession (Martin 1993). It should be noted that this typology does not necessarily correspond to emic ethnoecological classification but it a useful point of departure. I focus here on three domains: climate, stages of ecological succession and land use

. As noted in Chapter 2, the Tzeltal recognize three major ecological zones based on climate and elevation. These are hot country, *k'ixin k'inal* (900m-1500m); temperate country, called *k'ixin htebuk k'inal* or *sikil htebeuk k'inal*, glossed as a somewhat hot country or somewhat cold country (1500m-1800m); and cold country or *sikil k'inal* (1800m-2800m). Despite the lack of a refined term for the transitional temperate zone, the Tzeltal readily recognize this zone and the transitional nature of it.

Within each of these three major zones are a range of habitats. The Tzeltal are astute observers of vegetational succession and this is reflected in the lexicon. I do not wish to give the impression that the Tzeltal have a linear conceptualization of the landscape. Landscape successional processes are considered to be cyclical (Figure 4.3).

Figure 4.3: (after Holling 1992; Alcorn and Toledo 1998)



I will arbitrarily begin this discussion of the landscape cycle at the point at which fields are burned and prepared for milpa agriculture. The sub-cycle of burning, harvest and planting the *k'altik* (milpa) can continue up to three years but this time is lengthening as more and more Tzetal rely on chemical fertilizers that artificially boost the productivity of the milpa fields beyond what is provided through the release of nutrients during burning (Figure 4.4).

After the land is put into a fallow a number of terms are used depending on the amount of time the land has been in fallow and the types of vegetation emerging. The first year of fallow is called *k'ajbenal* (Figure 4.5). This is followed by *wank'altik*, second year fallow. The next two categories overlap. They are *unin k'inal*, which is a three to seven year period secondary growth vegetation and *k'inal* which is the six to twelve year period. (Figure 4.6).

After this period when woody shrubs and small trees emerge the habitat is termed *te'tikil*, which glosses as young secondary forest (Figure 4.7). Sometimes the modifier *ch'in* (small) is applied to particular young *te'tikil*. The structure and composition of *te'tikil* varies with altitude but there is no linguistic distinction made between hot country young secondary forest and cold country secondary forest. *Te'tikil* in hot country intermingles with areas of coffee production where *Inga* sp. is planted to shade the coffee plants (Figure 4.8).

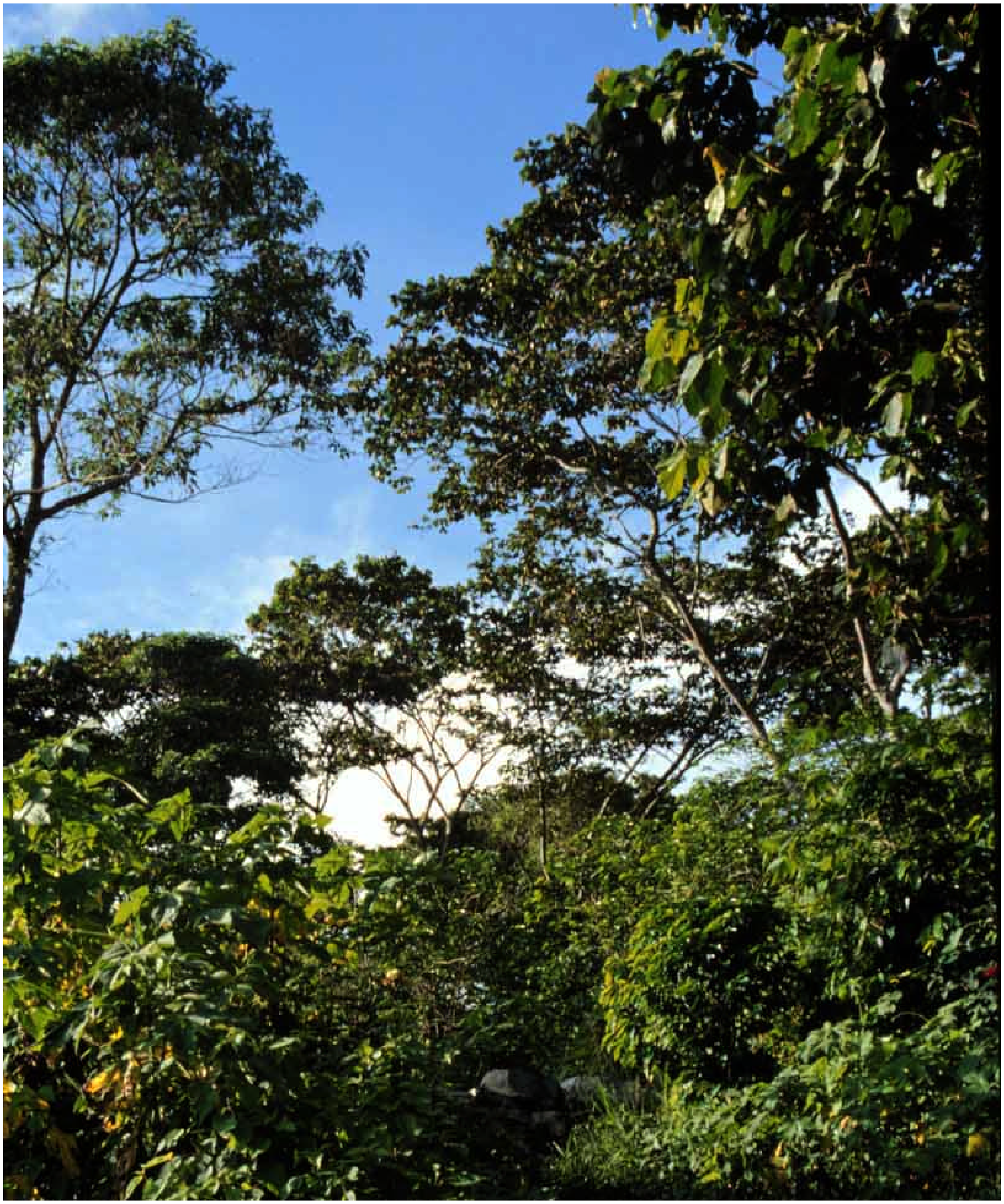
Figure 4.4: First planting of a milpa after a burn (photo by Brent Berlin)

Figure 4.5: First year fallow or *k'ajbenal*

Figure 4.6: 3-7 year (*unin k'inal*) and 6-12 year secondary growth (*k'inal*)

Figure 4.7: Young secondary forest (*te'tikil)*

Figure 4.8: Hot country young secondary forest (*te'tikil*)



After a period of 30-50 years te'tikil turns into *tojol k'inal* (lit. straight land), or old secondary forest (Figure 4.9). Mature or primary forest that has never been cut or not been cut for many generations is called *ja'mal* (Figure 4.10). This habitat is discussed in detail in Chapter 6.

Figure 4.9: Old secondary forest (*tojol k'inal*)

Figure 4.10: Mature forest (*ja'mal*)

The Tzeltal recognize other habitats based on either land use or the dominant vegetation growing in it. These *kajpetal* or coffee grove; *pat na* which sometimes is used to refer to the home garden but generally refers to the immediate area around the household complex; *akil* or grassland (Figure 4.11) and *ts'unbil*, meaning cultivated. This does not refer specifically to a habitat but was utilized in the study to make a distinction between volunteer plants growing in the *pat na* and plants that were intentionally cultivated (Figure 4.12).

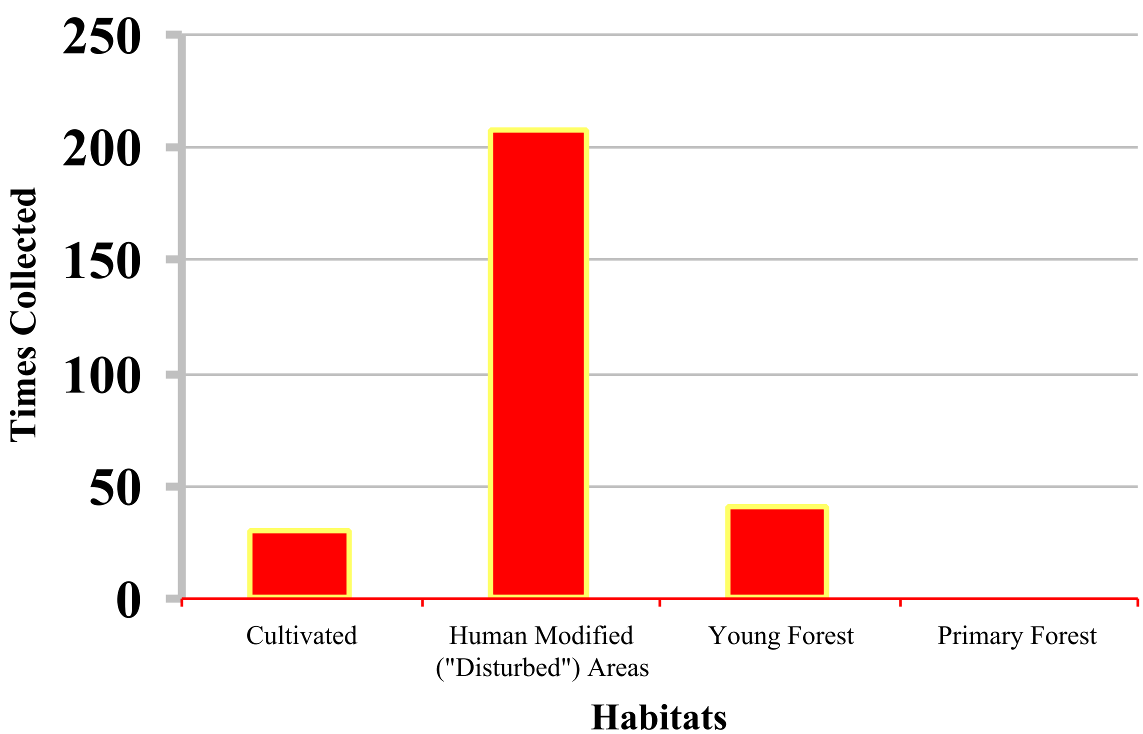
Figure 4.11: Grassland (*akil*)

Figure 4.12: Women and children planting medicinal plants in community of Balum Kanal, Tenejapa (photo by Paul Duncan)

Procurement of Medicinal Plants

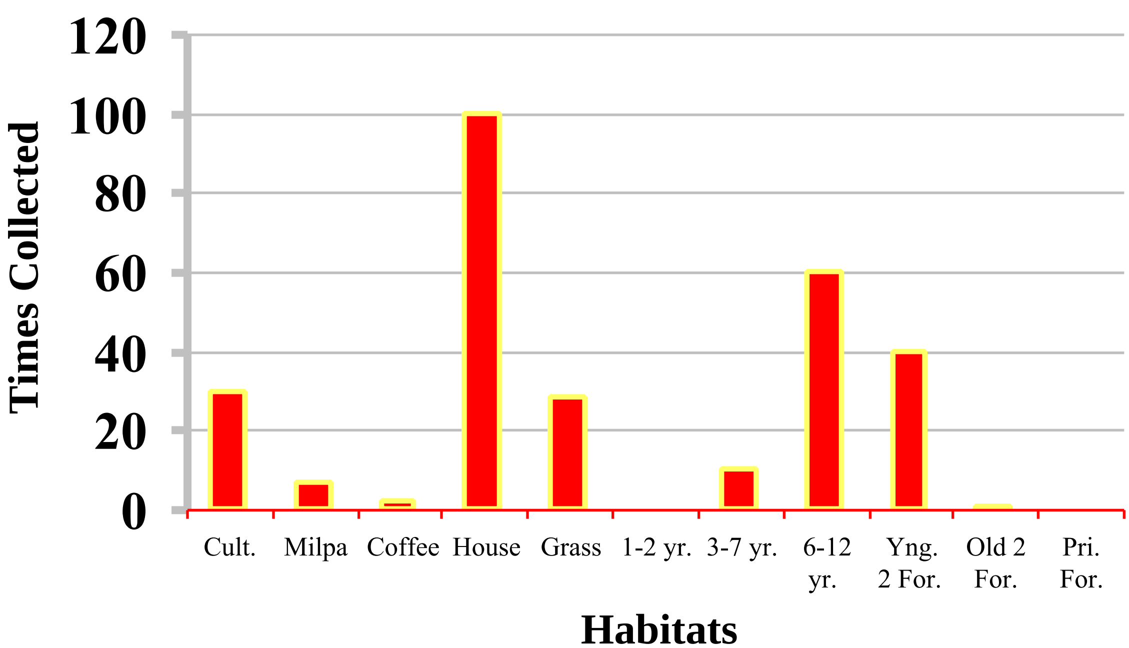
Medicinal plants were obtained from a wide variety of habitats but there are very clear patterns present. If the various managed areas and early successional stages are aggregated together, this accounts for where 86 percent of medicinal plants were collected (Figure 4.13). Only 14 percent of plants were collected in young secondary forest. There was only one collection of a medicinal plant in old secondary forest no collection of medicinal plants in mature forest during the study.

Figure 4.13: Procurement of medicinal plants in aggregate habitat categories



If these categories are disaggregated even more patterns emerge (Figure 4.14). The single most significant habitat to obtain medicinal plants in *pat na*, the immediate household area. This accounted for 35 percent of all collections. The next most important habitats were *k'inal*, where 21 percent of medicinal plants were collected, and *te'tikil*, where 14 percent were collected. *Akil* (grasslands) accounts for 10 percent of collections while another 10 percent of plants came from cultivation. The Tzeltal do not systematically practice medicinal plant cultivation but there are a few species that are regularly cultivated.

Figure 4.14: Procurement of medicinal plants in disaggregated habitat categories



The cultivated plants used during the study were *Abelmoschus moschatus*, *Allium sativum*, *Aloe vera*, *Ambrosia cumanensis*, *Artemisia absinthium*, *Brugmansia candida*., *Citrus limetta*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Musa paradisiaca*, *Nemastylis silvestris*, *Nicotiana tabacum*, *Persea americana*, *Sambucus mexicana*, *Taraxacum officinale*, *Trichilia habanensis*. These plant fall into four main categories: old world introductions with a long history of medicinal use (*Allium sativum*, *Aloe vera*, *Artemisia absinthium*, *Eucalyptus globulus , Foeniculum vulgare, Taraxacum officinale*); introduced plants that are also utilized as foods (*Citrus limetta*, *Musa paradisiaca*), native plants that are also utilized as foods (*Persea americana*, *Sambucus mexicana*), native plants that are used as medicinals that have been transplanted or brought into cultivation for ease of access (*Abelmoschus moschatus*, *Ambrosia cumanensis*, *Nemastylis silvestris*, *Nicotiana tabacum*, *Trichilia habanensis*).

