ETHNOBOTANICAL ANALYSIS OF DIFFERENT SUCCESSIONAL STAGES AS SOURCES OF WILD EDIBLE PLANTS FOR THE GUAYMI PEOPLE IN COSTA RICA

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2004

To Guaymi people of Costa Rica, to my wife Evelyn and to my family.

ACKNOWLEDGMENTS

Special thanks to my advisor, Hugh Popenoe and the other members of my committee John Richard Stepp and Walter Judd. I am very grateful to María Bejarano and Alejandro Palacios of the Guaymi Indigenous reserve for their having me at their home and helping me during my field work. Also, I give special acknowledgment to Luis Diego Gómez for his valuable help in providing contacts, advice, and logistics aid to my work. I am also thankful for the aid and support given to me by Rodolfo Quirós, Emilce Ramirez, and all the staff of Las Cruces Biological Station (Organization for Tropical Studies). I also thank Luis Poveda and Pablo Sanchez at the Juvenal Valerio Herbarium for their help in identifying plant material.

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Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

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By

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December 2004

Chair: Hugh L. Popenoe
Major Department: Natural Resources and Environment

The study took place in the Guaymi Indigenous Reserve of Coto Brus, in the southern pacific region of Punta Arenas, Costa Rica. The purpose of the project was to investigate the cultural importance of different successional stages have in providing the Guaymi with wild food plants. Forty six members of the community were interviewed about wild foods they knew and how they prepared them. Free listing was used to collect the data from each informant. Next the abundance of edible plants (those obtained from the interviews) was studied in five different successional stages.

The cultural importance of each successional stage was evaluated by calculating an Ethnobotanical Importance value (which combined the salience each species had in the free listings with the abundance it had in the different successional stages). Fifty three species of plants and one species of fungus were recorded. Through projections of the species informant curve, a total of 63 species were estimated to make up the wild-food-plant cognitive domain. To the Guaymi, the most culturally valuable and biologically diverse successional stages were the mature forests and their edges. Significant

differences were found in the number of plants mentioned by informants of different ages. In general, the tendency was for older informants to mention more species.

It was also found that older people tend to attribute more value to mature forests and their edges as sources of food than do younger people. Significant differences were also found in the number of species mentioned by men and women. The tendency was for men to mention more species than women. Because of their customs, women do not often go into mature forests since they are far from the inhabited areas; hence they are probably less familiar with the flora there. In general, mature forests and their edges (as well as older secondary growth) had more cultural value to men than to women. On the other hand, women valued early secondary growth as a source of wild food plants more than men do.

CHAPTER 1
SPECIES DIVERSITY OF THE CULTURAL DOMAIN OF WILD PLANTS USED BY THE GUAYMI AS FOOD

The purpose of the study was to determine the cultural and economic values of different successional stages of vegetation for local human communities in terms of the diversity and abundance of wild-food plants they provide. Costa Rica's high biodiversity provides indigenous communities with a vast array of wild food plants which contribute to the livelihoods of native people in significant ways (Stone 1962, 1949).

Since each successional stage contains different species of plants, different successional stages are expected to provide different kinds of products. Often, more-disturbed types of vegetation provide more useful plants than less-disturbed forests (Arnold & Perez, 1998). If this is the case, the Costa Rican government's restrictive land-use policies has regarding indigenous reservations (IIDH, 2002), which limit the types of disturbances within the forest may not be the best for the people that they seek to protect.

Knowing the value to human communities of each type of vegetation could serve as a decision-making tool, since it might be useful when evaluating the economic and cultural impact of new policies or the introduction of new farming techniques that involve changes in the use of the vegetation cover. The information gathered in this study could be used by the community as a way to record knowledge and practices.

To achieve this, the general methodology was to conduct semi-structured interviews with an indigenous community, assessing their knowledge and perception of the importance of the useful flora. To complement this data, field transects (with the aid of local guides to identify useful plants) were used to collect ecological data on the plants (light, soils, successional stage, associations, etc). Information on the species used; and their management, cultural importance and ecology were recorded to complete the project.

Spatial Location

The Guaymi (formerly the Ngöbe) are from Panama and Southern Costa Rica. While the main population is concentrated in Panama (54,285 people according to the official census of 1980) (Sinclair, 1988), a significant population of 10,568 exists in Costa Rica (Cordero, 2002), mainly in the South Pacific coast (Figures 1-1 , 1-2 and 1-3).

Within Costa Rica, the Guaymi are distributed in five main areas, four of them official indigenous reserves. The five main areas are Reserva Indigena Conte Burica, Reserva Forestal Guaymí de Coto Brus, Reserva Forestal Guaymi de Osa, Abrojo Montezuma, and Altos de San Antonio. This last community is not a reserve, but still preserves Guaymi culture and traditions (Cordero. 2002).

Costa Rica's geographic location has many factors that create conditions that increase biodiversity. Examples of these conditions are its location in a land bridge between two continental masses, pacific and Atlantic watersheds, a variety of hydrological regimes (from very wet year-round, to seasonally dry), and a steeply sloped topography that allows climatic changes within very small areas.

The cultural influence of Costa Rican groups is much more related to Amazonian cultures rather than to Mesoamerican cultures. No highly organized societies such as those of Mexico and northern Central America were found in this part of the isthmus when the Spaniards arrived.

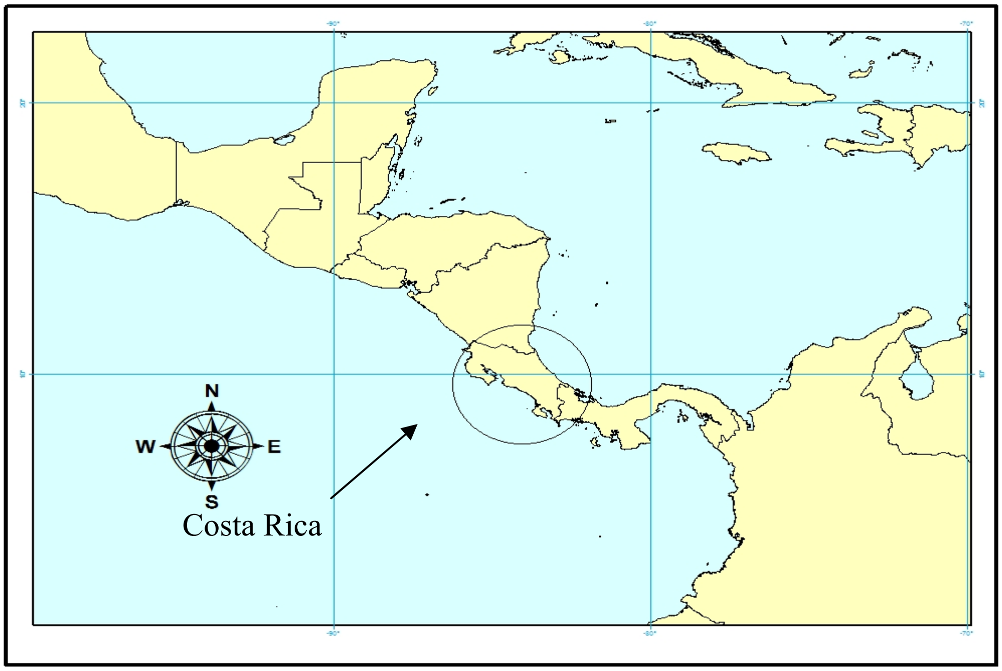


Figure 1-1. Geographical location of Costa Rica.

Figure 1-2. Geographical location of study area

The Guaymi are located in the southern Pacific slopes of the Talamancan range. Many family ties and cultural exchange continue between Panamanian and Costa Rican Guaymi. However, the Costa Rican side does not have the same racial conflicts that have alienated the Guaymi in Panama; and Costa Rican Guaymi are more accessible to outsiders.

No major roads come near the reserve. The closest town is about 17 km. Transportation to San Vito takes about 4 hours since there are only few transports that make it into the reserve through the dirt roads.

The focus of the present study was the Reserva Forestal Guaymí. The main reason was that the community already has a working relationship with Las Cruces Biological Station (OTS) and the Wilson Botanical Gardens nearby. It is also the second largest of the Guaymi reserves in both population and area; home to approximately 1,963 people (Casa de Salud Reserva Indigena Guaymi, 2003) of Guaymi descent in approximately 7,500 ha of primary and secondary forest (as well as agroforestry systems and farmlands).

The Ngöbe, as the Guaymi originally called themselves, lived in what is now northern Panama and Southern Costa Rica on both the Atlantic and Pacific watersheds. One of the main areas of habitation was the Guaymi Valley; hence the name that was given to them by Spaniards and later adopted by them as an ethnic group to adapt to colonial society. Few records of the Ngöbe society exist prior to the Spanish invasion. Records that do exist of this period are the only written history available and are often biased in favor of the Spanish concept of society. Nevertheless, valuable information can be obtained from these records.

In 1502, when Christopher Columbus landed on the Coast of Costa Rica (which was given this name because Columbus believed the inhabitants had large stockpiles of gold hidden in the forests) the Guaymi territories extended from Northern Panama to southern Costa Rica.

They had settlements on both Pacific and Atlantic coasts and there were probably concentrated along the fertile valleys such as the Valle de la Estrella and Valle del Guaymi (Cooke, 1982).

During the colonial period, the Guaymi remained resistant to the Spanish invaders. Efforts were made by both Cartago (then the Costa Rican capital) and Panama to conquer them but they remained independent until the late 1600's when they gradually declined in power due to lack of access to the more fertile lands. At this point religious missionaries finally subdued these populations and incorporated them into the colonial government to later be displaced from their lands. In 1680 it was declared that indigenous freedom was a danger to the colony and hence a system of "reducciones" or reserves, was established and indigenous people were not allowed to travel beyond these.

As the demand for land by the white and meztizo inhabitants grew, the different indigenous groups were forced to be relocated repeatedly into more remote and infertile lands. Little or no compensation was granted to them. One of the last fertile valleys to be taken over by modern society was the Valle de la Estrella. This remote valley remained inaccessible to the Costa Rican government until 1870 when a concession was given to a North American company to construct an Atlantic Railroad. With the advent of this railroad the United Fruit Company established a massive banana plantation project which ended up displacing the remaining Bri Bri, Guaymi, Cabecar, and Tayni groups. This

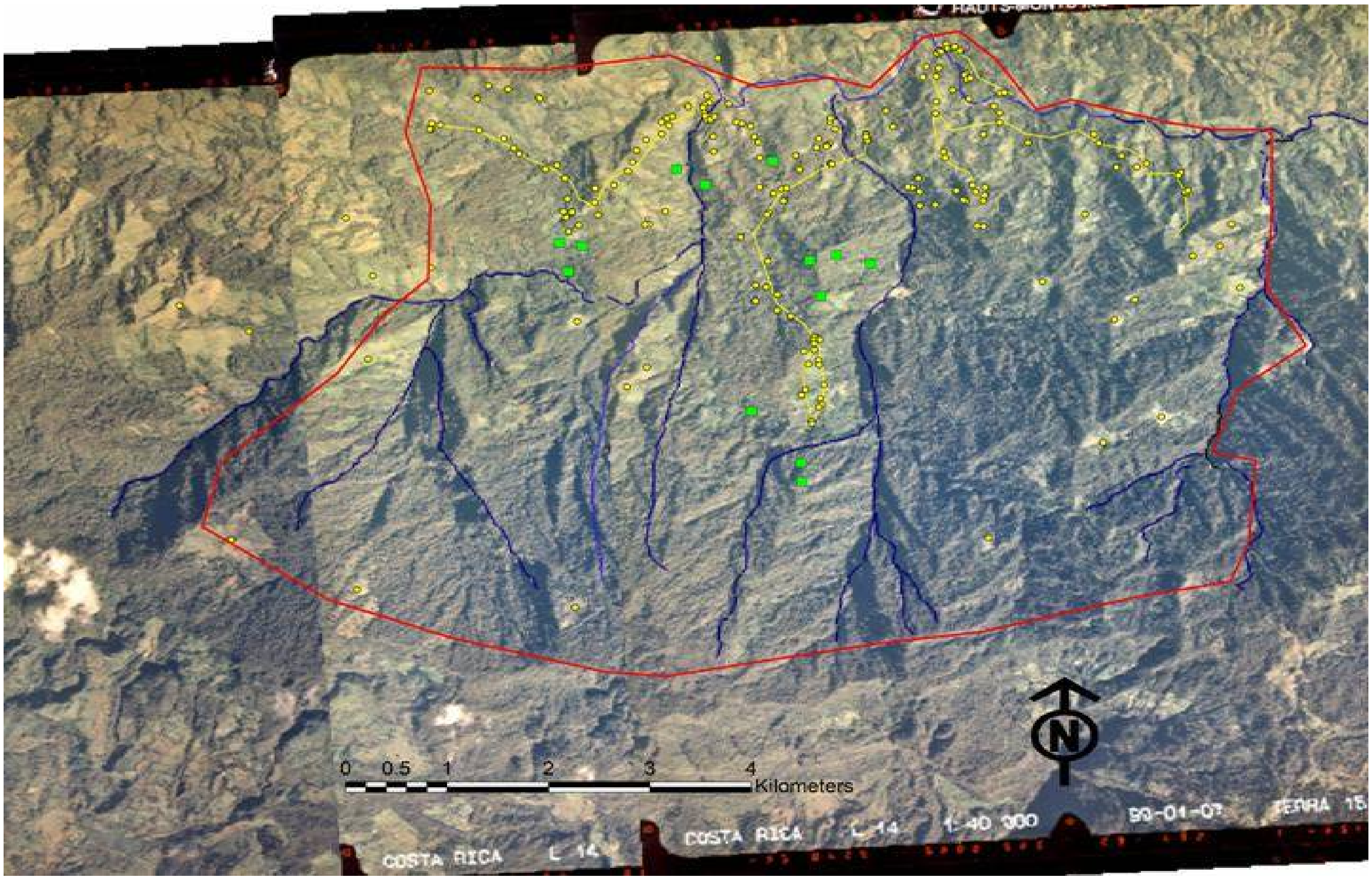


Figure 1-3. Aerial photograph of the Guaymi Indigenous reserve at Coto Brus. Yellow dots show points of habitation, green squares represent areas where sampling plots were set. Source: Instituto Geográfico Nacional de Costa Rica. (1998).

forced many of these groups to move up into the Talamancan and Cruces ranges where they were incorporated into existing reserves of different ethnic groups or formed new temporary ones. In spite of the historical data relating the Guaymi to the Valle de la Estrella in the Atlantic, most of the Guaymi in the Coto Brus area came in more recently in the 1940's from Panama (Camacho, 1996; Koshear, 1995). The main reason for this migration was the scarcity of land (Koshear, 1995).

The Guaymi experienced a long period of instability as they had no rights to individual land tenure, were not recognized as Costa Rican citizens, and could not defend themselves legally in case of invasions of their reserves. Even if the laws prohibited non indigenous people from moving into the reserves, many Costa Ricans sold their lands in the lowlands to banana companies and ended up invading the reserves, pushing the Guaymi and other people further into the mountains.

It was not until 1973 when a commission of indigenous affairs was first established to regulate conflicts between the government and indigenous groups, and to give them rights as Costa Rican citizens. In 1977 the first Indigenous Law was passed to assure equal rights to these groups. In practice, however, in recent years, the Guaymi and other indigenous people still have had trouble having access to education and health services, and their lands are still constantly being invaded by squatters in spite of the existing laws. Not until the 1990's did the government agree to give "cedulas" or ID cards to all the indigenous people. Presently, however, conditions seem to be improving as the government has set up 6 bilingual (Spanish-Ngöbere) primary schools, a health care center and is working on the electric light system.

Finally in 1976 the current location of the Guaymi reserve at Coto Brus was established and designated as such (IIDH, 2002). Presently, the Guaymi reserves are governed by a Communal Association which is required by the Indigenous Law. This organization is a step towards granting a certain degree of autonomy and protection to the Guaymi in the sense that it can take care of managing resources (as long as the management is in compliance with Costa Rican law) and it must be consulted by external entities who wish to exploit mineral resources or partake in other activities within the reserve.

Through these associations, the different indigenous groups have been able to channel tourism, external funds for development and other benefits for the communities. Still, native groups are not in complete ownership of their lands since they are considered as state property and every activity must be regulated by the central government.

Agriculture and Subsistence

With a mean annual rainfall of approximately 3500 mm (OTS, 2003) and poor acidic soils, the Guaymí area is not, in general, very favorable for corn cultivation, hence the Guaymi have tended to rely on a wider variety of crops for their subsistence (Cooke, 1982).

Chronicles of Spanish explorers that relate the way many Guaymi communities depended not only on maize but also relied on a diversity of roots, fruits, wild game, crustaceans, and estuarine, sea and river fish. The pejibaye palm (*Bactris gasipaes*) is mentioned as an important source of starch. This plant is cited as being central to their culture as a source of food, starch, drink, tools, and weapons (Cooke, 1982). This is still true today. Fish (both fresh and salt water) seemed to play a very important part in the local diet, more so than land animals according to Las Casas (1875 cited by Cooke, 1982).

Currently the Guaymi make a living out of subsistence farming, occasional hunting and gathering, handicraft sales, laboring outside the reserve and occasional tourism. Coffee and cacao are the most important cash crops, and represent the group's most profitable monetary activity. Costa Rican law prohibits them from exploiting timber for purposes other than self consumption, and land use change is strictly regulated (IIDH, 2002). This policy comes from decree No. 20045 on the 16th of August of 1991, whereby commercial logging was prohibited in indigenous reservations because they are state property and are supposed to remain forested to protect the native's traditional way of subsistence living. The law defines the traditional way of life as that of subsistence farming, hunting and gathering, and logging is considered as a threat to this way of life (IIDH, 2002). Apparently the government is not yet ready to trust Indigenous groups with full responsibility of management of their lands for fear of having other groups take advantage and deplete the forest resources.

Presently the Guaymi of Osa and Conte Burica reserves have engaged in other types of management with the aid of international NGO's, these include low impact extraction of fallen timber and commercialization of handicrafts.

Farming is somewhat limited because of the poorness of the soils and the steep slopes found in the reserve. In addition to this, the government's policies for retaining forestlands and "preserving" native people's traditional way of life further limit the Guaymi and force them to find ways of using the forest to subsidize their livelihoods.

The Guaymi of Coto Brus have incorporated themselves into the Costa Rican initiative of payment for environmental services. This initiative pays them a fixed amount for the conservation of forestlands in the northern part of the reserve. These funds are distributed among the larger land owners, usually the oldest families who arrived in the area. Overall, the Guaymi, as a group, have been active in incorporating new economical and developmental opportunities into their lifestyles.

Type of Vegetation

The Guaymi Indigenous reserve is classified by Holdridge’s life zone system as very humid pre-montaine forest, warm-wet transition (Hartshorn, 1983). Ranging from about 900 to 1500 meters above sea level, the reserve presents a variety of successional stages, which include primary and secondary forest, disturbed primary forests, farmlands and fallow fields of different ages.