Weeds and the Medicinal Flora

A striking feature of the Tzetal medicinal flora is the large number of plants that are herbaceous and grow in disturbed habitats. On way of analyzing the flora is looking at how many are considered to be weeds. Although weeds are a cultural construct, they have features in common that allow for definition. Baker (1965:147) defines a weed as "a plant…if, in any specified geographical area, its populations grow entirely or predominantly in situations markedly disturbed by man (without, of course, being a deliberately cultivated plant)." Weeds are those plants that are successful in disturbed environments, are fast growing, and, are often but not always herbaceous (Zimdahl, 1992). I might add that a plant, just by virtue of being herbaceous and growing in a disturbed area, does not automatically qualify as a weed. Some degree of invasiveness is also required.

122 different plant species were utilized during the study, of which 110 I was able to positively determine to the species level. I compared this list of plants with a definitive checklist of weeds found in Mexico and Chiapas (Villaseñor and Espinosa, 1998). A chi-square test was performed to determine the statistical significance of the distribution of weeds within the Highland Maya medicinal flora in relation to the distribution of weeds within the Chiapan flora as a whole (Stepp and Moerman 2001). Chiapas as a whole contains approximately 9,000 vascular plant species (Breedlove, 1981). Of these, 1,178 (13%) are considered weeds (Villaseñor and Espinosa, 1998). One could predict then, that if weeds were randomly distributed in the Tzeltal medicinal flora, there would be about 14 weed species among the 109 medicinals (Table 4.2). In fact the actual number is 41, much higher than predicted ($p<0.001$). Table 4.3 lists these plant species that are both weeds and medicinals for the Tzeltal Maya.

Table 4.2: Weed species in Tzeltal Maya medicinal flora

	Weed	Not Weed	Total
Medicinal	41	69	110
Not medicinal	1143	7748	8897
Total	1178	7822	9000

$\mathbf{X^2} = 56.70$; $p < 0.001$

Table 4.3: Weeds used as medicinal plants in Tenejapa

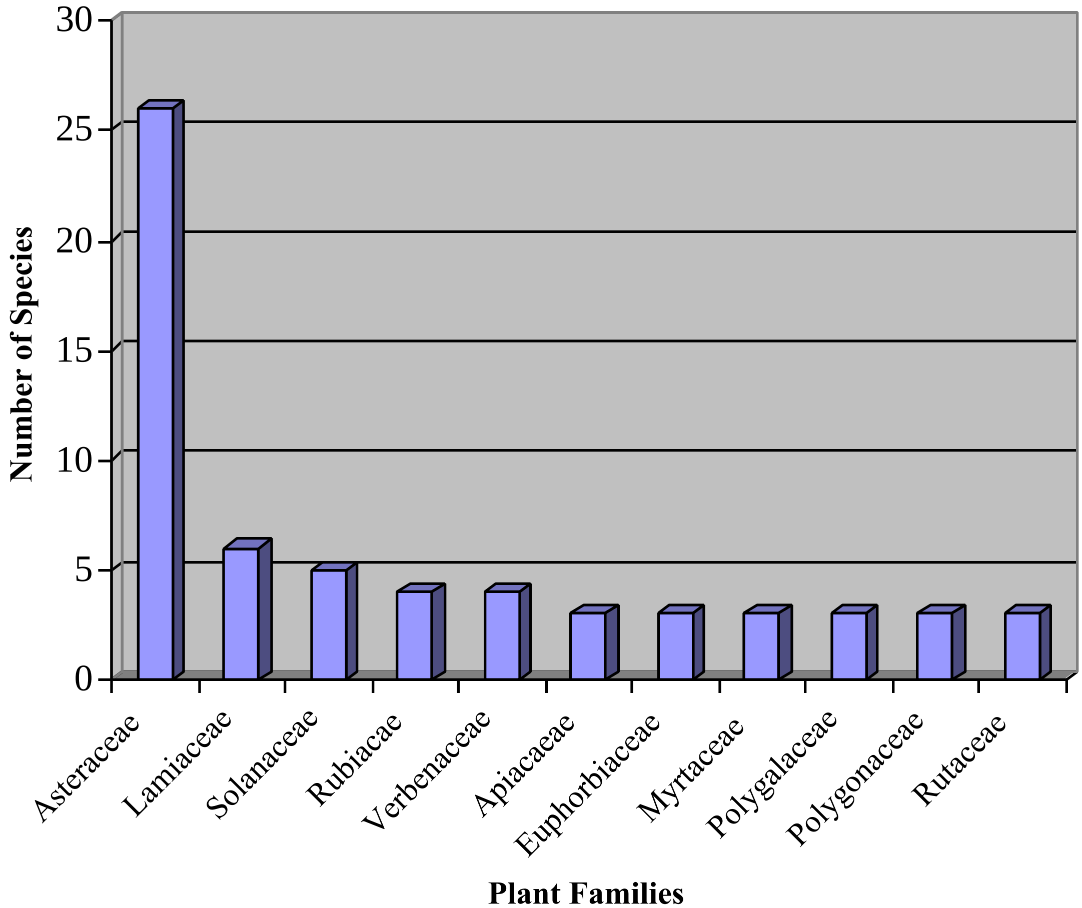
(Asteraceae) *Ambrosia cumanensis* Kunth
(Asteraceae) *Baccharis confertoides* Nesom
(Asteraceae) *Baccharis trinervis* (Lam.) Pers.
(Asteraceae) *Bidens pilosa* L.
(Crassulaceae) *Bryophyllum pinnatum* (Lam.) Kurz
(Scrophulariaceae) *Castilleja arvensis* C. et S.
(Chenopodiaceae) *Chenopodium ambrosioides* L.
(Menispermaceae) *Cissampelos pareira* L.
(Lythraceae) *Cuphea aequipetala* Cav.
(Asteraceae) *Erechtites hieracifolia* Raf.
(Asteraceae) *Erigeron karvinskianus* DC
(Umbelliferae) *Foeniculum vulgare* L.
(Rubiaceae) *Hamelia patens* Jacq.
(Malvaceae) *Kearnemalvastrum lacteum* (Aiton) Bates
(Verbenaceae) *Lantana camara* L.
(Brassicaceae) *Lepidium virginicum* L.
(Hamamelidaceae) *Liquidambar styraciflua* L.
(Lamiaceae) *Mentha spicata* L.
(Asteraceae) *Montanoa leucantha* (Lag.) Blake
(Myricaceae) *Myrica cerifera* L.
(Solanaceae) *Nicotiana tabacum* L.
(Lamiaceae) *Ocimum selloi* Benth.
(Onagraceae) *Oenothera rosea* L'Her. ex Aiton
(Phytolaccaceae) *Petiveria alliacea* L.
(Plantaginaceae) *Plantago major* L.
(Asteraceae) *Pluchea odorata* (L.) Cass.
(Polygalaceae) *Polygala paniculata* L.
(Rosaceae) *Prunus persica* (L.) Batsch
(Myrtaceae) *Psidium guajava* L.
(Euphorbiaceae) *Ricinus communis* L.
(Polygonaceae) *Rumex crispus* L.
(Polygonaceae) *Rumex obtusifolius* L.
(Labiatae) *Salvia lavanduloides* HBK
(Apiaceae) *Sanicula liberta* C. et S.
(Asteraceae) *Smallanthus maculatus* (Cav.) H. Robinson
(Solanaceae) *Solanum americanum* Miller
(Asteraceae) *Stevia ovata* Willd.
(Asteraceae) *Taraxacum officinale* Webb
(Asteraceae) *Tithonia diversifolia* (Hemsl.) A. Gray
(Verbenaceae) *Verbena carolina* L.
(Verbenaceae) *Verbena litoralis* Kunth

Plant Families of the Tenejapa Tzeltal medicinal flora

At the family taxonomic level, one can make some very broad and widespread generalizations about the characteristics of the plants within a particular family. For example, the Asteraceae is characterized primarily by herbaceous plants and evergreen shrubs with broad distribution, the Poaceae is characterized as grasses and is the most ecologically dominant group of plants in the world (Heywood 1993). Plant families have also been categorized with great success according to their importance for medicinals (Moerman 1991, 1996; Moerman et al. 1999). The most important families for medicinal plants in Tenejapa are presented in Figure 4.15. This analysis corresponds with a larger study of the entire Highland Maya medicinal flora that also found that Asteraceae, Lamiaceae, and Solanaceae were the three respective top medicinal plant families (Moerman et al. 1999). Absent from the top rankings of the Tenejapa data is Rosaceae, which was ranked fourth in the Berlin and Berlin data used in the Moerman et al. study. This difference can be accounted for by the fact that the Berlin and Berlin data is a comprehensive list of all plants noted as medicinals while this data set contains only medicinal plants that were *utilized* not reported.

Many of the same top families for medicinal plants are the same top families for weeds, with the exception of Poaceae. Among these families are Asteraceae, Fabaceae, Convolvulaceae, Euphorbiaceae, Chenopodiaceae, Malvacae, and Solanaceae (Holm 1978; Stepp and Moerman 2001).

Figure 4.15: Most Important Families of Medicinal Plants in Tenejapa



REPORTED DISTRIBUTION OF MEDICINAL PLANTS

I present here the results of a complementary study that was undertaken to determine local knowledge with regards to the availability and distribution of medicinal plants. Another purpose was to collect data that might be used to suggest improved management of the resource in the context of increasing human population pressures in the Highlands. It is important to note that this data is not based on actual medicinal plant use as in the study described above but rather is based on interviews about medicinal plant distribution.

203 medicinal plants were used in the study that had the highest consensus as to their medicinal status. This data was derived from Berlin and Berlin (1996). I collected most of these 203 medicinal plants during the first months of my research to make a travelling herbarium of dried vouchers without labels or identifying characteristics. Plants that I could not collect I borrowed from the original travelling herbarium set housed at ECOSUR in San Cristóbal. Fourteen adults who were knowledgeable about medicinal plants but not specialized healers participated in the study. Informants were equally divided between male and females and were from all of the major ecological zones within the municipality. Interviews were conducted in Tzeltal with the aid of AMG. A field assistant from the United States, Scott Taylor, worked with me extensively on this study.

The informants were first asked if they were familiar with and could name the plant shown to them. Then they were asked whether the plant grew in a particular successional stage or ecological zone. This study did not use an exhaustive list of ethnoecological categories but rather focused on successional stages, agricultural habitats and climatic zones. Informants were also asked to note any plants that were commonly cultivated. All of the informants were highly knowledgeable about the identification of the medicinal plants, with a 98% identification rate. In total there were 2842 number of responses recorded. There was also a high degree of consensus regarding the availability of plants within a specific ethnoecological category and their responses correspond to where actual field collections were made. Figure 4.16 shows the reported distribution of the medicinal plants.

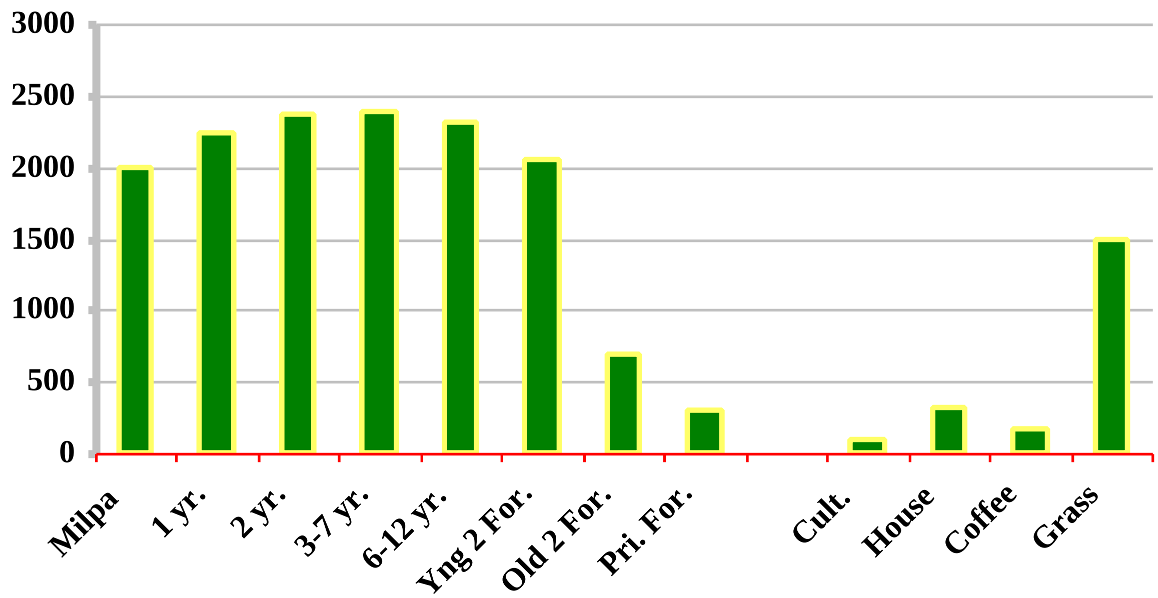
The highest reported concentrations appear in *unin k'inal* (3-7 year secondary growth). There was a high reported distribution of medicinal plants in disturbed areas as opposed to forested areas, especially primary forest. Overall, the results corroborate an earlier study done with the top 40 medicinal plants utilized in Tenejapa (Stepp 1998).

While the methodology utilized in this study can be time intensive to undertake for both researcher and informant when compared to the time required for actual vegetation studies it is relatively quick and efficient. Using this methodology may be useful for identifying plants which are potentially threatened or endangered prior to more detailed studies. I would not suggest replacing field studies of plant ecology with this methodology but it could help guide and refine further research.

CONCLUSIONS

Both the actual medicinal plant procurement and reported medicinal plant distribution demonstrate the overwhelming significance of disturbed habitats for medicinal plants. In the next chapter, I look in detail at the role of mature forests as a habitat for medicinal plants. This is followed by a botanical ethnography of the most utilized medicinal plants in Tenejapa. Reported distribution using the methodology described above are reported for these plants. The final chapter attempts an explanation of the results of this research by drawing from theories and examples in human ecology and biochemical ecology.

Figure 4.15: Aggregate reported distribution of 203 most reported medicinal plants



CHAPTER 5

MEDICAL ETHNOBOTANY AND MATURE FOREST

ETHNOBOTANY AND TROPICAL MATURE FORESTS

Beginning in the late 1980s, there was a flourishing of public interest in the conservation of the rapidly diminishing mature tropical forests of the world. While numerous arguments were developed to justify their conservation, those involving economic arguments proved to be most effective with the general public (Kempton, Boster and Hartley 1995). Mature tropical forests were valorized for their potential in providing new food crops and medicinals (see Table 1). Valuation studies speculated that tropical mature forests were worth more intact as a source of phytomedicinals and novel compounds for pharmaceuticals than for their actual timber value or other land uses (Mendelsohnn and Balick 1992; Principe 1991).