Surrounding Area

The environment surrounding the reservation is dominated by the presence of San Vito and other communities, which are a source of income, fertilizers and other goods to the Guaymi. Often Guaymi will find paying jobs in town or on local farms. The community of Savanillas and La Vega are also very close to the reservation. However, these towns often act as a negative influence since they are a source of poachers and squatters that invade the reservation. The Wilson Botanical Gardens and the Las Cruces Biological Station run by OTS are also a major influence since they bring in tourists, students and researchers who contribute to the community.

Relevance of the Project

Knowing the importance of different successional stages for a particular culture is useful for scientific, governmental, communal and non governmental organizations involved in the planning and decision making process regarding land use in the area. Furthermore, this project proposes a methodology that can be used for evaluating the importance of successional stages in providing non timber forest products other than edible plants and for other cultures other than the Guaymi.

Another objective is to develop a background of information upon which further forest resource development projects can be based on in the future to aid the Guaymi and improve their quality of life. Since Costa Rican law currently prohibits the more profitable activity of commercial logging and restricts land use change, it is important for any development program to consider the ecology and ethnic dynamics of Non timber Forest Products available within the reserve.

Finally, the project will also serve to record the Guaymi's knowledge of their environment. This will aid in preserving it for their future generations and for the general scientific and lay community.

Guaymi Indigenous Reserve as a Human Ecosystem

There exists a complex relationship between the Guaymi culture and its environment. This relationship is based on the interactions that result from the Guaymi's partial dependence on the forest and its resources. It is a two way interaction in which the culture and knowledge of the Guaymi is influenced by the dynamics of the ecosystem (species composition, phenology, climate, soils, etc), and the environment is at the same time shaped by the Guaymi's use of it (harvest intensities, methods of extraction, patterns of habitation, management, modifications of vegetation cover, etc).

The accumulation of ethnoecological knowledge regarding plant uses (food, medicine, fiber, etc), animal behavior, soils management, and agricultural practices is essential for the Guaymi to transform the raw resources provided by the forest into useful products such as food, building materials, handicrafts, dyes, and others. Accumulating this knowledge, however, requires the investment of energy on the part of the community. This energy manifests itself in time spent teaching the young, time spent by the younger generations learning about the uses of plants, time spent in the forest collecting these to preserve it in the memory as well as to generate new knowledge. All this time could be invested in other activities such as paid work outside the reserve. Although not a formal process of learning in most cases, the activity involves a specific community structure in which members spend time together sharing knowledge.

From the ecosystem's point of view, the Guaymi community is a central component that has, as most human communities do, a determining influence on its workings. Activities such as agriculture, wild plant collecting for food, materials and medicine, hunting and clearing for habitation and tourism have a direct effect on the animal and plant communities surrounding them.

The clearing of vegetation for agriculture in the flatter areas that have more fertile soils initiates a successional cycle that would not otherwise exist in the forest. Each succession stage is characterized by a different community of plants that are adapted to the conditions of light, temperature and moisture therein. This will benefit those plants adapted to such conditions and harm those which cannot compete under them. In this way, the species composition is directly affected by human activities.

Aside from the impacts of agriculture, other activities such as direct extraction of plants or plant parts from the forest also affect the spatial distribution and abundance of species. Extraction can have adverse or positive effects on plant populations. For example, plants for which extraction involves the elimination of the whole plant such. Other plants where extraction involves plant organs such as leaves or stems but which leave the plant alive to resprout another season may be affected in a more indirect way. For example, a plant whose leaves or stems are removed must invest its energy into re-sprouting, energy that could have been used for reproduction; hence the abundance of offspring that this plant produces will be diminished, consequently reducing the plant's abundance in the future. Plants used in this way are likely to be more abundant in places less frequented by humans.

On the other hand, there are some plants that may benefit from human use. Plants which produce edible fruits may use humans as a means of seed dispersion, consequently thriving in areas near human habitation. Other plants useful to humans receive special care such as weeding and vine removal whether they grow in the forest or as volunteers in agricultural fields. Other plants receive even more care through partial or complete domestication as is the case for *Bactris gassipaes* and many tubers commonly grown in plots or home gardens (*Xanthosoma violaceum*., *Dioscorea* spp.).

Finally, the impacts on the local fauna are similar to those of vegetation. As animals depend on plants as a source of food and shelter, changes in the composition of vegetation are prone to benefit or undermine their survival according to their ecological requirements. In a similar manner to plant extraction, hunting will also have an effect on animal populations.

Thus humans play a determining role in the composition and distribution of vegetation surrounding them either by direct or indirect manipulation. This effect cannot be said to be either positive or negative, but only as a reality within the reserve which is key to the current state of the ecosystem. Both plants and animal communities existing in the reserve have been shaped by the presence of the Guaymi community in a similar fashion that the Guaymi community is structured to adapt to the environment.

Guaymi Classifications of Ecological Successions

The Guaymi have a simple way of classifying ecological successions. They recognize the original state of the forest as “kotowä” which simply means mountain. After the forest is cut down and fields are established they are known as “work places”. Once these are abandoned after four or five years of cultivation, they recognize early secondary growth as “komu kia” or small brush. After five or six years more of this stage it becomes “komu” or brush. The next and final stage before returning to mature forest is called “komu kri” or tall brush. This stage lasts about ten years, and is recognized because the girth of the trees is such that an axe must be used to clear the area. The species composition of the tall brush stage differentiates it from mature forests. Finally after eleven to 15 years they say the mountain returns to its original state.

The Guaymi Wild Edible Plants Cognitive Domain

The knowledge held by a community regarding a certain topic is called a Cultural Domain. It does not depend on a single individual, but rather it is spread throughout the community. In this case, the cultural domain under study is that of wild edible plants. In studying this domain, two main characteristics were taken into account: diversity of plants known and relative importance of each plant. The reason for this is that not all plants will have the same importance as others. For example, some may be used by most of the community, indicating they are culturally important, while others may be used by only a small percentage of the community, making them culturally less important. More important plants will also tend to be more salient in the informants' minds.

In this study, any wild plants used for food (as well as one fungus species) were considered to form part of the domain. This first chapter includes a description of the plants that were found to be part of this domain, their methods of preparation, cultural details associated with them and the part of the plant that is used for food.

Methodology

The method for obtaining information on the cultural domain in question was free listing. A total of 46 informants were interviewed for this purpose. Each informant was asked to enumerate all the wild edible plants that came to his mind at that moment. These were noted down in a questionnaire. Additional information such as successional stage, part used, preparation and frequency of use was also noted down (See Appendix A for questionnaire).

The number of informants to be interviewed was determined by using the informant-species curve (Figure 1-1). This curve was obtained by comparing the number of species mentioned with the number of informants interviewed. These results were randomized 130 times through bootstrapping to estimate the tendency of new species to appear. Through this curve, the total number of species that compose the cultural domain were estimated as the curve started to level off.

All the plants that could be found in the wild during ecological sampling were collected for botanical identification at the Herbario Juvenal Valerio of the National University of Costa Rica. Digital pictures of most species were taken. The names of the plants in Ngöbere were taken from the Guaymi Grammar and Dictionary (Alphonse, 1956), the Alfabeto Practico Ilustrado Guaymi (Constenla, 2001), and personal consultations with the bilingual school teacher of La Casona school: Santos Gonzalez (2004).

Results

Figure 1-3 presents the informant- species curve after bootstrapping the results for the freelistings 130 times. The curve tends to stabilize itself slightly above 60 species. The decision to stop the free listing interviews at 46 informants to maximize the available time was taken based on this curve.

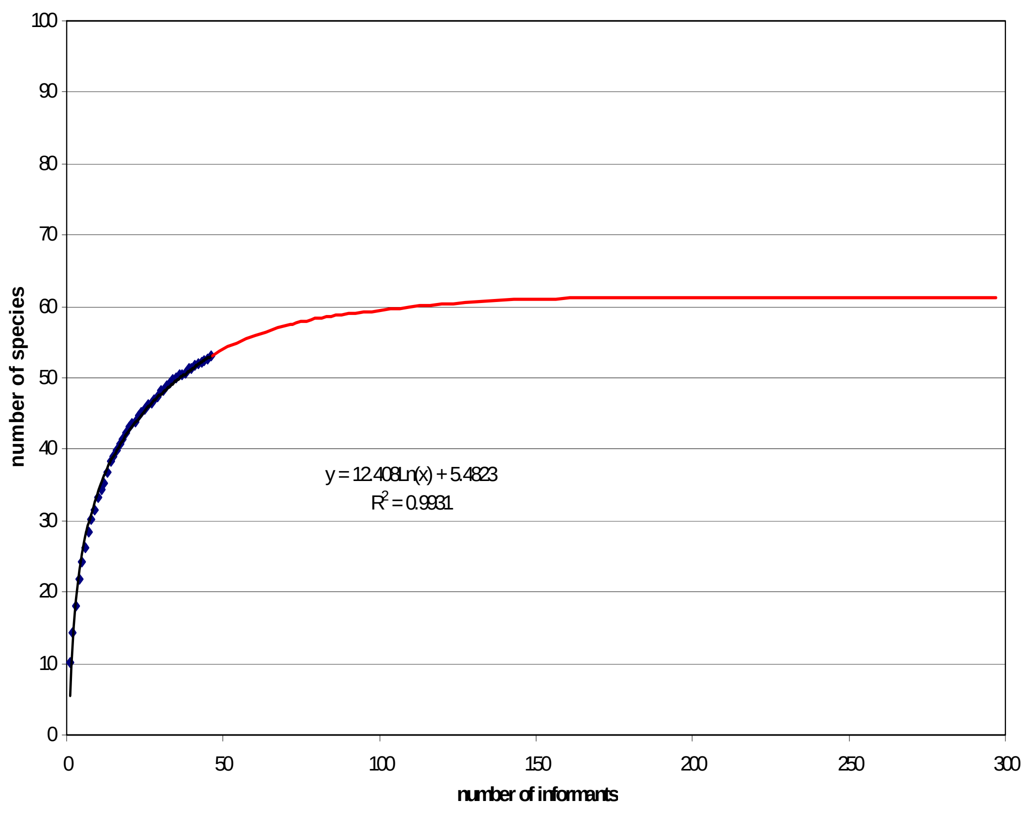


Figure 1-4. Species informant curve for wild edible plants used by the Guaymi in Coto Brus Costa Rica.

From the free listings, a general list of the plants used by the Guaymi was created. Table 1-1 presents the list of items with their common and scientific names and the parts of the plants mentioned by the informants. Spanish and English names (often generic) were used when possible, but often only the Ngöbe name was the only specific name that could be found.

For the Spanish names, Leon et al (2000) was used to mention the other names that the plants are given throughout Costa Rica. The reason for this is that the Guaymi would often know only few or none at all of the names given to plants in Spanish. English names were taken from various books that describe tropical crops, these, however were not complete since many of the plants are not commonly seen as crops and do not have common names in English.

The scientific names were spelled according to the spelling recognized by the Missouri Botanical Garden (Tropicos 3 database, 2004). Although the original Ngöbere toungue does not have a written alphabet, native names were spelled according to the official phonetical representation used in Guaymi written language Alphonse (1956) and Constela et al (1981).

Table 1-1. List of wild edible plants found during this study.

Family	Species	Part used	Ngöbere name	English name	Spanish name
Anacardiaceae	*Spondias mombin* L	shoots	Jögo	Yellow mombin	jobo
Apiaceae	*Eryngium foetidum* L.	leaves	Kulandro	False coriander	culantro
Arecaceae	*Chamaedorea tepejilote* Liebm. ex Mart	immature flower	Ñürüm		pacaya
Arecaceae	*Socratea exorrhiza* (Mart.) H. Wendl	shoots	Búro	heart of palm	chonta
Arecaceae	*Geonoma interrupta* (Ruiz & Pav.) Mart.	shoots	Juö	heart of palm	súrtuba

Table 1-1. Continued

Family	Species	Part used	Ngöbere name	English name	Spanish name
Arecaceae	*Euterpe precatoria* Mart.	shoots	Midrá	heart of palm	Palmito de mantequilla
Arecaceae	*Prestoea acuminata* (Willd.) HE Moore	shoots	Titi	heart of palm	palmito morado, palmito de matequilla
Arecaceae	*Oenocarpus mapora* H. Karst	shoots	Jöra	heart of palm	manqueque
Begoniaceae	*Begonia sp.*	stalk	ibiagro	begonia	begonia
Bignoniaceae	*Mansoa hymenaea* - (DC.) AH Gentry	leaves	do boin		ajo natural
Bromeliaceae	*Bromelia pinguin* L.	fruit	viru		piñuela
Burseraceae	*Protium panamense* (Rose) I.M. Johnst.	fruit	judra tain		alcanfor
Caricaceae	*Vasconcella cauliflora* (Jacq.) A. DC	fruit	kegema	wild papaya	papaya de monte
Convolvulaceae	*Maripa nicaraguensis* Hemsl.	fruit	drwä köi		
Chrysobalanaceae	*Licania belloi* Prance	fruit	sabo		sonsapote
Clusiaceae	*Garcinia madruno* (Kunth) Hammel	fruit	tröbo		Madroño, limón de montaña.
Cucurbitaceae	*Sechium pittieri* (Cogn.) C. Jeffrey	shoots	mirera		tacá, tacaco cimarrón
Cucurbitaceae	*Sechium tacaco* (Pittier) C. Jeffrey	shoots	ka käre		tacaco
Cyclanthaceae	*Carludovica palmata Ruiz & Pavon*	immature flower	dogogo		Elotillo, chidra,
Dennstaedtiaceae	*Hypolepis repens (Linnaeus) C. Presl.*	shoots	ka ugwó		helecho de espina
Dioscoriaceae	*Dioscorea trifida* Lf	root	drün nuen	Yam	ñampi
Dioscoriaceae	*Dioscorea alata* L	root	drün ñampi	Yam	ñampi
Dioscoriaceae	*Dioscorea trifida* Lf	root	drün drüne	Yam	ñampi
Fabaceae	*Inga spectabilis* (Vahl) Willd.	fruit	bü		guaba
Fabaceae	*Inga cotobrucencis*.	fruit	bü		guaba
Fabaceae	*Inga hibaudiana*.	fruit	bü		guaba
Heliconiaceae	*Heliconia pogonantha* Cufod.	shoots	müne	Heliconia	platanilla

Table 1-1. Continued

Family	Species	Part used	Ngöbere name	English name	Spanish name
Heliconiaceae	*Heliconia danielsiana* W.J. Kress	shoots	müne	Heliconia	platanilla
Heliconiaceae	*Heliconia latispatha* Benth.	shoots	bidu	Heliconia	platanilla
Lauraceae	*Persea sp.*	fruit	dügá	Wild avocado	aguacate de montaña
Lecythidaceae	*Gustavia superba* (Kunth) O.Berg	fruit	tüba		membrillo
Malpighiaceae	*Byrsonima crassifolia* (L.) Kunth.	fruit	miga		nance
Malvaceae	*Theobroma bicolor* Bonpl. in Humb. & Bonpl.	fruit	ödobá	Wild cacao	pataste
Malvaceae	*Theobroma angustifolium* Sessé & Moc. ex DC.	fruit	müra	Wild cacao	cacao de montaña
Malvaceae	*Triumfetta sp.*	stalk	mozote		mozote
Maranthaceae	*Calathea crotalifera* S. Watson	shoots	krigo bugün		bijagua
Marantaceae	*Hylaeanthe hoffmannii* (K. Schum.) A.M.E. Jonker & Jonker ex H. Kenn.	root	apú		
Moraceae	*Brosimum guianense* (Aubl.) Huber	fruit	bere	Bread nut	Azulillo, mariabe, granadillo.
Myrtaceae	*Psidium guajava* L.	fruit	ngima	Guava	guayaba
Passifloraceae	*Passiflora vitifolia* Kunth	fruit	guate	Passion fruit	granadilla
Passifloraceae	*Passiflora quadrangularis* L.	fruit	guate	Passion fruit	granadilla
Passifloraceae	*Passiflora* sp.	fruit	guate	Passion fruit	granadilla
Phytolaccaceae	*Phytolacca rivinoides* Kunth & C.D. Bouché	leaves	segá	Poke weed	jaboncillo
Sapotaceae	*Chrysophyllum brenesii* Cronquist	fruit	zuli krie		caimito
Sapotaceae	*Pouteria sapota* (Jaq.) H.E. Moore & Stream	fruit	ngomo		zapote
Sarcoscyphaceae (Ascomycetes)	*Cookeina tricholoma* (Mont.) Kuntz	fruiting body	kri olo		hongo
Simaroubaceae	*Simarouba glauca* DC.	fruit	rugá		aceituno
Solanaceae	*Cestrum* sp. *Cestrum racemosum* Ruiz & Pav.	leaves	ñulio		zorrillo
Theophrastaceae	*Clavija costaricana* Pittier	fruit	dräw kri		
Theophrastaceae	*Clavija costaricana* Pittier	fruit	musola		

Table 1-1. Continued

Family	Species	Part used	Ngöbere name	English name	Spanish name
Urticaceae	*Urera baccifera* (L.) Gaudich. ex Wedd.	shoots	bugrün		ortiga
Urticaceae	*Urera elata* (Sw.) Griseb.	shoots	bugrün		ortiga
Unknown		seed	graju		
Unknown		stalk	ka ñüde		

All the scientific names and authors were taken from TROPICOS[3] database of the Missouri Botanical Gardens (2004).

Table 1-2 presents the number of species per family that were found. The tendency of the Guaymi is to use one or a few species (often of the same genus) from a large number of families, with exception of the palms, there seems to be no preference for any particular family.

Table 1-2. Number of edible species per botanical family used by the Guaymi in Coto Brus, Costa Rica.

Family	number of edible species
Arecaceae	6
Fabaceae	3
Malvaceae	3
Passifloraceae	3
Dioscoriaceae	2
Cucurbitaceae	2
Heliconiaceae	2
Maranthaceae	2
Theophrastaceae	2
Chrysobalanaceae	2
Anacardiaceae	1
Apiaceae	1
Begoniaceae	1
Burseraceae	1
Caricaceae	1
Clusiaceae	1

Table 1-2 Continued

Family	number of edible species
Cyclanthaceae	1
Dennstadeitaceae	1
Lauraceae	1
Lecythidaceae	1
Malpighiaceae	1
Convolvulaceae	1
Moraceae	1
Myrtaceae	1
Phytolaccaceae	1
Sapotaceae	1
Simaroubaceae	1
Solanaceae	1
Urticaceae	1
Sarcoscyphaceae	1
Bignoniaceae	1
Bromeliaceae	1
unknown	2

Figure 1-5 presents the number of species according to the part of the plant that is eaten, it shows that most of the species used by the Guaymi are plants with edible fruits. Plants that provide edible shoots are the second largest group in terms of plants consumed. There are not many wild root crops even if the Guaymi do rely on several cultivated roots. This tendency gives an insight into the food preferences of the community.

During informal conversations, it was noted that greens of bitter taste are very appreciated as a complement to every-day diet. Shoots were similarly appreciated although they did not seem as varied. Many of the shoots, especially those of palms, were considered more as food for special occasions rather than an every day meal. Fruits, in general, do not form part of formal meals but are taken in between meals as desserts or as snacks.