At first glance it appears that this argument has merit. For example, Farnsworth and Soejarto (1991) found that of the 95 plant species currently used for prescription drugs, 39 are plants said to originate in and around tropical forests. No data are provided by Farnsworth and Soejarto as to how many of the species are tropical mature forest obligates (those species that grow *only* in mature forest). Further investigation finds that of these 39 species, 13 of them are considered to be weeds (Stepp n.d.)

By the early 1990s the assumption that tropical mature forests were rich in potential pharmaceuticals was widely shared by the public at large (Kempton, Boster and Hartley 1995). At around the same time, there was increased public recognition of ethnobotany as a discipline that could aid in the quest for new pharmaceuticals by suggesting potential candidate plant species for bioassay based on their ethnobotanical use by specialized healers or shamans (Table 2). The linkage of ethnobotany with the search for new drugs and conservation of mature tropical forests had a significant impact on the field.

At least within the natural sciences, the field of ethnobotany had long languished as an obscure discipline, afforded little respect or interest by other scientists and was mostly unknown to the general public. The field had fared somewhat better in the social sciences and within anthropology where insights and theoretical developments dealing with ethnobotanical classification had been influential in the development of ethnoscience and cognitive anthropology (e.g. Berlin, Breedlove and Raven 1974, for a good historical account see D'Andrade 1995). The rigor demonstrated in these sub-fields subsequently influenced empirically oriented social scientists interested in developing more robust methods and field techniques (cf. Bernard 1995).

Regardless, public interest in ethnobotany was almost non-existent until the early 1990's when ethnobotanists began to ride the coattails of the growing movement to conserve mature tropical forest. In many ways, the results have been positive. Ethnobotany programs have sprung up in departments around the world. In many universities, there has been enormous demand for ethnobotany classes at the

Table 5.1: Utilitarian arguments for mature tropical forest conservation

"Most of the plants that have not been analyzed and tested grow in the tropics– a large fraction of them in the rain forests. Insofar as the forests are being destroyed, species are being lost that might yield useful medicine (Abelson 1990: 513).
"There exists no shortage of 'wonder drugs' waiting to be found in the rain forests, yet we in the industrialized world are woefully ignorant about the chemical-and, therefore medicinal-potential of most tropical plants (Plotkin 1993:7)."
"In order to slow the rapid destruction of tropical forests and the concurrent loss of biodiversity, it is critical to identify and quantify the benefits of conserving the remaining standing forests...the existence of undiscovered pharmaceuticals for modern medicine has often been cited as one of the most important reasons to protect tropical forests (Mendelsohn and Balick 1995: 223)."

Table 5.2: The linkage of utilitarian arguments for mature tropical forest conservation with the promotion of ethnobotany during the early 1990's

"We all had a mantra that we had to save the rain forest because it was a repository of natural drugs,' said Wade Davis, who studied ethnobotany at Harvard. (Christensen 1999)"
"Tropical forest peoples represent the key to understanding, utilizing and protecting tropical plant diversity…a single Amazonian tribe of Indians may use over 100 species of plants for medicinal purposes alone (Plotkin 1991:57)."
"Local forests are the source of the plants processed into therapies used in traditional medical systems (Balick and Mendelsohn 1992 citing Balick 1990)."
"How much do the tropical rain forests contribute to the mature health care of man? With such a tremendous store of biotic richness, certainly one expects them to be a storehouse, and a source, of potentially important medicinal drugs (Farnsworth and Soejarto 1991:29)."
"This is the last generation of scientists who have the opportunity to study indigenous groups and their interaction with the rain forest." says Michael Balick of the New York Botanical Garden. "Logic says that among the tens of thousands of plants that haven't been studied there must be something of value (Jackson 1989:97)."

Table 5.2 continued: The linkage of utilitarian arguments for mature tropical forest conservation with the promotion of ethnobotany during the early 1990's

"Concentrating on those plants that Amazonian tribal peoples by experimentation over the centuries have found to be bioactive could provide chemists with a kind of short cut. The value of learning from the perspicacity of many aboriginal peoples about the biodiversity of plants–those which they use and those which they know only as elements of the forest–should not be overlooked. Ethnobotanical studies devoted to this aspect of field research should be given greater and immediate attention in view of the unchecked and wanton destruction of vast areas of the world's forests. (Schultes and von Reis 1995:13)."
"How do ethnobotanists choose the societies they study?...First, the societies should be located in a floristically diverse area, such as a tropical rain forest. Such diversity dramatically increases the number of plants available; it thus enhances the likelihood that plants with pharmacologically active molecules will be pressed into service. (Cox and Balick 1994: 84)"
"One of the many aspects of the Amazon that are difficult to comprehend is the intimate relationship between the forest Indian and his ambient vegetation…The widespread belief that his 'secrets,' especially his uncanny knowledge of the plants and animals, must be pried from him is, in general, a falsehood. (R.E. Schultes in Plotkin 1993: viii)"

Table 5.2 continued: The linkage of utilitarian arguments for mature tropical forest conservation with the promotion of ethnobotany during the early 1990's

"The conservation community was beginning to wake up and pay attention to the importance of ethnobotany for rain forest preservation and utilization…Somehow both plants and indigenous peoples had to be factored into the equation…Ethnobotany takes a holistic approach to conservation and proves the vital importance of the role indigenous people can play in the ongoing struggle to protect, use and sustain the rain forest…The beauty of ethnobotany is that it brings people into the forest picture, showing that tribal peoples can help provide us with answers on the best ways to use and protect the forest. (Plotkin 1993:272-273)."
"Michael Balick of the New York Botanical Garden just returned from the interior of Belize, where he worked with a well known *curandero*, or healer, who uses herbal remedies to treat illness. As the forests disappear, however, so do sources such as Balick's medicine man. 'These people are encyclopedias of local flora and they're not being replaced'. (Booth 1987: 970)."

undergraduate and graduate level. Traditional peoples are increasingly doing their own ethnobotanical research. Best selling books such as *Tales of a Shaman's Apprentice* (Plotkin 1993) have introduced ethnobotany to tens of thousands of peoples (albeit in a limited and shallow manner).

Interestingly enough, the assumption that mature tropical forests were a significant habitat for indigenous peoples to find medicinal plants was never systematically tested but simply taken for granted. Like the popular myth of the 'hundreds of words for snow in Eskimo (Inuit),' tropical rainforests as untapped stores of new pharmaceuticals became common knowledge.

The origin of the assumption likely lies in the influential work of R.E. Schultes, often dubbed the father of economic botany. His work in the Amazon from 1941-1953 led to a remarkable 24,000 plant collections with 1500 species noted as medicinals or poisons by the Amazonian indigenous groups with whom he worked (Plotkin 1993). However, it is unclear exactly how many of these plants were mature forest obligates and perhaps more importantly, the frequency with which they were collected by indigenous peoples in mature forest habitats. Because systematic studies of *actual* plant use and procurement have been non-existent in ethnobotany the assumption remains untested.

However, there are several studies that suggest mature tropical forest is not nearly as significant a habitat for indigenous peoples to obtain medicinal plants as one could be led to believe by the statements in Table 2.

Voeks (1996) found that healers along the Atlantic coastal tropical forest of Brazil overwhelmingly preferred secondary forest and disturbed habitats. Using carefully controlled plots he evaluated the medicinal plant potential in different types of habitats and found that the majority of species used medicinally show up in disturbed areas. He also noted that the most common life form for medicinals was herbaceous plants and that trees were the least common.

Other case studies corroborate Voeks. Posey's research (1984) with the Kayapó in Brazil found extensive use of disturbed habitat for medicinal plant procurement. In what he terms "anything but abandoned" fields he found that 94% of the 368 species collected were of medicinal importance. Posey found that the Kayapó utilize almost no medicinal plants from the mature forest.

A recent study by Caniago and Siebert (1998) did not specifically look at habitat preference but looked at medicinal plant distribution in different ecological zones for a community in Indonesia. They found that while there was some use of the mature forest for medicinals (42 species), by and large, secondary growth habitats were richer in medicinals (227 species). Alcorn's work (1984) with the Huastec (Teenek) Maya in the state of Veracruz, Mexico also found that medicinal plants appear to be collected more often from disturbed habitats. Other indigenous groups in Mexico appear to follow similar patterns. Both the Mixe and Zapotec demonstrate an overwhelming preference for selecting medicinal plants in disturbed habitats with over 80% of plants used as medicine occurring in non-forested disturbed areas (Frei, Sticher and Heinrich, 2000).

Even those who have argued that mature forest is the most important habitat for traditional people to gather medicinal plants have demonstrated the significance of disturbed habitats in their own research. For example, a perusal of Arvigo and Balick's book *Rainforest Remedies* (1993), an account of the most utilized medicinal plants in Belize based on their work with 24 specialized healers, finds that the vast majority of the "100 healing herbs" of the rainforest are found in disturbed habitats such as roadsides and fields. Of the 100 plants listed in it, only ten are said to grow exclusively in forests.

It appears that in the enthusiasm to conserve mature tropical forest and promote ethnobotany, an unsupported assumption was made. A colleague once told me that he was pulled aside at an ethnobotany meeting in the mid 1990s and taken to task for reporting his data showing the abundance of use of medicinal plants within the Asteraceae family (a family characterized primarily by herbaceous plants, many with weedy qualities). His interrogator did not find fault with his work but rather expressed his concern that such findings were contrary to the public image of indigenous peoples and medicinal plants. While paradigm shifts in science are often unpleasant and characterized by divisiveness and emotion (Kuhn 1970) it is important for ethnobotanists to let the data speak for itself. "But the rhetoric (*about the rainforest being a repository of new drugs-JRS*) ran away from reality, and the whole thing has backfired. We have not found new drugs. And the fact that the idea is deeply flawed is never questioned (Wade Davis quoted in Christensen 2000)." However, bioprospecting for new pharmaceuticals from the rainforest continues to this day (cf. Calderon et al. 2001).

MEDICINAL PLANTS AND MATURE FOREST: THE TZELTAL MAYA CASE

Like many of the new generation of ethnobotanists, I was influenced by utilitarian arguments for conservation of mature tropical forest. When I began fieldwork in Highland Chiapas I expected that there would be some use of the little remaining mature forest for medicinal plants (see Chapter 4 for a full description and definition of mature forest in Highland Chiapas). However this was not to be the case in the study discussed in Chapter 4. To summarize the results:

1) There was no use of mature forest (*ja'mal*) by any of the participants in the study as a source of medicinal plants over the nine month period.
2) There was no use of old secondary forest (*tojol k'inal*) by any of the participants in the study over the nine month period.
3) Young secondary forest (*te'tikil*) was utilized only 16 percent of the time as a habitat to obtain medicinal plants.
4) The average amount of time spent procuring medicinal plants for a specific treatment is 16 minutes, meaning that an area with a radius of less than 1 km around the house is the mature zone in which to collect medicinal plants.

On first glance it appears that these data clearly demonstrate that more disturbed habitats will be visited more frequently to obtain medicinal plants. Secondary forest is abundant in Tenejapa and almost every household in the study was within one kilometer of secondary forest. Yet it is used infrequently and old secondary forest and mature forest are not used at all.

This argument can be attacked on the grounds that there is little mature forest left in Tenejapa or in the Highlands at large (Figure 5.1, Figure 5.2). It is estimated that in 1982 there was less than 398 sq. km of mature forest remaining in Northern Chiapas from an "original" area of approximately 1025 sq. km (Bubb 1991). The current figure is undoubtedly lower. The greatest losses have occurred in the surrounding municipalities of Tenejapa. For example, there is nothing remaining of what was once 864 sq. km of mature forest in San Andrés Larráinzar. The adjacent mature forest of Tzontehuitz is now only 5 hectares, from an original area of 102 sq. km. Significantly, the mature forests of Tenejapa are not included in the study by Bubb (1991) probably due to their small size and relative inaccessibility (neither lie near paved roads). It could be that there are other overlooked small patches of mature forest in other municipalities as well.

I estimate that a little more than 5 percent of the land in Tenejapa is mature forest. I obtained this figure by utilizing a grid of one square km increments from the 1:50,000 topographical map entitled Oxchuc.E15D52 (INEGI 1990). In travelling throughout the municipality I noted that there was mature forest in three areas: The two hills adjacent to the community of Matzab (Figure 5.2; for an ethnobotanical inventory of Matzab see Casagrande n.d.), The hilly area adjacent to the community of Ach'lum, and a narrow ridge between the communities of Majosik' and Oxeb Wits. Because of the high edge to area ratio of this latter ridge I did not include it in my estimate. However, the mature forests of Matzab and Ach'lum are relatively intact although there has been some selective logging and one of the slopes of Matzab was accidentally burned recently (Casagrande n.d.). Both areas lie between 2400 meters to 2600 meters. The combined area mounts to approximately 5 square km (Matzab is approximately 2 square km, Ach'lum is approximately 3 square km). Given that the total area of the municipality is 99 square km, we find that a little more than 5 percent then is mature forest.

Another basis to challenge the findings of Chapter 4 comes from the fact that none of the households that participated in the study were near these areas of mature forest. The closest community to the forests of Matzab and Ach'lum was Balum Kanal, yet it was still 6-8 kilometers away. Majosik' lies only 2-3 kilometers from the narrow

Figure 5.1: Under the mature forest canopy in Matzab, Tenejapa

Figure 5.2: Bromeliads growing in mature forest of Matzab in Tenejapa

Figure 5.3: The twin mature forest hills of Matzab

strip of mature forest to the northeast of the community. Yet even this shorter distance is still greater than the one kilometer radius where the majority of medicinal plant collection takes place. Taking this into account, I initiated a study to examine use of the mature forest for medicinal plants by people living in communities close to mature forest.

METHODOLOGY

Based on reconnaissance trips around the municipality I was familiar with the communities that were adjacent to the mature forests of Matsab and Ach'lum. These communities are Matsab, Ach'lum, Santa Rosa, and Banabil. I sought out individuals from these communities who were knowledgeable about medicinal plants and willing to participate in the study. Ten individuals participated in the study (eight males and one female) who ranged in age from 35 to 50 years old (the average age was 41.2 years old). I did not interview individuals older than 50 because older individuals are less likely to gather medicinal plants and instead rely on their children and grandchildren to obtain them.

Previous research in the mature forest of Matsab identified eight plant species that were considered medicinal and were mature forest obligates (Casagrande n.d.) Using voucher specimens of these eight plants (Figures 5.4 – 5.11) I asked the informants if they knew the plant, and its uses (Table 5.3). They were then asked if they had ever used the plant themselves. The second part of the study involved a use recall methodology similar to that described in Chapter 3. The same questions were asked, except that informants were requested to note any illnesses they could remember and what the treatments were, rather than just the illnesses in the previous week.