The one edible fungus that was recorded was a very appreciated seasonal food. Found mostly during the burning season it is collected in large quantities and incorporated into regular meals. Seeds and stalks however were not so popular, mostly they were not used or used for other purposes other than food (for example medicine).

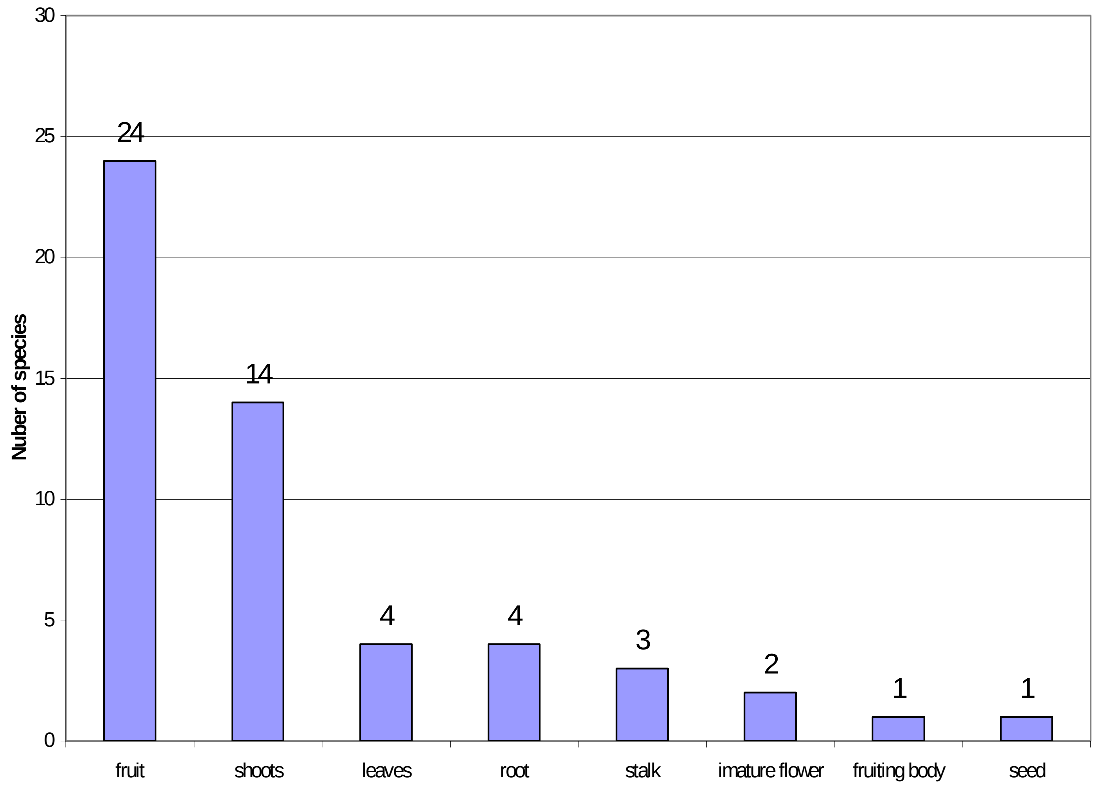


Figure 1-5. Number of species of wild edible plants according to the part used by the Guaymi of Coto Brus, Costa Rica.

It can be said that fruit bearing plants are the most abundant type of food plant. Many of these are trees from the mature forests. Later on the analyses, this will influence the cultural importance of that succession and especially its edges as a source of food for the Guaymi. Figure 1-6 shows the percentage of wild plants used by the Guaymi that are not native to the area. These plants are exotics that have escaped cultivation and adapted to the local environment.

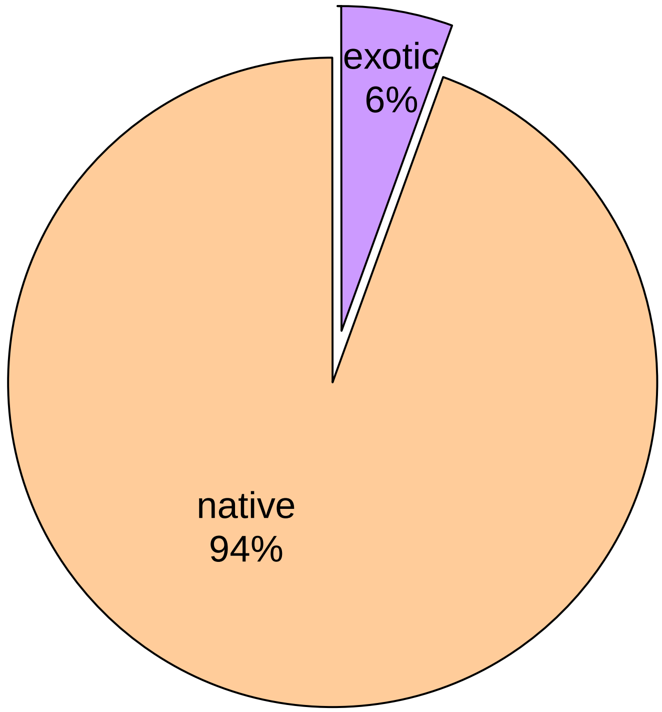


Figure 1-6. Exotic vs. native species of wild edible plants used by the Guaymi in Coto Brus, Costa Rica.

In general, the Guaymi tend to eat more wild native plants than exotics. Although many of their cultivated crops are exotic to the area, not many have adapted to the Coto Brus area enough to become wild.

Figure 1-7 shows the distribution of species according to their life forms. Overall, most of the plants used by the Guaymi, regardless of their cultural importance, are trees. Vines and herbs have similar numbers of useful species. Palms and shrubs are next in number of species per life form class, and finally there is just one species of fungus.

Trees are the life form with the most edible species in Guaymi culture. Although many of these are not considered very important (See Chapters II and III), they are relevant because the large number of species makes them a year round source of food.

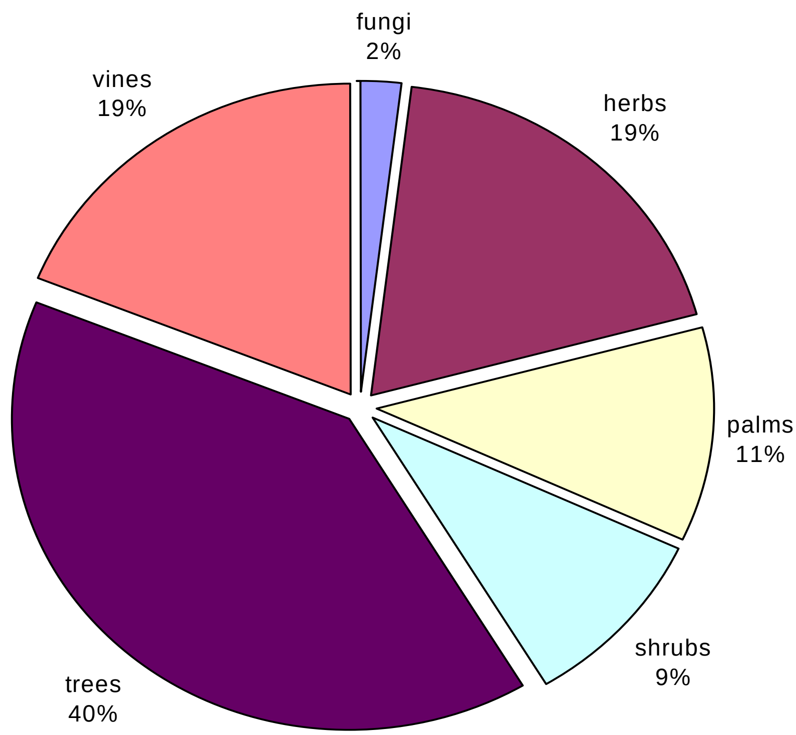


Figure 1-7. Number of wild edible plant species according to their life forms as used by the Guaymi of Coto Brus, Costa Rica.

Discussion

The wild edible plants used by the Guaymi consist mostly of common plants such as those that can be found in roadsides or in easily accessible parts of mature and secondary forests. This is logical since it would be the most abundant plants the ones that would be more likely to be tested as edible plants, also it is these plants that can be relied on as an abundant source of food in case of an emergency.

Some of the plants mentioned by the informants could not be confirmed by botanical sampling, which raises the question of whether these plants are not really found in the wild. Informants may have made a mistake, or the plants simply may not have been found while sampling.

Another common problem was the fact that common names were used differently by the various informants. Often a group of plants would be referred to by an informant using a single name while a more knowledgeable informant would be able to give individual names for them. In these cases, the more general name was used and later the botanical species and other common names covered by this grouping were specified. This may be due to the age, background, interest, intelligence or socio-economic condition of the informant. Another problem encountered was the recognition of varieties by the Guaymi that are not recognized by botanical systematics. In this case the botanical name was used and the local names of the varieties were specified.

Role of Wild Edible Plants in Guaymi Culture

It is important to approach the topic of wild edible plants knowing what is their role in Guaymi culture. The Guaymi have long stopped being a hunting and gathering society. Even though historical authors such as Las Casas (1875, cited by Cooke, 1982) describe them as dependent on hunting, fishing and gathering, in the tradition of many Amazonian-influenced cultures, evidence is also found in literature that the bulk of their diet came from starchy crops (*Manihot esculenta, Dioscoria alata, Xanthosoma violaceum, Bactris gasipaes*) .

Modern day Guaymi in Coto Brus still rely on the above listed crops for their diet. In addition, with the advent of fertilizers and pesticides, other crops that have lately become more feasible to them such as rice and maize, which historically were not central to their farming systems (Cooke, 1982). Coffee and cacao are also grown for sale, and the money is used in purchasing outside foods such as tuna, spam, pasta, beef, and other goods.

The introduction of western farm animals such as pigs and chickens has also made them less reliant on hunting as a source of protein. Nowadays, hunting is viewed more as a pastime and a luxury than a source of nourishment.

In spite of all these changes, however, the Guaymi plant very few vegetables or greens. What few vegetables they can purchase such as cauliflower, can only be found in San Vito, which is about two to three hours (and $3.50) away by bus. Thus the only source of vegetables and greens, and consequently of the vitamins these provide, are the ones collected in the wild.

The absence of electric power in most of the reserve is also an impediment for keeping foods refrigerated. This however may change in the next few years.

While wild food plants may not be a central part of the diet, they are an essential one. It is well known that a diverse diet contributes to a nutritional well being (Gura, 1986; Marten, 1988; Hernandez, 1974). The forests and fallows provide a ready and free source of greens for the Guaymi. Often this importance is overlooked by them since the products are "free", and their use is sporadic and varied. There is no marked dependence on any one type of wild food plant, since they are usually consumed when they are found by chance. Nonetheless, if these were not available, the variety and quality of the Guaymi's diet would be reduced to basically carbohydrates and occasional proteins, leaving out many essential vitamins.

Even if most wild foods are consumed as snacks or side dishes, wild greens and vegetables often provide indigenous communities with a source of minerals, protein, and vitamins not available elsewhere (Fleuret, 1979; Hladik, 1990; Levy, 1936). Very often wild plants serve to complement maize based diets by supplying the lysine that that crop lacks (Caldwell, 1972; Ogle, 1985) Even plants viewed as “children’s’ food” serve as a complement to their diets.

During the interviews, a social tendency to look down on native wild foods was perceived, particularly from the younger generations. While people above their 40’s did not seem to have any problem in talking about this topic, younger people seemed to be less willing to cooperate in general. Many made the point that their parents used to eat that but that they preferred “white people” foods like the rest of the Costa Rican population. Many parents also complained that their children did not want to eat those foods anymore but preferred the groceries and canned foods sold in the local store.

Species Richness of the Cognitive Domain of Wild Edible Plants of the Guaymi

Fifty two plant species and one fungus were recorded as being used as sources of wild food by the Guaymi. Figure 1-1 presents the species informant curve used to estimate the size of the cognitive domain in question. As can be seen in Figure 1-1, the curve tends to level off as it approaches 60 species. According to the logarithmic regression equation, the estimated number of species that would have been found if the sample size was doubled would be of 61.31, which means an increase of only 3 species would result from 46 additional interviews. However, since there is, in theory, a finite number of species that compose the domain (Bernard, 2004) the logarithmic model is problematic since it does not contain an asymptote. Instead, an asymptotic model is best and is assumed to show the limit of the cognitive domain. This asymptote is estimated to be to be at around 63 species meaning that the 84.12% of the species composing the Guaymi wild edible plants cognitive domain are covered by this study.

The richness of wild food plants used by the Guaymi is relatively high compared to other indigenous groups in Costa Rica. Ramos Garcia-Serrano (2004) reports only 34 species of wild plants being used as food by the Bribri and Cabecar groups. Using the reported plants for the Guaymi as a base of comparison, it means that their cognitive domain is 58.8 % larger than that of these groups (76.5% if the estimated number of species is used)

Distribution of Species According to Botanical Families

It was found that the edible plants used by the Guaymi that could be identified properly belonged to a total of 33 botanical families (Table 1-2). While most families contained only inedible species, certain families showed a particular abundance of edible species. For example, Arecaceae presented a total of 6 species that were used as food. Others such as Fabaceae (genus *Inga*), Passifloraceae and Malvaceae contained three edible species each.

It is important to note that a greater number of species in a family does not necessarily make that family culturally important. This is because a family may contain many trivial species while another family may contain only one species with great importance. This will be analyzed in detail in Chapter III.

Distribution of Species According to Part Used by the Guaymi

Figure 1-5 is a chart indicating the number of plants used by the Guaymi according to the edible part that they use. Fruits tend to be the most diverse group of edible plants, followed by shoots. As in the case of the botanical families, a greater number of species in a group does not necessarily show cultural importance. Fruits, as will be seen later in this document, are not particularly culturally important individually, yet their great diversity may amount to a greater importance as a group in Guaymi diet.

Leaves, roots, stalks and flowers are of secondary importance in terms of number of species used. Seeds and fungal fruiting bodies have the least number of species.

Use of Native vs. Exotic Species

In spite of having been in this particular area for a relatively short period of time (70 years), the Guaymi are particularly well adapted to using plants native to Costa Rica (94%) vs. exotics (6%) (Figure 1-6). This is understandable since the original Guaymi territory did encompass parts of Costa Rica and, in Panama, it extended over a wide range of successional stages that contain similar species to the Coto Brus region. It is not surprising then that the knowledge possessed by the original immigrants also worked for the new area they were moving into.

Also, not many of the edible exotic plants have been able to thrive in the ecological conditions of the reservation. For example, plants like *Zizigium jambos* and *Mangifera indica,* which have readily become invasive in other tropical regions and incorporated into the local cultural domains as “wild”, can be found only sparingly at the reservation and are not considered “wild” by the Guaymi. Some plants, however, which are native to Costa Rica and the Guaymi region, but not present in the Coto Brus region have also been introduced by them and are sometimes found as escapees in fallows and secondary forests. Such is the case of *Gustavia superba*, *Bromelia pinguin*, *Mansoa hymenaea*. These are found mostly in home gardens but sometimes in wild or semi wild conditions.

Species Richness of Edible Plants According to Their Life Forms

It was found that the most useful life forms to the Guaymi, in terms of number of edible species were the trees, followed by herbs and vines (Figure 1-5). Palms and shrubs presented a relatively low number of species compared to other life forms and just one fungus was reported.

The tree group also coincides with the previous fruit group since 80% of the trees are used for their fruits. This means that fruits are more likely to be available year round for complementing human diet.

Plant Uses and Description

The plant uses, common names and descriptions are based on field observations, informant interviews and on the work of León's (2000) work. These are all grouped according to the botanical families the species belong to according to the Missouri Botanical Gardens' TROPICOS[3] data base (2004).

Anacardiaceae

***Spondias mombin* L.** (Jögo, yellow mombin, jobo). This fast growing tree is commonly found in secondary forest since it is a pioneer species. Unlike other indigenous groups such as the Cabercar and Bribri of the region (Economic botany), the Guaymi do not eat the fruits. Instead they harvest the young apical stems, peal them and eat the juicy, green tissue inside. This plant is taken as a snack by workers when clearing their fields for planting. It is very refreshing and tastes like green mangoes. Also, they say it is good for treating and preventing colds. Leon et al (2000) also cites the fruits as being edible but not always of agreeable flavor. He also reports that the roots accumulate water in them and are used to quench thirst.

Apiaceae

***Eryngium foetidum* L** (Kulandro, coriander, Culantro coyote). Culantro coyote or "kulandro" as the local pronunciation goes, is an exotic but naturalized herb that commonly grows as a volunteer weed in fields and home gardens. Its leaves are used in everyday cooking to flavor food.

Arecaceae

In addition to having many other ethnobotanical uses such as a source of fiber, building materials, tools, and thatching, the Arecaceae, or palm family, contains the most numerous wild edible species for the Guaymi. With one exception, the most often eaten part is the “palmito” or heart of palm. This food is considered important to the Guaymi as a delicacy and is prepared for special occasions. While the cultivated heart of palm (*Bactris gasipaes*), which does not grow wild in the region, is the most commonly consumed palm, wild palmito is considered better tasting and of higher quality than this one.

Preparation of the heart of palm is similar for all species. The first and simplest way is to eat it raw, alone or marinated in lime juice. Another common way to prepare it is to fry it in butter and chop it into a fine “picadillo” to be accompanied by rice and beans. Another method of preparation that was mentioned was to roast it. For this, the heart of palm is left within its tougher protective stem and tossed directly into the burning coals. It is left there for a few minutes until the husk is charred and finally it is pulled out and served.

Socratea exorhiza (Buro, chonta, maquenque). This species has a rather bitter flavor to its heart of palm, this is why it is not as popular as others. Buro, however, is harvested and mixed in with other species of palmito to make a bitter-sweet picadillo. The Guaymi find the combination very attractive and prepare it for special occasions. It is found mainly within old growth forests. It is easily recognized by its spiny support roots.

Geonoma interrupta (Jüo, súrtuba). This is another species with bitter tasting heart of palm. Its uses are similar to *S. exhorriza* and it is found mainly within old growth forests.***Euterpe precatoria*** (Midrá, palmito morado, palmito de matequilla). Midrá is one of the most sought after palmitos. Its sweet flavor is very palatable and can be eaten raw or prepared in any of the common ways. It is found mainly within old growth forests.

Prestoea acuminata (Titi, palmito de matequilla). This is the other sweet palmito, often called "true" palmito by the Guaymi. It is common in the lowlands and used in ways similar to *E. precatoria*. Its taste is very sweet and could have potential commercial value if cultivated or managed. It is found mainly within old growth forests. This palm presents abundant regeneration under mature forest conditions (León, 2000) and could have potential form management as a non timber forest product.