Table 5.3: Mature forest obligate species with potential use as medicinals

Scientific Name	Family	Tzeltal Name	Reported as Medicinal
Aechmea nudicaulis L.	BML	**yaxtinin**	100%
Sedum praealtum A. DC.	CRS	**pimil majben**	100%
Smilacina amoena H.L. Wendl.	LIL	**ch'ib wamal**	60%
Phoradendron falcatum (Cham. & Schltdl.) Trel.	VIS	**yijkats' te'**	80%
Isochilus auramtiacum	ORC	**pech'e ch'e**	10%
Elaphoglossum sp.	PTR	**takin tsib**	60%
Deppea grandifolia	RUB	**tsajal te'**	30%
Symplocos limoncillo Bonpl.	SYM	**tsuj te'**	40%

Figure 5.4: Voucher specimen of *Aecmea nudicaulis* used in study

Figure 5.5: Voucher specimen of *Sedum praealtum* used in study

Figure 5.6: Voucher specimen of *Smilacina amoena* used in study

Figure 5.7: Voucher specimen of *Phoradendron falcatum* used in study

Figure 5.8: Voucher specimen of *Isochilus auramtiacum* used in study

Figure 5.9: Voucher specimen of *Elelphoglossum sp.*used in study

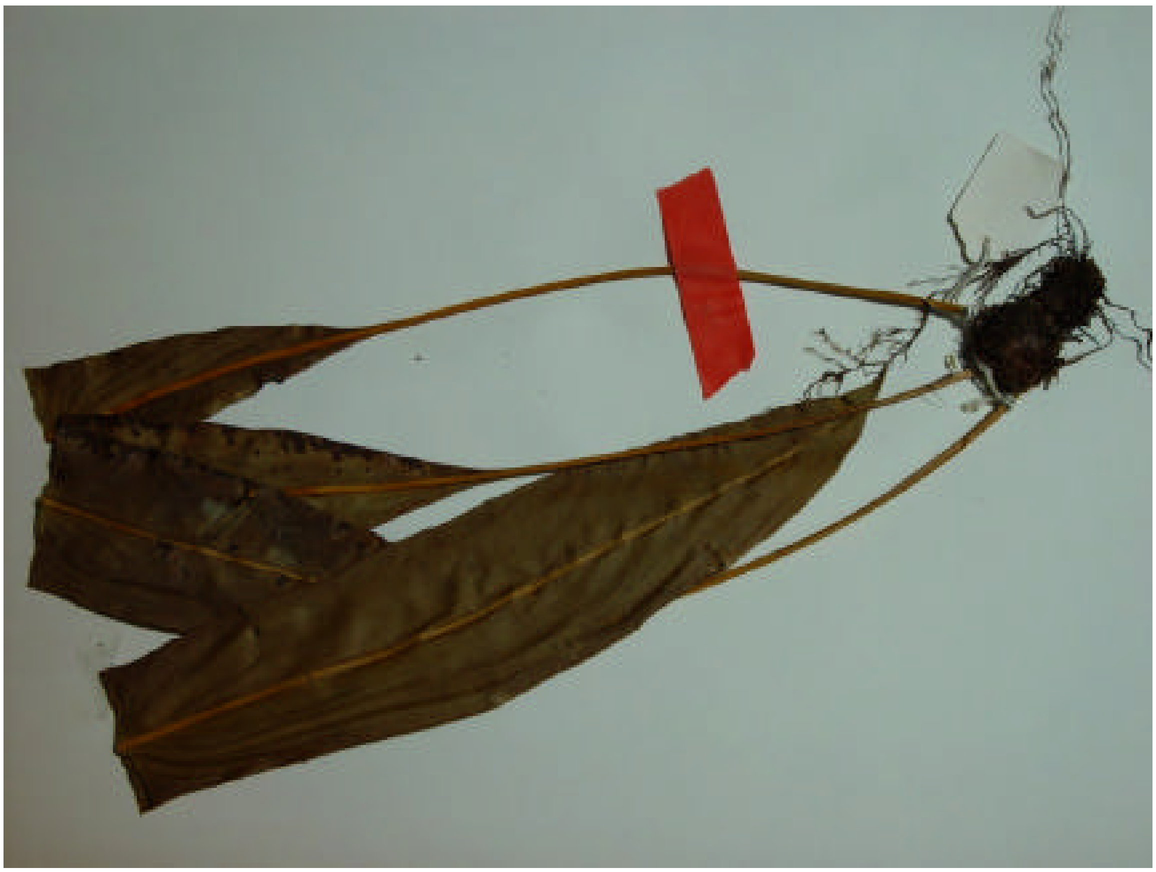


Figure 5.10: Voucher specimen of *Deppea grandifolia* used in study

Figure 5.11: Voucher specimen of *Symplocos limoncillo* used in study

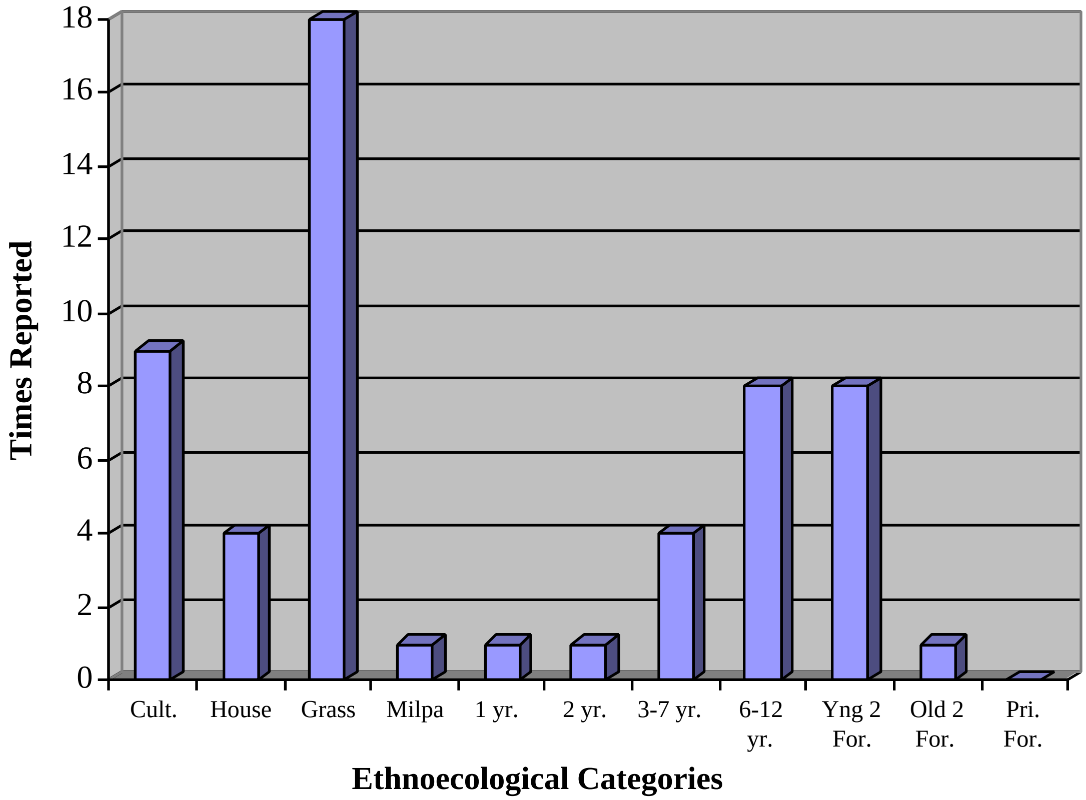
RESULTS

Informants were very familiar with the eight mature forest obligate species, and were able to correctly identify them 97 percent of the time. Responses varied regarding the uses of the plants (Table 5.3). While plants such as *Aechmea nudicaulis*, and *Sedum praealtum* were unanimously reported as medicinals, consensus was much lower on others. For example, only one informant reported a medicinal use for *Isochilus auramtiacum*. Interestingly, none of the informants responded affirmatively when asked if they had ever actually used any of these plants as medicinals.

The use recall interviews found 59 uses of medicinal plants (Figure 5.11). The frequency with which medicinal plants were collected from particular habitats closely matches the results from the larger study discussed in Chapter 4. Over half of the time (52 percent) medicinal plants were collected from the highly disturbed areas of *akil* (grassland, trailside), *pat na* (area around house) or were cultivated. The frequency with which plants were collected from the various successional stages also matches the results of the larger study. Relatively few plants were collected in the very early successional stages but later stages (3-7 year and 6-12) were utilized 20 percent of the time. Young secondary forest (*te'tikil*) was utilized 13 percent of the time. There was only one reported procurement of a medicinal plant in old secondary forest and there was no use of the mature forest.

The average length of time to obtain a medicinal plant was 50 minutes. This is a significantly longer than the 16 minutes for the main study population. However, there were two instances were informants reported spending five hours to obtain medicinal

Figure 5.11: Habitats Where Medicinal Plants Obtained by Tzeltal Living Adjacent to Mature Forest



plants from hot country communities. If these outliers are removed the average time is 19 minutes. The total reported relative abundance of medicinal plants was 4.3 on a scale from one to five. The total reported relative strength (*yip)* of the medicinal plants was 4.4 on a scale from one to five.

DISCUSSION

The close correspondence between the results of this chapter and that of chapter 4 suggest that lack of availability and access to mature forests is not the reason that they are unutilized for medicinal plant procurement. Despite living within a kilometer of mature forests, none of the informants in this study reported use of mature forest, virtually no use of old secondary forest, and relatively little use of young secondary forest.

What is the significance of these results for the assumption that lowland mature tropical forest is the most important habitat for indigenous peoples to obtain medicinal plants? Montane tropical mature forest is, in many ways, significantly different than lowland mature forest. However, it is similar in that it is characterized by multi-layered hardwood species, high overall diversity and high in endemic species. Also, the fact that forests in general are under-utilized for medicinal plants suggests that there may be processes involved that are not particular to Highland Chiapas and that these results may have significance in other tropical areas as well. In the concluding chapter (Chapter 7) I present some possible explanations for the results of Chapters 4 and 5 based on theory and evidence from human ecology and biochemical ecology

CHAPTER 6

BOTANICAL ETHNOGRAPHY OF THE MOST UTILIZED MEDICINAL PLANTS

INTRODUCTION

This chapter presents a botanical ethnography (cf. the subtitle of Berlin, Breedlove and Raven 1974) of the most utilized medicinal plants in the municipality of Tenejapa. Inherent in the phrase "botanical ethnography" is the interconnectedness between the local flora and the local culture. Linguistic, economic and ecological aspects of medical ethnobotany are described for five plants with the greatest use as medicines based on the study described in Chapter 4 (see Table 6.1). Plants were included if they were used ten or more times during the period of study. In addition, a reported ethnoecological distribution of these medicinal plants based on degree of human modification of the landscape and gross climatic zones is presented. Plants are listed in order of their importance.

Table 6.1: Five most utilized medicinal plants in Tenejapa

Name of Plant	Rank	Times Used	Percent of Total Use
Verbena litoralis Kunth	1	33	11%
Salvia lavanduloides Kunth	2	15	5%
Baccharis confertoides Nesom	3	13	4%
Tithonia diversifolia (Hemsl.) A. Gray	4	12	4%
Foeniculum vulgare L.	5	10	3%

FORMAT OF ENTRIES

For each plant the entry is divided into two sections: Ecology, Botany, Folk Classification and Nomenclature; Medical Ethnobotany and Ethnopharmacology. In the first section the family name is given followed by a botanical description of the plant. Botanical descriptions are based on field notes and observations and a variety of sources including Berlin and Berlin (1996), Berlin, Breedlove and Raven (1974), Morton (1981), Mabberly (1997), Ross (1999), Chevallier (1996), Strother (1999), Breedlove and Laughlin (1993), Mason and Mason (1987), and Thomson (1978). Authorities and proper nomenclature was verified through Mabberly (1997) and the Missouri Botanical Garden Tropicos website (www.mobot.org). This is followed by a description of the ethnoecological habitats where it is reported to grow along with its range in altitude and its distribution across gross climatic zones. The data from which this description is derived is present in graphs at the end of each entry. The methodology and source for this data is fully described in Chapter 4. If the plant grows in other places besides Chiapas this is noted. If the plant is considered a weed this is noted. At the end of each entry is the Tenejapa Tzeltal name for the plant along with any other relevant information regarding its folk taxonomy.

The section notes what illness(es) the plant is used for and how it is prepared. Other secondary uses are also noted. It is noted if it is used by other socio-linguistic groups in different areas. If there is bioassay literature on the plant it is summarized. Any known compounds present in the plant are summarized. Ethnopharmacological descriptions were derived primarily from a search of the NAPRALERT database (www.napralert.org) at the University of Illinois, Chicago although other literature is cited as well.

Following these descriptions are a photograph(s) of the plant in its natural habitat, and if available a botanical illustration of the plant drawn by Don Nicolás Hernández Ruíz, a Tzotzil Maya illustrator at ECOSUR (Figure 6.1). Also a photograph of the herbarium voucher used in the distribution study is included.

Figure 6.1: Botanical illustrator Don Nicolás Hernández Ruíz

THE MOST UTILIZED MEDICINAL PLANTS OF TENEJAPA

1) ***Verbena litoralis*** Kunth

Ecology, Botany, Folk Classification and Nomenclature

This plant in the Verbenaceae (Verbena) family is the most utilized medicinal plant in Tenejapa, along with the closely related species *Verbena carolina*. The use of this plant accounted for 11 percent of all medicinal plant use during the study. It is an erect, branched aromatic perennial herb up to 1.5 meter tall (Figure 6.1, Figure 6.2). Stems are quadrangular, sometimes minutely hairy on the angles. Leaves are nearly stemless, opposite, oblanceolate, 3-10 cm long, 1.4 to 4 cm wide, and short-petiolate, with serrate margins and rounded apex and are prominently veined beneath. Flowers are minute, blue to purple, tubular,5-lobed, 2.5 to 3 mm wide in lateral bracteal spikes 10-14 cm long. The seed capsule is quadrangular and separates into 4 segments, each with 1 seed (Berlin and Berlin 1996; Morton 1981). It commonly grows in the *pat na* (immediate area around the house) and along trailsides and fallow fields (Figure 6.3). It is unlikely that any household in Tenejapa is more than 1 km from a specimen of *Verbena litoralis*. This species is common throughout disturbed areas in Tenejapa and the Highlands, although less so at lower elevations (Fig 6.4). It is common and native throughout the neotropics, extending into Arkansas, Louisiana and Texas to the north and Chile to the south. It has become naturalized in Hawaii and New Zealand. It is noted as a weed in Chiapas (Villaseñor and Espinosa 1998). It is also considered a weed in

Argentina, Colombia, Brazil, Chile, Peru, Uruguay, Venezuela, USA, Hawaii and New Zealand (Holm et al. 1979).

The plant is known by the Tenejapa Tzeltal as *yakan kulub wamal* lit. 'grasshopper's leg herb'. This is because the flowers resemble a grasshopper's leg. This name is utilized throughout the Tzeltal highland region (Berlin and Berlin 1996). *Verbena carolina* is sometimes called this as well although it is further recognized by some Tenejapans as *sakil yakan kulub wamal* lit. 'white grasshopper's leg herb' due to the white flowers that distinguish it from the bluish- purple ones of *V. litoralis*.

Medical Ethnobotany and Ethnopharmacology

The leaves of this plant are brewed into a tea and drunk to treat a variety of gastrontestinal illnesses, most commonly general diarrhea (*tza' nel*). However, I noted two cases where it was used for cough (*obal*) and two cases where it was used for stomach pain (*k'ux ch'ujtil*). It it also used to treat fever and weakness and wasting type illnesses (Berlin and Berlin 1996). Its use as a phytomedicine is widespread throughout the Americas. It is used in Argentina to treat diarrhea, respiratory tract infections and urinary tract infections (Peres and Anesini 1994), in Guatemala to treat stomach pains (Giron et al. 1991); and for menstrual disorders and as an emmenagogue in Colombia (Gonzales and Silva 1987). Laboratory analysis shows antibacterial activity against *bacillus subtilis*, *e. coli*, *pseudomonas aeruginosa*, and *staphylococcus aureus*; antimycobacterial activity; and activity against *candida albicans* (Chesney and Adams 1985). Compounds present include brasoside and verbenalin, monoterpenes and verbascoside, a phenylpropanoid (Umana and Castro 1990; Castro et al. 1990).

Figure 6.2: *Verbena litoralis* growing in karst landscape of Nabil, Tenejapa

Figure 6.3: Botanical illustration of *Verbena litoralis* by Nicolas Hernández Ruíz

Fig 6.4: Voucher specimen of *Verbena litoralis* used in distribution study

Figure 6.5: Reported habitat distribution of *Verbena litoralis*

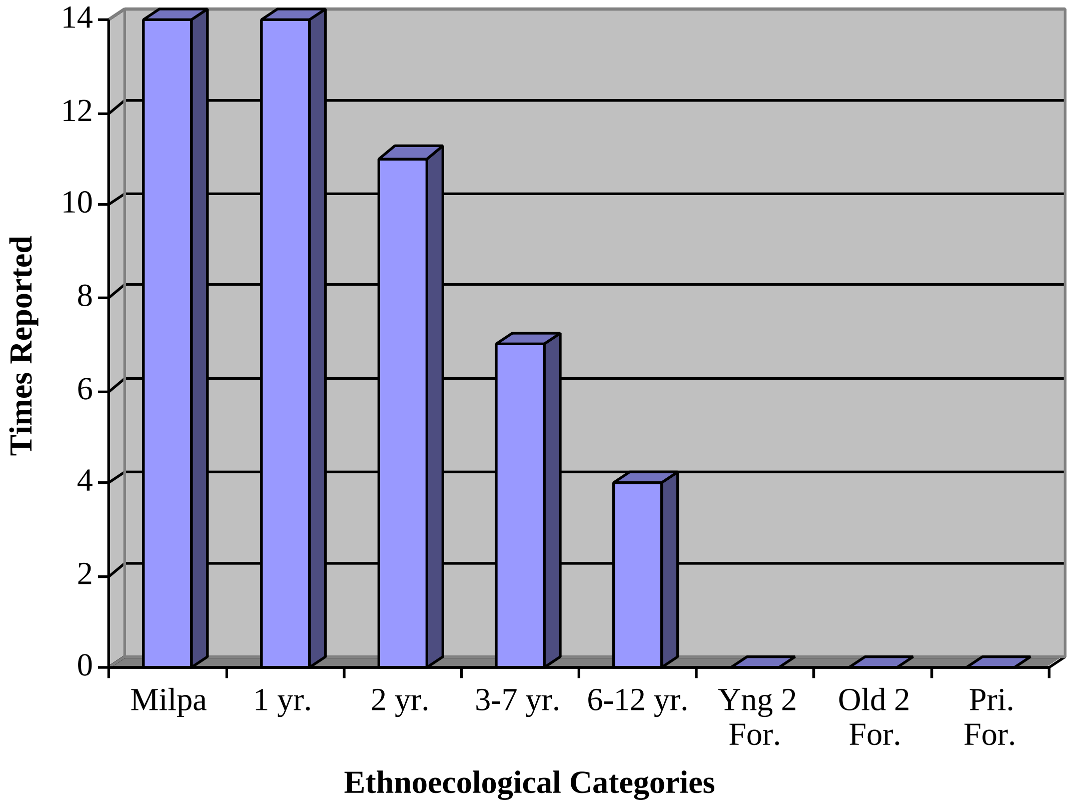
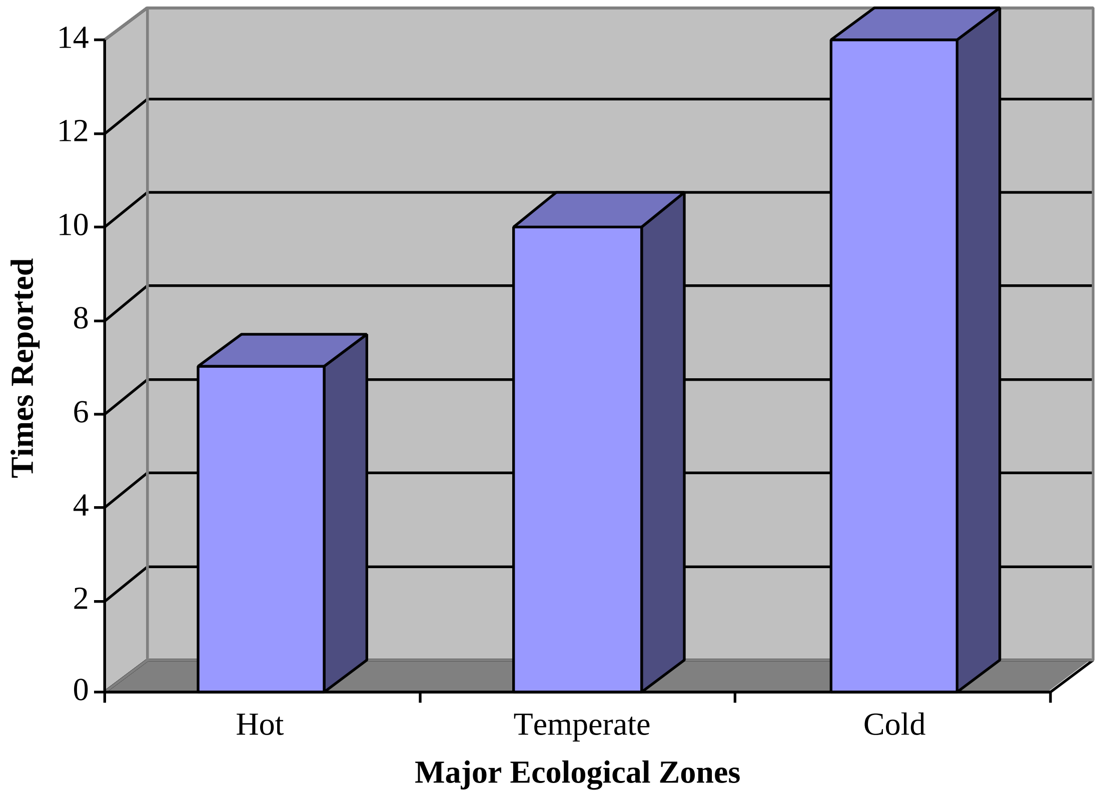


Figure 6.6: Reported climatic zone distribution of *Verbena litoralis*



2) *Salvia lavanduloides* Kunth

Ecology, Botany, Folk Classification and Nomenclature

This plant in the Lamiaceae (Mint) family is the second most utilized medicinal plant in Tenejapa. The use of this plant accounted for 5 percent of all medicinal plant use during the study. *Salvia lavanduloides* grows as a branched aromatic perennial spindly herb or shrub up to 1m tall. It has a square stem and the flowers are blue, bilabiate, .5cm to 1 cm long, calyx is dull violet blue with a blue corolla (Fig 6.5, Fig 6.6). The leaves are opposite, long stemmed, 1-10 cm long, pubescent, lighter beneath, and short-petioled. The plant is readily found in highly disturbed areas, fallow fields, and young secondary forest as an understory plant with limited distribution in older secondary forest (Fig 6.7). Two informants reported that it can be found in primary forest although it is uncommon. It was not found to grow in the primary forest of Matsab but three other species of *Salvia* were found there (Casagrande pers. comm.) The plant is usually found above 1800m although its range can extend to approximately 1400m (Fig 6.8). *Salvia* is an abundant genera with 63 species found in Chiapas (Breedlove 1986). *S. lavanduloides* is noted as a weed in the state of Chiapas (Villaseñor and Espinosa 1998). The plant is known to the Tenejapa Tzeltal as *ch'abakal wamal* or *ch'aalbakal wamal* (lit. 'bitter bone' herb). The significance of the plant as a medicinal is apparent in the Zinacantán Tzotzil name for this plant-*poxil obal* meaning literally cough medicine (Breedlove and Laughlin 2000).

Medical Ethnobotany and Ethnopharmacology

The plant was used during the study to treat generalized cough (*obal*) with one reported use for diarrhea (*tza'nel*). It is the most utilized cure for respiratory illneses. The leaves and stems are boiled in water to make a tea. A search of the NAPRALERT database yielded no existing studies on the bioactivity of *Salvia lavanduloides* although the worldwide use of plants from this genus for medicinal purposes suggests that this plant merits detailed study of its potential biological activity. The plant is known to contain the following flavonoids: santin, eupatorin, flavone,5-hydroxy-3'-4'-6-7-tetrame, flavone,5-hyfroxy-3'-4'-6-tetrametho, and glucoferide; the following diterpene: horminone; the following triterpenes: oleanolic acid, ursolic acid; and the following diterpenes: salvianduline A, salvianduline A, salvianduline B, salvianduline C, and salvianduline D (Rodriguez et al. 1974; Ortega et al. 1991; Maldonado et al. 1992).

Fig 6.7: *Salvia lavanduloides*

Fig 6.8: Close-up view of *Salvia lavanduloides* in flower

Fig 6.9: Voucher specimen of *Salvia lavanduloides* used in distribution study

Figure 6.10: Reported habitat distribution of *Salvia lavanduloides*

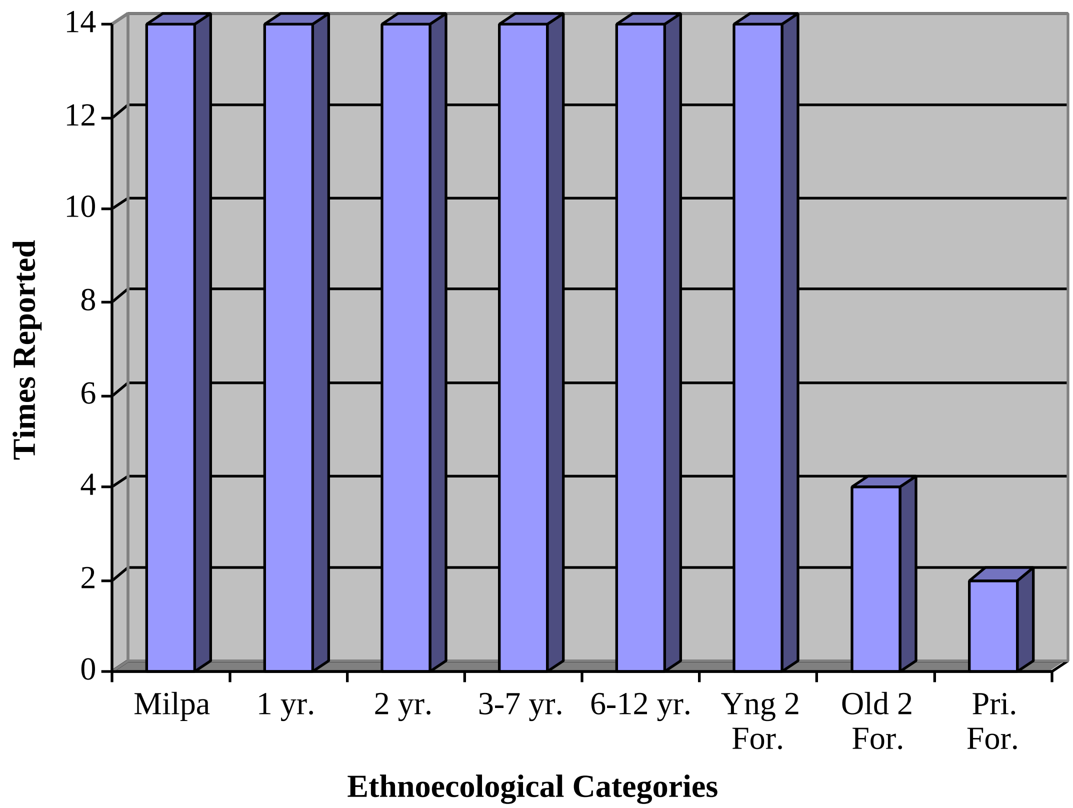
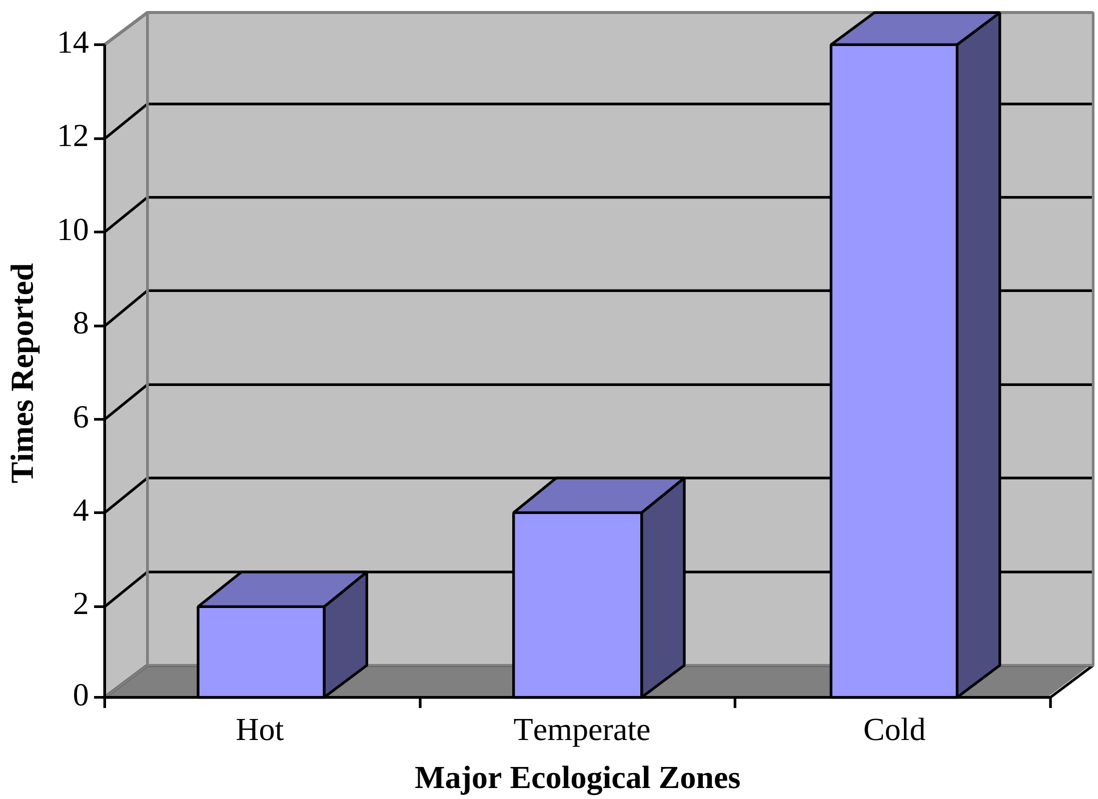