Oenocarpus mapora (Jöra, maquenque). This is the least common of the palms used by the Guaymi at Coto Brus. It seems to have been more common in the past on the higher slopes of the reserve. However, it seems to be quite rare now because of over harvesting. This is not necessarily because its better quality but instead related to its distribution. The higher lands are not very inhabited so the owners of the land seldom look over them. This provides an opportunity for poachers both from within and outside the reservation to come in and harvest their plants and animals in excess. Preparation is the same as with other palmitos.

Chamadorea tepejilote (Ñürüm, pacaya, piciplina). *Chamadorea tepejilote* is a common palm in moist areas such as river beds or terrain depressions. Because of the high moisture of the forests within the reserve, even in slopes, it is found throughout old growth and mature secondary forests in the reservation. The part eaten is the immature inflorescence. This is harvested at a particular point before it starts to mature and become bitter. If harvested properly, the taste and texture of the flowers is very pleasant. It is commonly prepared by boiling along with black bean soup and served together with rice and other wild greens. There is a popular belief that the taste is determined by the person who harvests it: if it is bitter it means that the harvester is a stingy person.

Ascomycetes (Sacroscyphaceae)

Cookenia tricholoma (Kri olo). Kri olo literally means “tree ear” and it is the name given to almost any tree dwelling fungus. However, when referring to eating kri olo the term refers largely to just the species: *C. tricholoma*. This fungus is found very sparsely within the forests, and it often grows in large numbers in dead wood. However, this species has been favored by human habitation, and it is found in great numbers when the forest is burned down in the cycle of shifting cultivation. Charred wood in the open sun seems to be an especially favorable medium for it, since there it grows in quantities superior to those found within the natural forests. There are two other species that were mentioned during the interviews, but only as second hand experience (the informants mentioned they believed some people ate them but that they them selves did not). One is another species of *Cookeina*, which was mentioned by a Ngöbe woman as being eaten by her Buglere daughter in law. She said, however that eating that species was not well looked upon by the Ngöbe because they considered it inedible. The other species was a gelatinous tree ear which my key informant said he had heard could be eaten, but he himself did not dare to try it for fear of being poisoned.

The preparation of *C. tricholoma* can be done in two ways. One is to fry them in butter and adding them to rice or beans, and the other is to salt them and envelop them in a krigo (*Calathea crotalifera*) leaf and roast them in hot coals until the leaves started to char. This species is very delicious and commonly eaten during the burning season.

Begoniaceae

Begonia sp (Ibiagro). This small herb is commonly found along roads and cliffs that border the primary forest. It is very easy to find because of its red stalks. These are eaten by the Guaymi as a snack when traveling through the reserve. Its sour, juicy taste is used to quench thirst when water is not available. Also, it is used medicinally to treat colds.

Bignoniaceae

Mansoa hymenaea (Doboin). This plant was reported by some informants as wild, and is infrequently found in secondary growth. However this could not be corroborated as the only specimens found were cultivated in home gardens. The natural distribution of *M. hymenaea* is on the drier Pacific coast, so it is possible that it was brought by immigrants from Panama and it occasionally escapes into the wild. This plant possesses a strong garlic-like smell and it is used as a substitute for it in cooking.

Bromeliaceae

Bromelia penguin (Viru, piñuela).This bromeliad is another plant of doubtful origin. Several informants reported it as being wild, however, the only time it was found in natural surroundings during this study was in a secondary forest near a home garden. It is therefore unclear whether it is native or an escapee from cultivation. One informant mentioned that it was far more common in the drier area where he lived in Panama. It was included however because of the reports by knowledgeable informants that it was wild and sometimes cultivated.

Viru provides a reddish, sticky fruit which grows in a central disc-like inflorescence. It is eaten raw as complement to everyday diet.

Burseraceae

Protium panamense (Judra tain, alcanfor). Judra is a very common tree found mostly in mature secondary forests and primary forests. In spite of its commonness, it was not mentioned by many informants, which leads me to believe it is not a very well liked food. The part eaten is the fruit, which has a very aromatic pulp.

Caricaceae

Vasconcella cauliflora (Kegema). Wild papaya or Kegema is commonly found in secondary forests, primary forest gaps, and along roadsides. Its abundant fruits are eaten raw just like those of *Carica papaya* fruits and are said to be just as good.

Chrysobalanaceae

Licania belloi (Sabo, zapote, sunzapote). This large tree is native of the mature forests of the region. Due the popularity of its fruit it is often left when clearing fields and can be found in coffee and cacao plantations as a remnant tree. This species is one of the most popular wild food plants, Guaymi men will actually take time off their daily labors to go deep into the forest and actively look for zabo fruits instead of just collecting by chance during other activities. *Licania belloii* usually grows in groves deep inside the primary forests. Often, permission of the owner is needed to come in and gather fruits. The sweet, sandy pulp is eaten raw and considered a delicacy by the Guaymi. Trees are highly appreciated and care is taken when inside the forest not to damage saplings or adult trees. This management practice may be a cultural adaptation to the trees's scarcity since it is not observed with other wild species. The tree and its regeneration is not very common and its distribution within the reserve is clumped in small patches.

Clusiaceae

Garcinia madruno (tröbo, madroño, limón de montaña, manzana amarilla). This tree is fairly common in mature forest patches. Its fruits are abundant when in season and commonly eaten by people traveling through the forest as a snack or sometimes collected in large quantities to take back home as a dessert. One curious thing about this tree is that, unlike *Licania belloi*., there is no cultural protection of the plants. If a tree is found with a very abundant harvest, it can be cut entirely to collect all the fruits. My guide even offered to cut down a tree so I could collect a sterile herbarium sample (an offer that I urgently declined). This destructive method of collection does not appear to make the tree or its regeneration less abundant.

Cucurbitaceae

Two species of Cucurbitaceae were identified as being used by the Guaymi. However, the names used for these plants were often interchangeable and it was hard to determine to which one of the species the informants were referring. Often different names were attributed to the same plant or both plants grouped under one name.

Sechium tacaco, S. Pittieri (Mirera, Ka, Ka küre, Mirera küre, chayotio de monte, tacá, tacaco cimarrón, tacaco). These two plants are climbing or sprawling vines commonly found in early secondary growth. Because of their very similar appearance, their common names are often used for both plants. Although both of these species produce fruits that have been reported as being eaten in Costa Rica's Central Valley, the varieties found in the Guaymi reservation present spiny, hard fruits that make them difficult to eat. Instead, the Guaymi use the young sprouts. These are collected and cut into fine chunks or "picadillos". They must be boiled and have the water changed at least once to eliminate bitter substances. *Sechium tacaco* is an endemic species of Costa Rica.

Cyclanthaceae

Carludovica palmata (dogogo, uchi, elotillo, chidra, estocoque) This plant is extremely common throughout the reserve, particularly in secondary forests. For the Guaymi, the plant itself is called “dogogo”, while the inflorescence is called “uchi”. Guaymi men will often collect these while out working in their fields and bring them home for the women to prepare. These plants are so common that there is no offense implied in taking uchi from another person’s field as long as it borders the roadside. The common way of preparing the flowers is by boiling them along with bean soup. However, it can also be roasted directly on hot coals until the protective bracts are charred and then served with lime juice along with rice and beans. Its widespread distribution make it a good, abundant vegetable. In other areas it is used for making baskets and hats (León, 2000).

Dennstadeitaceae

Hypolepis repens (Ka uguo, helecho de espina) This is the only fern that is eaten by the Guaymi. However, it is one of the most popular and sought after wild foods. The plant is a weedy species easily recognized by the presence of spines. It grows abundantly in abandoned fields and early secondary successions. Although it is commonly found along roadsides, it is hard to find plants that have not yet been collected. To get more abundant harvests, the Guaymi usually have to rely on what grows in their own abandoned fields.. The part eaten is the shoot or “fiddlehead” of the fern. The usual way of preparing the shoots is to fry them in butter with *Mansoa hymenaea* leaves and serve them along with rice or other vegetables. There exists a specialty market for edible fern shoots in Asia and Europe and this particular plant, because of its weedy habit and rapid growth, could be a potential cash crop if it were domesticated and all nutritional properties turned out acceptable for human consumption.

Dioscoreaceae

There are two botanical species that were recognized during the study, of which only one was found in the wild. However, the Guaymi recognize several distinct varieties of this plant, which they consider to be separate species altogether.

Dioscorea trifida (Drün nuen, Drün tain, Drün Drune, Drin, Küli, yam, ñampí)

Dioscorea trifida is a twining vine commonly found in early middle stages of forest regeneration (4-9 yrears). It produces a tuber which is eaten boiled in water much like a potato. Along with *D. alata, Manihot esculenta,* and *Xanthosoma violaceum*, it is one of the Guaymi's major staple food and source of starch. Although it is cultivated in home gardens, it is also found growing wild along fences and abandoned fields. In cases of food scarcity or if the need arises, people will resort to gathering them from the wild. This semi-domesticated status may be the reason why not many informants mentioned it as an important wild food, perhaps considering it more a cultivated plant.

Drün Nuen, is the most commonly cultivated variety. The term "Nuen" means white and this is attributed to the color of the tuber. The tuber is said to be larger than other varieties.

Drün Drune, or black Drün, is said to posses a smaller tuber and can be recognized by the darkish spots that it has on the underside of the leaves. It is also good for eating and sometimes cultivated around the house.

Drün Tain, or red Drün, is said to produce a large tuber which is not very good for eating. However, it will remain without spoiling for a long time which makes it good when food is scarce. It is often used to feed pigs and chickens.

Drin or Küli, is another variety mentioned by some informants, which is said to have a small, carrot like tuber. No sample of this plant was collected or seen.

Dioscoria alata (Drün ñampí, ñampí) this cultivated variety is often found in home gardens or even in monocultural plantations. It will occasionally be found in abandoned fields or fences. This plant originated in Asia.