Figure 6.11: Reported climatic zone distribution of *Salvia lavanduloides*



3) ***Baccharis confertoides*** Nesom

Ecology, Botany, Folk Classification and Nomenclature

Baccharis confertoides Nesom is in the Asteraceae (Sunflower) family. It is the third most utilized medicinal plant in Tenejapa. The type of *Baccharis vaccinioides* Kunth is conspecific with that of *Baccharis conferta* Kunth and the name *B. vaccinioides* has long been misapplied to plants now called *B. confertoides* (Nesom 1990; cf. Berlin and Berlin 1996). The plant grows as a shrub or treelet generally 2-6m tall. Leaves are alternate, obovate or oblancelolate to elliptic, 1-3.5 cm long, .3-1.5 cm wide. The margins are entire to minutely spiny-toothed. Apices are acute, faces are glabrous, usually glutinous or vernicose. Infloresences are white and in small heads in 3-8 compact terminal clusters from 8-12 cm long.. Florets number 20-40. It is a common plant on the central plateau of Chiapas although it is rarely found in the Sierra Madre mountains and the Northern highlands. The plant appears to thrive in karst topography, perhaps due to the high limestone content of the soil. It is commonly found along trailsides and roads and in openings in secondary forests and fallow fields. It often forms pure stands in disturbed areas. The plant generally grows above 2000 meters. Other *Baccharis* species are noted as weeds through North America and the neotropics but *B. confertoides* is not listed as a weed (Holm et al. 1979). The plant is known in Tenejapa and throughout the highlands as ***mes te'*** (lit. broom tree) because the branches of the plant are gathered together into a makeshift broom for sweeping.

Medical Ethnobotany and Ethnopharmacology

In Tenejapa this plant was used to treat diarrhea (***tza'nel***) and cough (***obal***). When used to treat diarrhea it was much more likely to be used as an admixture rather than a primary plant. However when used for cough it was not taken with any other plants. For both illnesses, the leaves of the plant are stripped off of the stems and then boiled in water. While the Tzotzil also use the plant in this manner it is unknown if it is used medicinally outside of the highlands of Chiapas. In a methanolic extract it shows strong spasmolytic effect and also cytotoxic activity on KB and P388 cell cultures (Berlin and Berlin 1996). A slight antimicrobial activity was noted against *Staphyloccocus aureus* (Berlin and Berlin 1996). Numerous flavonoids have been isolated from B. confertodies (Wollenweber et al. 1986).

Figure 6.11: *Baccharis confertoides*

Figure 6.12 *Baccharis confertoides* (photo by Brent Berlin)

Figure 6.13: Voucher specimen of *Baccharis confertoides* used in distribution study

Figure 6.14: Botanical illustration of *Baccharis confertoides* by Nicolas Hernández Ruíz

Figure 6.15: Reported habitat distribution of *Baccharis confertoides*

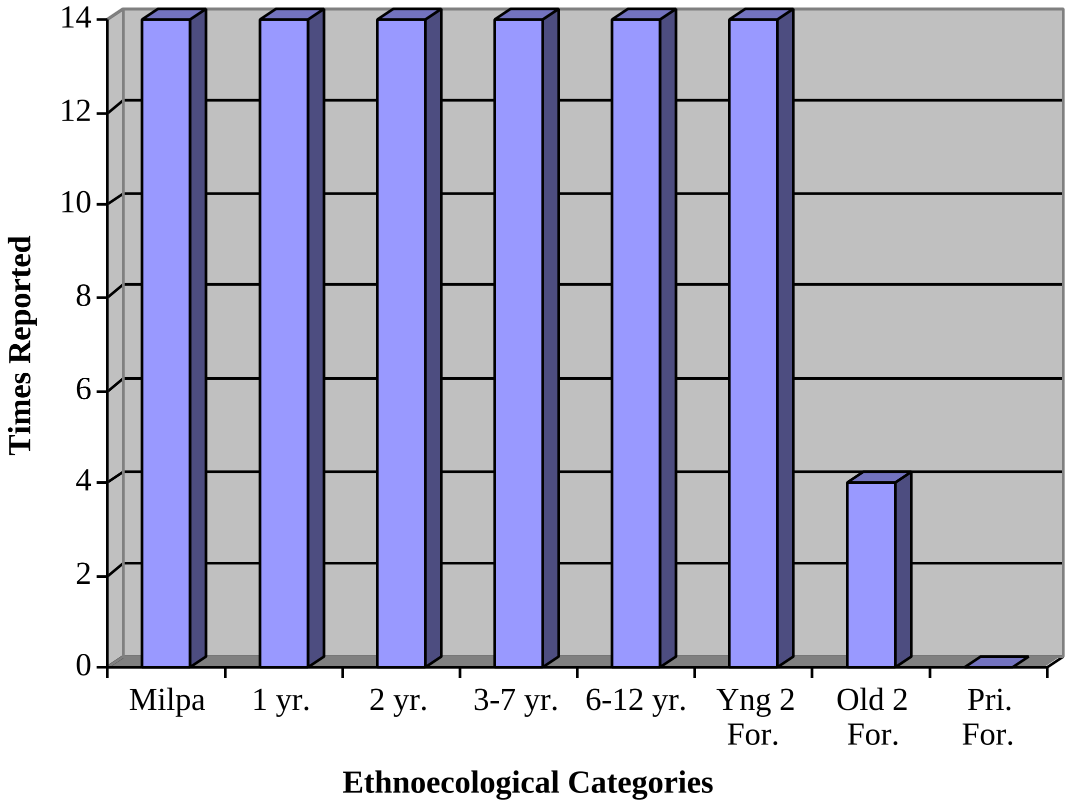
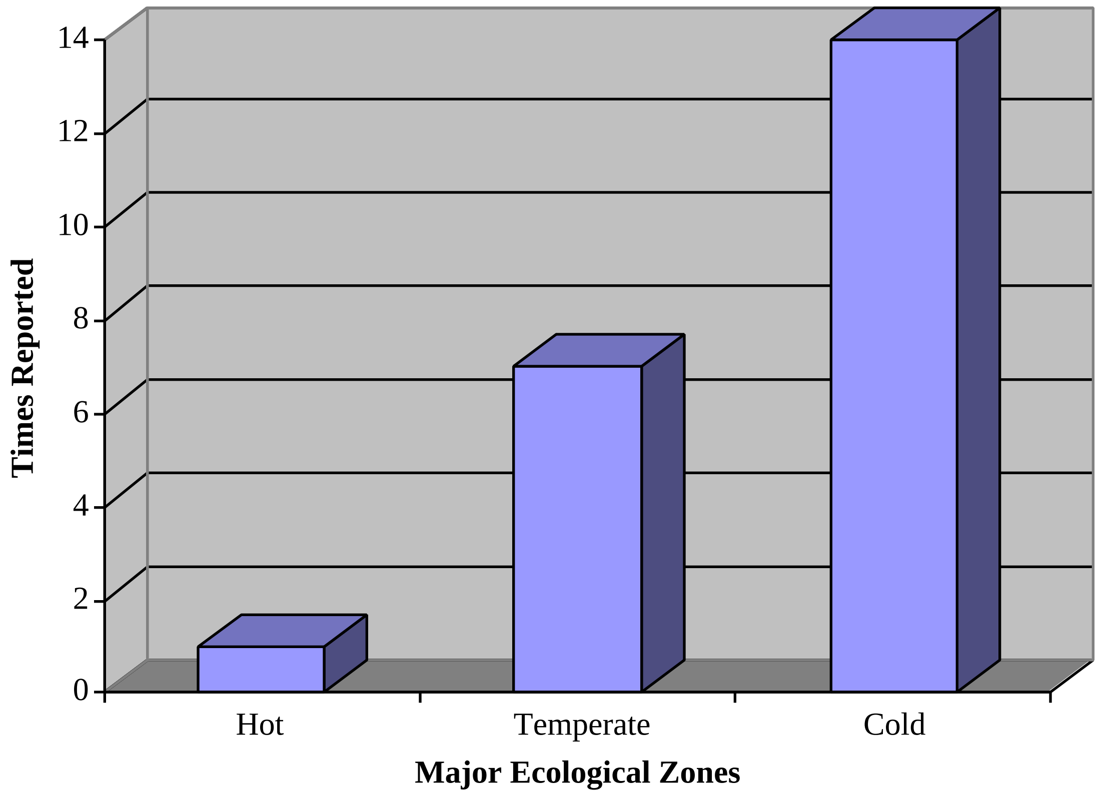


Figure 6.16: Reported climatic zone distribution of *Baccharis confertoides*



4) ***Tithonia diversifolia*** (Hemsl.) A. Gray

Ecology, Botany, Folk Classification and Nomenclature

Tithonia diversifolia (Hemsl.) A. Gray is in the Asteraceae (Sunflower) family. It is the fourth most utilized medicinal plant in Tenejapa. The plant is an herbaceous or shrubby perennial up to three meters tall. The petioles are 2-6 cm long, winged. The leaf blades are lance-ovate to rhombic, deltate or pentagonal, 10-20 cm long, 6-18 cm wide and densely pubescent on both surfaces. The flowers are bright yellow to orange with ray florets 12-13 in number and appear mostly in September to October (Figure 6.17, 6.18, 6.19). The plant is found throughout disturbed areas in Tenejapa and at all elevations, although it is reported to be slightly more prevalent at lower altitudes (Figures 6.20, 6.21). The native distribution is throughout Southern Mexico , into Central America and down into Colombia, Venezuela and Ecuador. It is also naturalized in the Old World tropics. It is noted as a weed in Chiapas and also in Australia, Indonesia, Fiji, Thailand, the continental United States, Hawaii and Mauritius (Holm et al. 1979). The plant is known in Tenejapa as *ch'akil* (unanalyzable constituent).

Medical Ethnobotany and Ethnopharmacology

In Tenejapa this plant was used to treat diarrhea (***tza'nel***) and cough (***obal***) and one case of abdominal pain (*k'uxch'ujtil*). It is possible that its importance in treating this latter category was underreported as Berlin and Berlin (1996) note that it is one of the prinicpal species used by the Tzotzil in the treatment of abdominal pain. It is not reported to be used for cough in Berlin and Berlin (1996) but in Tenejapa this accounted for 50 percent of its use. The leaves are boiled in water and a tea is made to treat the illness. It is used to treat malaria in Guatemala (Calzada and Ciccio 1978). In Kenya it is used to treat gastrointestinal problems (Johns et al. 1995). In Thailand it is used to treat stomach pain (Anderson 1996). Studies have demonstrated the plant's spasmolytic activity (Kambu et al. 1990) and its cytoxicity (Mungaruire 1991). Numerous terpenoids (monterpenes and sesquiterpenes) such as tagitinin A, B, C, and ocimene have been isolated from the plant (Lamaty et al. 1991, Schuster et al. 1992).

Figure 6.17: *Tithonia diversilfolia* in flower

Figure 6.18: Botanical illustration of *Tithonia diversilfolia* by Nicolas Hernández Ruíz

Figure 6.19: Voucher specimen of *Tithonia diversifolia* used in distribution study

Figure 6.20: Reported habitat distribution of *Tithonia diversifolia*

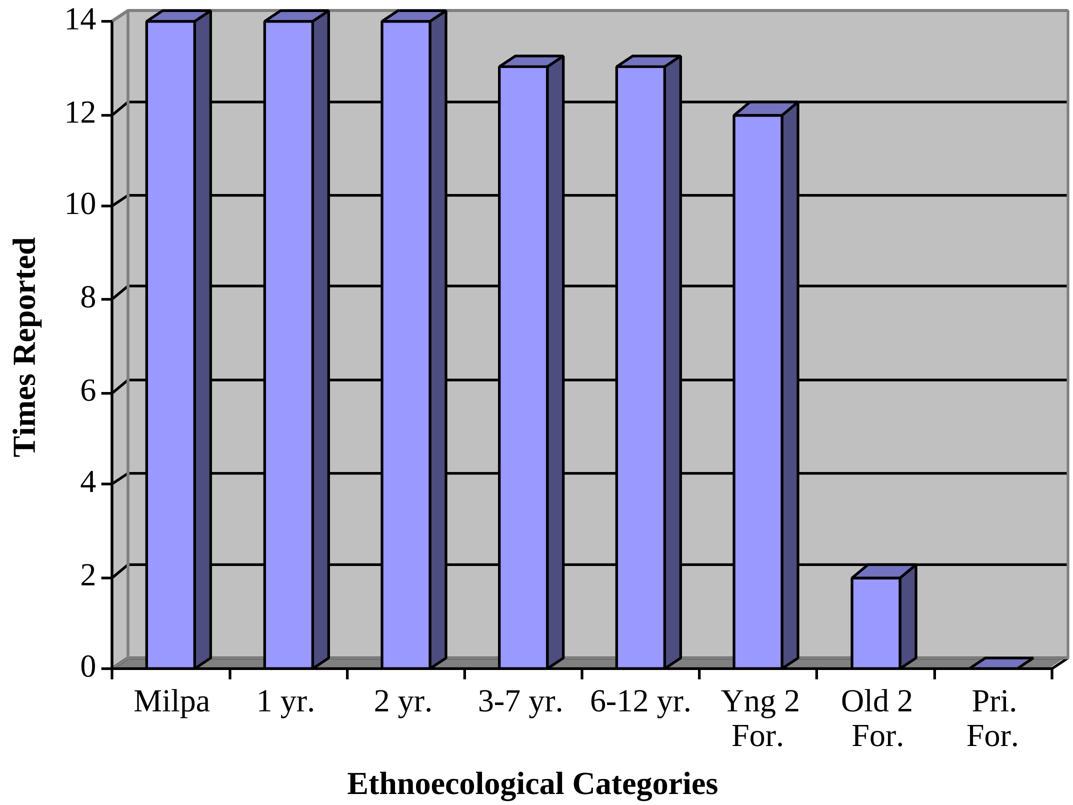
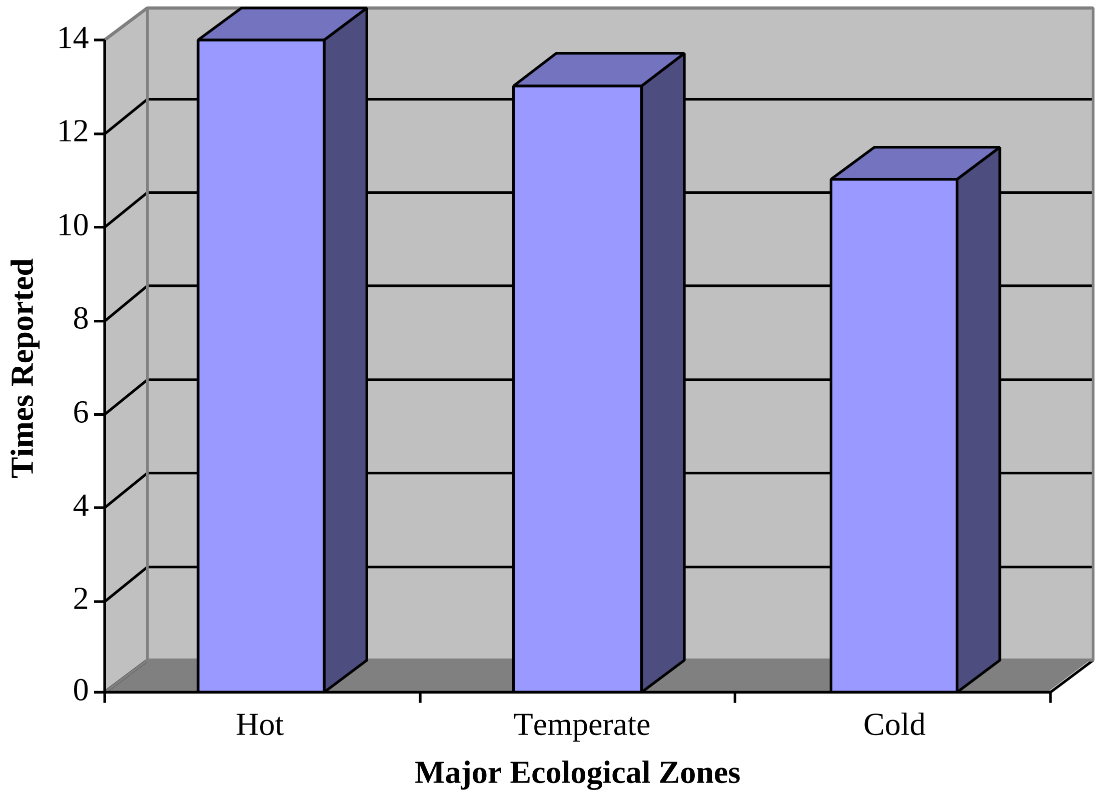


Figure 6.21: Reported climatic zone distribution of *Tithonia diversifolia*



5) ***Foeniculum*** *vulgare* L.

Ecology, Botany, Folk Classification and Nomenclature

Foeniculum *vulgare* L., commonly known as fennel, is in the Umbelliferae (Carrot) family. It is the fifth most utilized medicinal plant in Tenejapa. The plant is a coarse aromatic herb with a biennial or perennial root with an annual erect green stem up to 2 meters with finely divided, glabrous leaves up to 3 cm long, alternate, feathery and composed of deep green, forked, threadlike segments (Figures 6.22, 6.23). The flowers are small, yellow and in terminal flat-topped umbels up to 15 cm across. The seed is aromatic, oblong, ridged 5 mm long, 1.5 to 2 mm wide. The plant is native to the Mediterranean but is now cultivated worldwide. It was introduced in Chiapas shortly after contact with historical literature noting that it was introduced into the nearby Tzotzil muncipality of Zinacantán in 1545 by Fray Jordan de Piamonte from Oaxaca (Ximenes 1929). The plant grows at all elevations in Tenejapa and is usually cultivated although it can be found in milpas, where it is maintained as a volunteer crop and in recently disturbed vegetation (Figures 6.24, 6.25). The plant is noted as weed in Chiapas (Villaseñor and Espinosa 1998) and throughout South America, New Zealand, Australia, Afghanistan and Israel (Holm et al. 1979). The plant is known in Tenejapa and in Tzotzil municipalities as *inojo* or *inajo*. This name has been borrowed from the Spanish name *hinojo*.

Medical Ethnobotany and Ethnopharmacology

The plant is used primarily to treat epigastric pain, more commonly known as colic and in Tzeltal, *sk'ajk'al o'tanil*. There were two reports of its use for heartburn (*k'ux o'tonil*). The leaves are gathered and then boiled into a tea and occasionally the root is used as well. Fennel is a significant medicinal plant worldwide and it use traces back at least to ancient Greek civilization. It is included in the Physician's Desk Reference for Herbal Medicines and was also included in the German government's commission E list of safe and effective medicinal plants (Fleming 1998).

A wide range of studies have shown the effectiveness of fennel in the treatment of epigastric pain (e.g. Giordano and Levine 1989). The essential oil of the seeds contain d-pienen, camphene, d-phellandrene, dipenene, fenchone, methyl chavicol, aldehydes and anisic acid (Furia and Bellanca 1971).

Figure 6.22: Botanical illustration of *Foeniculum vulgare* by Nicolas Hernández Ruíz

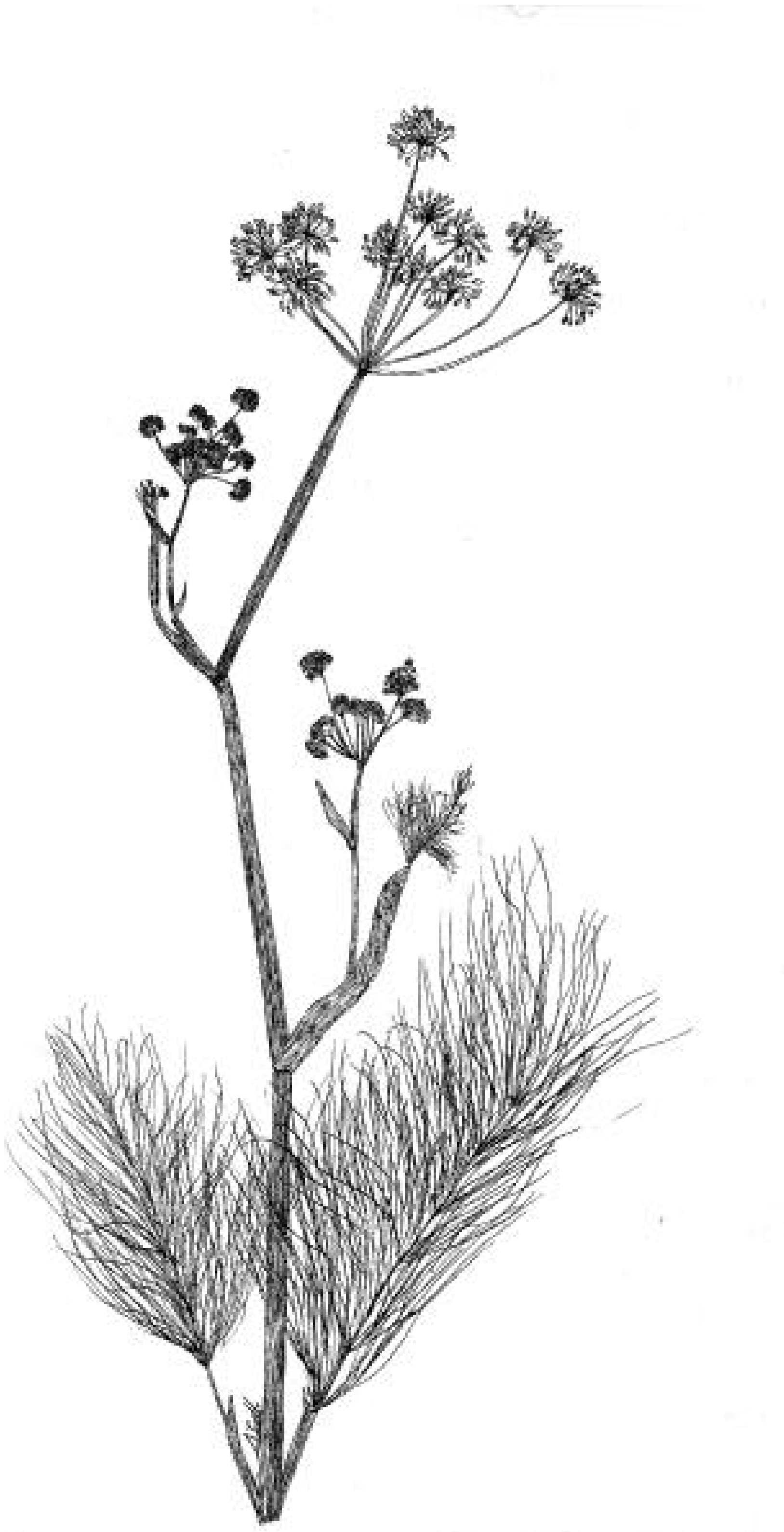


Fig 6.23: Voucher specimen of *Foeniculum vulgare* used in distribution study

Figure 6.24: Reported habitat distribution of *Foeniculum vulgare*

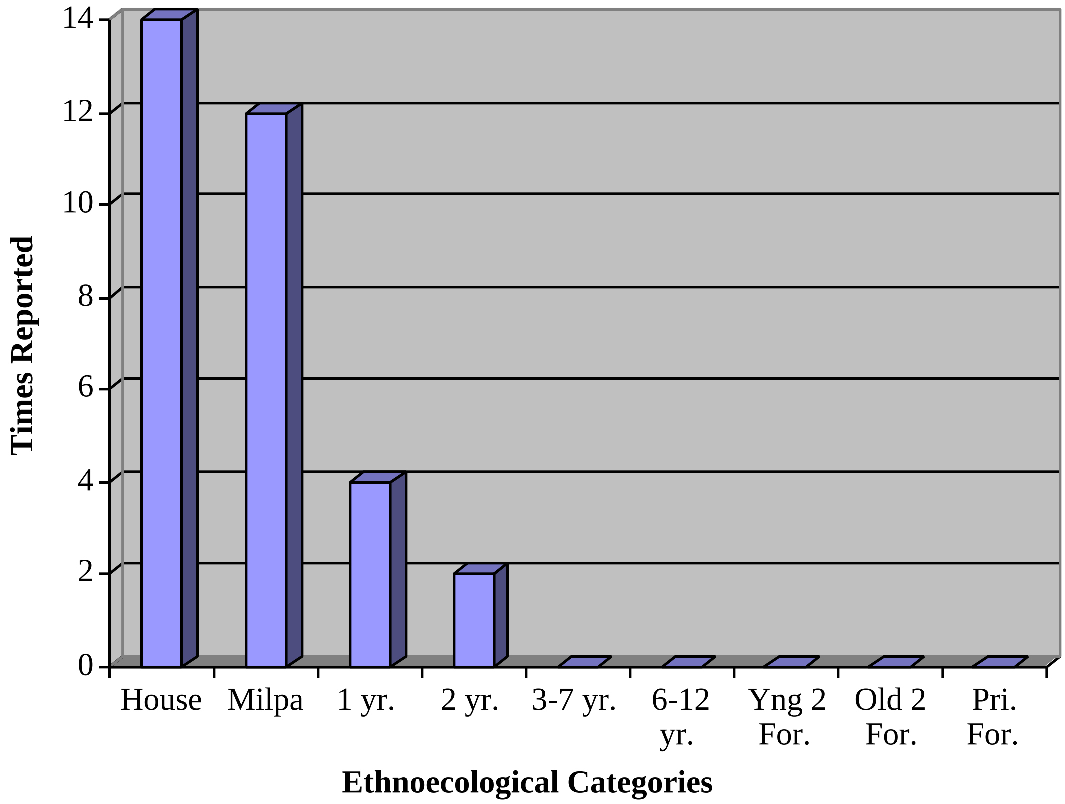
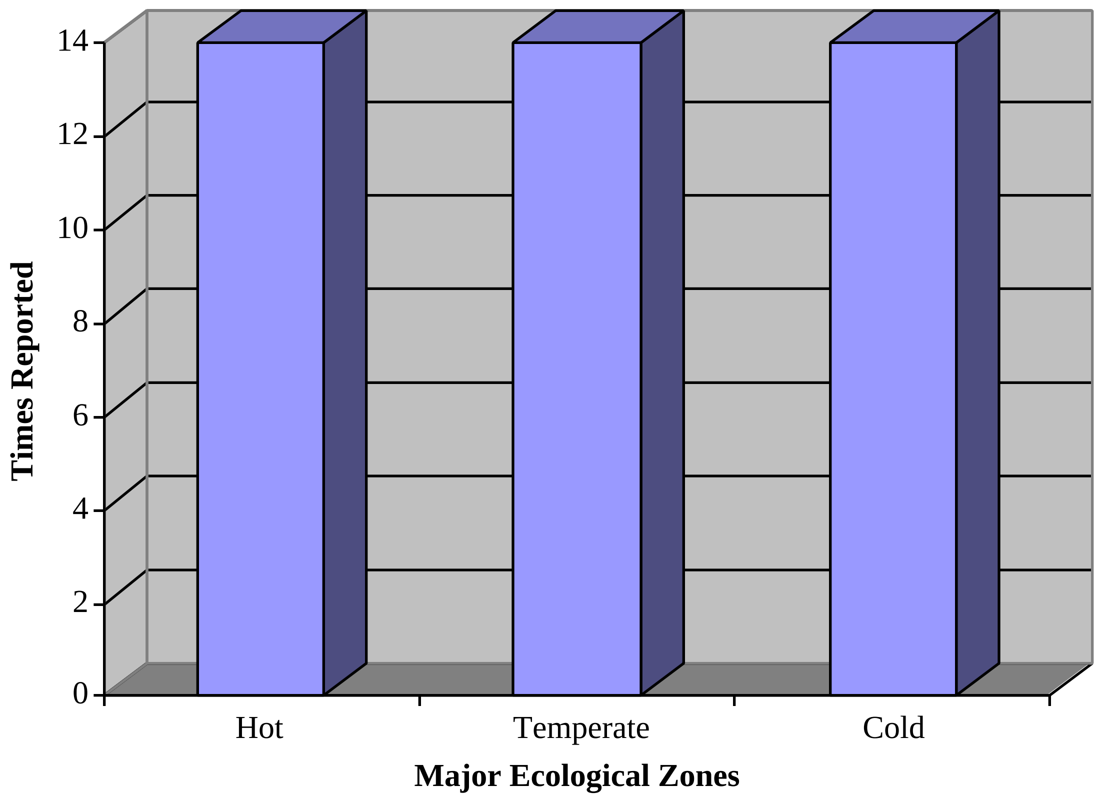


Figure 6.25: Reported climatic zone distribution of *Foeniculum vulgare*



CHAPTER 7

CONCLUSIONS

In this concluding chapter I present a summary of the major findings of the dissertation followed by a potential explanation of the results based on evidence and theory from human and biochemical ecology. I then discuss the implications of the study for ethnobotany and conservation followed by some concluding remarks.

SUMMARY

This research was concordant with previous work on medical ethnobotany with the Highland Maya (Berlin et al. 1974; Berlin and Berlin 1996) that demonstrated that medicinal plants play an overwhelmingly primary role in the daily health care of the Highland Maya. Despite having access to clinics in most of the communities, people continue to self-administer treatments derived from medicinal plants and rely on clinics on rare occasions for very serious conditions.

93 percent of medicinal plant procurement was conducted within a 2-km radius around each household and plants with limited ecological distribution are usually utilized only in communities where they are readily available. The average time spent in procurement of medicinal plants for a specific and discrete treatment is 16 minutes. This correlates with data that demonstrated that a 1 km radius around a given household is the primary (71 percent) area for obtaining medicinal plants.

The distribution of medicinal plants within specific ecological zones based on successional stages was also analyzed. 86% of medicinal plants were obtained in managed areas or areas of secondary vegetation (non-forest). 14% were obtained in young secondary forest. No medicinal plants were obtained in areas of old secondary or primary forest during the study.

Research was also conducted on the ethnoecological distribution of 203 plants with the highest consensus regarding their status as medicinals. Detailed information was recorded regarding their distribution across gross climatic zones and successional stages. These data show that early successional stages are the most common habitats for medicinal plants and that distribution falls off sharply in forested areas. These findings support the main study.

A study was also undertaken to look at medicinal plant use by people living adjacent to primary forest. Ten individuals living within a 1km radius of primary forest were interviewed. None of the individuals could recall obtaining medicinal plants in the primary forest for any illness, although they could identify a small set of eight plants that were previously identified as primary forest obligate medicinal plants (Casagrande n.d.) The ratio of use between secondary non-forest habitats and secondary forest was comparable to the results of the main study. Overall, the results support the data from the main study.

HUMAN ECOLOGY AND MEDICINAL PLANTS

When one looks at non-specialized healing by the general population a few aspects become apparent. As discussed in Chapter 5, there are numerous anthropological studies that suggest disturbed areas are preferred habitats for obtaining medicinal plants. Widely utilized medicinal plants need to be abundant and accessible. Rare plants are not often found in medicinal floras because they either quickly become extirpated or are brought under cultivation, and thus cease being rare. Plants that take several days to find and collect are not very beneficial when one is sick. Thus plants that are close by will be preferred. Traditional peoples, even those *of* the primary forest, generally do not live *in* the forest but rather on its edges, in riverine environments or in cleared areas (see, as examples, Rappaport, 1984; Descola, 1993; Chagnon, 1997). This is certainly true with regards to horticultural and agricultural societies but perhaps less so for foraging societies and, of course, there are always exceptions (e.g. Shepard 1999). This issue of accessibility may be part of the reason that plants from disturbed areas have such significant representation in medicinal floras.

But as demonstrated in this study, people will, occasionally, walk a long distance to obtain a medicinal plant if it is the only plant known to treat a certain condition. Thus a medicinal flora needs to be efficacious and a medicinal flora needs to be biologically active, for the most part. Although efficacy is a cultural construct, it is a cultural construct with a broad biological foundation. Plants that are not regarded as efficacious will be discarded for ones that are. As noted in Chapter 6, there is abundant scientific literature attesting to the bioactivity of many of the most utilized Tzeltal Maya medicinal plants. It is highly unlikely that the continued use of these plants is due only to their symbolic value. However, it is important to note that placebo effects *are* present in treatments with medicinal plants, just as they are present in pharmaceutical treatments. Placebo effects are a complex cultural phenomenon and are likely present in all healing systems.(Moerman, 2000). This does not negate the demonstrated potential for medicinal plants to be bioactive and efficacious.

Once adopted, ethnopharmacopeias show remarkable persistence over time. Perhaps the most striking example comes from the Monte Verde site in Chile that gained notoriety when independently verified dates were established for human presence at the site at least 13,000 years ago (Dillehay 1989). This predated the Clovis site in New Mexico which had previously been considered the oldest known site of definite human occupation in the New World. At the site archaeologists found remnants of 23 species of plants still known as medicinals by the present day indigenous Mapuche living in the area. Of the 23 plants, 10 have no other uses other than as medicines. Four of the species did not grow in the region, meaning that they had to have been brought in, a strong indication of their ethnobotanical significance. While it may be unlikely that the use of these plants as medicines represents an continuous transmission of knowledge over 13,000 years, it nevertheless demonstrates persistence and perhaps repeated re-discovery of efficacious phytomedicinals.

BIOCHEMICAL ECOLOGY AND MEDICINAL PLANTS

Here I provide potential explanations for the results of the study through a presentation of ecological and biochemical theories and findings in relation to plant secondary compounds. These qualitative (*sensu* Feeny, 1976) low molecular weight compounds are the ones that exhibit bioactivity and can serve as medicinals for humans (Kinghorn, 1994).

Secondary compounds in plants are important for a variety of ecological functions. Chief among these are as insect and animal attractants for pollination and seed dispersal; allelopathy, where they inhibit germination and growth of other plants; and, as chemical defense against herbivory (Harborne 1993). With regards to allelopathy, at least 50 species of plants have been shown to interfere with crops through secondary compounds (Putnam, 1994). However, because allelopathy usually occurs through the complex chemical matrix of the soil it is difficult to conclusively show a causal relationship (Zimdahl 1999) and their remains much work to be done in this area (cf. Rice 1984).

Investigations into plant anti-herbivore defense are further developed. Scientists have long pondered what Feeny (1976) termed a conspicuous non-event on the planet: given the enormous destructive potential of herbivorous insects, why have they failed to prevent plants from dominating most of the terrestrial surface of the planet. In short, why is the planet so green? A response is neatly provided by Janzen (1975), 'The world is not colored green to the herbivore's eyes, but rather is painted morphine, L-DOPA, calcium oxalante, cannabinol, caffeine, mustard oil, strychnine, rotenone, etc."

Yet anti-herbivory secondary compounds in plants are not equally distributed across the landscape. Plants vary enormously in their strategies to prevent herbivory. Yet researchers have noted some patterns. There are two current major theories of plant defense, apparency theory (Feeny 1976, Rhoades and Cates 1976) and resource availability theory (Coley et al. 1985). I discuss these two theories in more detail below. Both support the hypothesis that vegetation in disturbed areas would tend to be high in bioactive secondary compounds. These two theories are complementary to each other and share some predictions such as the prevalence of bioactive compounds in early successional species and digestibility reducers in late successional and climax species (Howe and Westley, 1988). Like all theories there are exceptions to the rule. Both theories have been criticized because of these exceptions. This points to the difficulty of developing a general theory of plant defense, given the wide range of strategies that plants engage in and the wide range of habitats in which they live. The explanatory value of both theories is greatest when one looks at general cases. Also, in as much as these theories dichotomize, they provide a model of nature. The reality is probably closer to a continuum of defense strategies with significant clustering into two overall patterns.

Apparency Theory

Feeny (1976) suggests that there are two main types of antiherbivory chemical defense strategies for plants depending on their degree of apparency (i.e. how likely they are to be discovered by herbivores). Unlike animals, plants can not flee predation and require defenses. First, there are metabolically inactive, *quantitative defenses* such as tannins and lignins of high molecular weight. These compounds have been shown to reduce digestibility but do not act as biological toxins (Feeny, 1976). These generalized and oftentimes structural defenses, are advantageous for plants that are easily found. This correlates with the lifespan of the plant. Feeny notes that trees and shrubs are highly apparent along with perennial grasses. Grasses rely on structural defenses such as silica, or they simply grow back after they are consumed by herbivores. This may explain the significant under-representation of medicinals from the Poaceae family in the Highland Chiapas ethnopharmacopeia and ethnopharmacopeias worldwide. Since grasses do not usually rely on qualitative defense compounds they rarely have bioactive secondary compounds. Consequently they are rarely used as medicinals, and instead are the single most important source of human food plants (wheat, maize, rice, barley, sorghum, oats, rye, sugar cane, etc.)

The second type of strategy relies on *qualitative* defenses, low molecular weight secondary compounds such as alkaloids, cardiac glycosides or terpenoids. These compounds are toxic at low concentrations (usually <1 percent dry weight) and highly biologically active (Feeny, 1976; Coley et al., 1985). Ephemeral, successional or *r*-selected species, meaning species that are opportunistic, rapidly colonize an area, and are short-lived tend to rely on these sorts of toxic chemical defenses (Rhoades and Cates, 1976; Abe and Higashi, 1991). These plants are less likely to be discovered by insects and thus less in need of generalized defenses that require a significant metabolic cost and investment. Qualitative defenses usually serve the plants well against herbivory because their short life span makes it less likely that a population of insects will evolve ways to detoxify the compounds. Of course, this is not always the case and there is abundant literature noting the ability of specialized herbivores to bypass plant qualitative defense compounds (Harborne 1993).

Apparency theory can also be applied to predictions about specific parts of plants. McKey (1979) hypothesizes that in the same way that plants with long life spans invest in quantitative defenses, so will the longer living parts of plants. He suggests that quantitative compounds are more likely to show up in woody tissues and mature leaves while new leaves are more likely to contain qualitative compounds. This may explain why the Tzeltal usually use fresh leaf material and young stems to prepare treatments rather than more woody parts of plants.

Resource Availability Theory

In many ways, apparency theory is a theory developed from the perspective of the animal in that it implies that herbivory is the selection pressure that allows for the evolution of defense compounds. A more recent body of theory termed resource availability theory emphasizes the plant perspective. In some regards, it is a more robust theory in terms of explaining certain patterns of plant defense (Howe and Westley 1988).

Resource availability theory (Coley, Bryant and Chapin 1985) derives from an assumption that the availability of resources for plants to replace parts lost to herbivory is the primary determinant in the type of defense. It was similarly suggested as the "rich man spendthrift hypothesis" by Janzen (1985: 210) when he stated that "the harder it is for a plant to replace lost tissues, taken by an herbivore, the more intense should selection be for those traits that prevent herbivory."

There are two main variables affecting growth potential that determine which defense strategy plants will engage in: 1) growth rate and lifespan; 2) resource availability (including light) and resource type. With regards to growth rate and lifespan, Coley, Bryant and Chapin (1985) state that fast-growing species tend to invest in mobile (qualitative *sensu* Feeny) defense compounds rather than immobile (quantitative *sensu* Feeny) compounds. They also demonstrate a positive correlation between short-living plants and a reliance on mobile compounds. Further support for the relationship between lifespan and type of defense is provided by the fact that all over the world, alkaloids are twice as likely to appear in annuals than perennials (Levin, 1976). Leaf life is also an important predictor of defense strategy (Coley, 1988). Plants with long-lived leaves rely on immobile defenses while plants with short-lived leaves invest in toxic compounds.

Resource availability theory also predicts that plants that are growing in conditions with abundant light and fertile soil will invest in mobile defenses because they can more readily replace lost leaves. The metabolic cost is less to develop mobile defenses. When resources are not as available, each leaf becomes valuable to the plant. Thus, the plant will tend to invest in immobile defense which, while more expensive initially, protect the leaf better over an extended period of time.

Both apparency theory and resource availability theory suggest a biochemical explanation for the results of this study. They predict that herbaceous plants in early successional habitats are more likely to contain bioactive compounds than trees and shrubs in mature forest. They demonstrate that the characteristics of weeds in particular make them more likely to contain bioactive compounds. These are the same types of plants from the same types of habitats that the Tzeltal use as phytomedicinals.

IMPLICATIONS FOR CONSERVATION

Before presenting some final remarks I would like to discuss the implications of this study for conservation, both in general and in the Highlands of Chiapas. The intention of this study was not to attack economic arguments for preservation of primary forest despite results demonstrating the non-use of primary forest for medicinals. Yet I do feel that making such arguments is dangerous even when there is good supporting data. For example, if the main reason for preservation of primary forest was for their value in providing novel compounds for pharmaceuticals, they would only remain valuable until the compounds could be discovered and synthesized. Economic arguments are subject to change and fluctuation in markets and technology in a way that intrinsic arguments for conservation are immune. While economic arguments are useful in reaching a broad audience with a conservation message, my opinion is that they should always remain secondary to arguments based on the intrinsic value of primary forests for humans.

Obviously primary forest in the Highlands of Chiapas is not going to be protected for its medicinal value. But there are other aspects of conservation apart from habitat conservation such as medicinal plant conservation, regardless of the habitats from which they come.

While medicinal plants in the Highlands taken as a whole are not in any apparent danger of localized extinction, some species, by virtue of growing during a narrow period of time in the successional process, might be considered potentially threatened. The Tzeltal Maya system of obtaining medicinal plants from nearby early successional habitats appears to have served the Tzeltal well until recent surges in the human population may be affecting the distribution and availability of some species. As discussed in Chapter 2, deforestation and reduced fallow times (due in part to lack of cultivable lands and the increased use of chemical fertilizers) are common processes throughout the Highland region. These changes could be impacting the distribution of the medicinal flora. As the fallow cycle is reduced, the amount of regeneration in secondary habitats and forests is similarly reduced. This, in turn, potentially affects the distribution of the medicinal plant species that show up later in succession. Meanwhile, cultivation of medicinal plant species has been almost non-existent. There are encouraging signs that communities are beginning to develop medicinal plant gardens and it could provide an infrastructure for the conservation of medicinal plants and the transmission of knowledge across communities and municipalities.

Figure 7.1: Women in the Tzeltal Municipality of Oxchuc working in community garden (photo by Paul Duncan)

CONCLUDING REMARKS

It is clear from this and many other studies in Highland Chiapas that the Highland Maya have an intimate knowledge of their biophysical environment. The landscape that the Highland Maya live in is very much a human landscape and research should reflect the complex interactions taking place. Especially with regards to the so-called 'disturbance' vegetation, it is important to understand human modification of the biophysical environment in a non-pejorative manner. The Highland Chiapas 'disturbance' vegetation and the medicinal plants it provides is likely the result of thousands of years of human-plant interactions. An ethnoecological framework can provide an understanding of these interactions that takes into account both ecological and sociocultural factors.

In this dissertation, I have presented data that runs counter to some popular notions about indigenous peoples, medicinal plants and their environments. I would like to conclude with a question: What is in fact, more impressive and exotic? A solitary healer trekking deep into the forest to find a magical cure? Or, a culture that develops an empirically based system of healing over millennia and by transmitting this knowledge orally successive generations are able to find effective treatment for a wide range of illnesses from a 'living pharmacy' that they create within their biophysical environment?

Figure 7.2: Community of Balum Kanal gathered together to share medicinal plant knowledge (photo by Paul Duncan)

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