Fabaceae

Inga spectabilis, I. cotobrucesnsis, I. hibaudiana. (bü, guaba) In spite of the high diversity and abundance of this family, the only species of Fabaceae mentioned as edibles were those of the genus *Inga*. Three species of this genus are consumed, often more as a snack for children or passersbyes than as a sought after food. The part eaten is the fruit. The white aril surrounding the seeds is eaten and the seed is spit out. *Ingas* can be found along roadsides, in young secondary forests and in old growth forests. They are usually left in cleared fields as a source of shade, or, if cut down, resprout promptly. As in other regions, they are used as a source of shade for coffee and cacao. Here they not only fix nitrogen and improve soil fertility but provide good fuel wood. Of all the uses of *Inga*, food seems to be the least important.

Heliconiaceae

Heliconia pogonantha , H. danielsiana, H. latispatha. (müne, bidu, platanilla).Three species of *Heliconia* were recorded as edibles during this study. These plants are probably the most abundant of all edible plants mentioned. They grow in most successional stages from early successions to old growth forests (preferring the early stages over the older ones). All of them fall under two common Ngöbere names: müne or bidu. As with other plants, it is was hard to tell sometimes which plants the informants had in mind when talking about them since vegetatively they are so similar. However, the botanical specimens taken as vouchers for these names show that there are three main species.

The part eaten is the apical shoot, found within the stalk in a similar fashion as the hearts of palm. This shoot is taken and boiled together with bean or chicken broth and served along with the regular meals. The taste is similar to that of asparagus although there is a silky strand of fibrous material in the center. This plant is a good source of vegetables during times of scarcity due to its extremely high abundance.

Lauraceae

Persea sp. (Dugá, aguacate de montaña) Dugá or “mountain avocado” is found in a more or less sparse but even distribution along the primary forests of the reserve. The fruit of this plant is said to be similar to that of regular avocados but rounder in shape. Although it is eaten, it is not as actively sought like other fruits such as *Licania belloi*. and *Chrysophyllum sp*.

Lecythidaceae

Gustavia superba (tuba, membrillo). This peculiar tree is scarce, reported only in secondary forests of the Villa Palacios area and under cultivation in home gardens. Informants mentioned how it grows much more abundantly and reaches a larger size in Panama. This leads me to think that it was introduced from other regions and has adapted to the local environment. The part eaten is the fruit, which is taken in a semi green state, cooked in boiling water, and served as a vegetable along with meals.

Malpighiaceae

Byrsonima crassifolia (Miga, nance). This tree is common to all of tropical America. It grows mostly in open fields and is particularly resistant to burning. It can often be seen in pastures, roadsides, home gardens or abandoned fields. The fruit is eaten raw as a snack or made into sweets by adding sugar or fermenting it. Although it is not very common, its distribution is wide spread, mostly seen near human habitation and working fields.

Malvaceae

Malvaceae are an important family since the Guaymi's sacred, plant cacao (*Thobroma cacao*), is a member of this group. Cacao is native to some parts of Costa Rica, none of the informants reported it as being wild in the reserve. It is worth mentioning that, along with coffee, cacao is the most important cash crop planted by the Guaymi. The demand for organic cacao has benefited them and buyers from San Jose readily buy their harvests as soon as they are available. Cacao is also used in rituals to ward off evil spirits. These involve the preparation of bitter, unsweetened cacao, which is offered to the community. Also, the "sukia" or shaman is said to cure using cacao grains and pastes as medicine for spiritual evils and curses.

Chocolate is also prepared for everyday consumption and is a preferred beverage that is drunk hot or at room temperature.

Other species of *Theobroma* are also used in similar ways.

Theobroma angustifolium (mura, cacao de montaña). This wild cacao is found mostly in the mature forests of the reservation. Even if it is not cultivated, the seeds are also used to make chocolate and will sometimes be gathered for that purpose. Children will also eat the pulp of the seeds when they can find them.

Theobroma bicolor (ödobá, pataste). Although similar to cacao, *T. bicolor* is used more for its fruit than its seeds. These are eaten when ripe. The tree was only found growing in cultivation around houses, but several informants did report it as also being found in the wild.

Triumffeta sp. (Mozote). This native plant is found almost in every early secondary succession within the reserve. It was, however not reported by many informants as being used. The name “mozote” is actually a Spanish nahuatism (that is a nahuat name adopted by the Spaniards to name a plant) and no Ngöbere name was reported. This leads me to think this plant was not originally used by the Guaymi but rather its use came with the colonists who had learned to use it in northern Central America. The stalks of the plant are boiled to make an infusion that is drunk as a refreshment or as a medicine to “refresh” the stomach in case of any illness.

Maranthaceae

Calathea crotalifera (Krigo, Krigo bogon, bijagua). This common herbaceous plant can be found growing abundantly in the under story of primary and old secondary forests. Sometimes it will also be found in early secondary growth were there is enough shade to block out direct sunlight. The edible part of the plant is the unopened shoots, similar to those of the *Heliconia*. These are taken out and eaten and have a very pleasant flavor without the silky fibers of *Heliconia*. The amount of food obtained per plant is minimal though, and it takes a lot of plants to get out a significant quantity. Nevertheless, krigo has a very important role related to food. Its leaves are preferred by the Guaymi to wrap food. Whether it is fruits, shoots, or medicinals collected in the wild or cooked meals from home to be taken out into the field, krigo leaves are always used in preference to other similar leaves (banana, heliconia, etc.). The reasons given by one informant for this are the convenient length and width of the leaves, their resistance, the fact that they can be tied with vines without ripping, and their ability to keep things “fresh”. Also, as has been mentioned, krigo leaves are used in cooking other wild plants since they are also resistant to heat. Food is wrapped in them and tossed into the hot coals for roasting and the leaves will not burn easily allowing the food to be cooked.

Hylaeanthe hoffmannii (Apu). This plant is not very common and was mentioned only by a few, older informants. The part eaten is the root, which produces numerous small tubers. These are said to be very tough and not very palatable which may show that they are considered a famine food and reserved only for emergencies.

Convolvulaceae

Maripa nicaraguensis (drwä köi, dulce). The Ngöbe meaning of this plants name literally means "monkey vine", probably referring to the fact that monkeys like to feed on its fruits. It is a widespread, yet not very abundant twining vine found mostly in forest edges and roadsides near primary forests. The part eaten is the fruit which is yellow when mature. The pulp and seeds are not eaten, but rather the sweet, black liquid that it produces is sucked on. This plant is considered a snack by children or people traveling to their fields or amongst communities.

Moraceae

Brosimum guianense (Bere, bread nut, azulillo, mariabe, granadillo). The fruit of this tree is eaten fresh. It commonly grows in mature forests and their edges. The regeneration of this tree is very abundant although mature individuals are not very common.

Myrtaceae

Psidium guajaba (Ngiba, guayaba). Ngiba is a common plant throughout the neotropics. Commonly found growing in secondary growth, gaps, pastures, and roadsides. Its fruits are eaten green and ripe, it is unusual that trees will be planted by the Guaymi since they grow so abundantly in disturbed areas.

Passifloraceae

Passiflora vitifola, P. quadrangularis, P. sp. (guate). Guate is a common fruit found in both disturbed and undisturbed vegetation. Although it is very common, its consumption is occasional, linked to the accessibility of the plants since these will often grow up on trees and give fruits out of human reach. There are three species that were recognized in the wild, all are used in very similar ways. The arils associated with the seed are eaten directly or made into a refreshment.

Phytolaccaceae

Phytolacca riviniodes (Segá, jaboncillo). This is one of the most prominent food plants used by the Guaymi. It is found gaps within primary forests, roadsides, but with particular abundance in newly cleared fields bordering primary forests (it is conspicuously absent in secondary forests and its edges). This plant is easily recognized by its reddish stems containing betalin pigments (Foster, 2000). The part eaten is the leaf which is cooked with one change of water to eliminate bitterness (HCN toxins) and then chopped up into fine pieces and served in lime juice with meals. Sometimes it is also mixed with eggs and cooked.

Members of Pytolaccaceae have been known to have cancerigenous substances (*Phytolacca americana* L.), as is the case of poke weed which is eaten in rural parts of southern US (Foster, 2000). Care should be taken when consuming this plant, and studies to determine its toxicity would be useful before promoting the use of this plant. The Guaymi eat it very often and was the most commonly mentioned plant during the interviews.

León (2000) reports the green fruits are used in other places for washing clothes, hence the common name “jaboncillo” or little soap.

Sapotaceae

Chrysophyllum brenesii (Suli krie, caimito de montaña). This tree is commonly found in the primary forests of the reserve. It is appreciated for its fruits and good construction wood. Although not as popular as *Licania* b*elloii*, it is also protected when collecting fruits. Cutting down a caimito tree to harvest its fruits is not well looked upon by land owners and young men who do that are reprimanded by their elders. The fruit is eaten raw.

Pouteria sapota (Ngömo, zapote).This fruit is very popular. It is only found in the deeper parts of the mature forests, although it is often cultivated in home gardens. The fruit is very popular and is eaten raw.

Simaroubaceae

Simarouba glauca (Ruga, aceituno). Although this tree is not very common within the reservation, the fact that one of the informants mentioned it suggests that it may have formed part of the edible plants cognitive domain at one point. It is a tree found throughout the Guaymi territory and it would not be surprising that other Guaymi groups still consume its edible fruits. Only one tree was found in the reserve during the study.

Solanaceae

Cestrum racemosum. (Ñulio, zorrillo). Ñulio is a small tree that grows in early secondary growth such as abandoned fields. Although its distribution is wide, it is not very abundant and is usually found growing alone or in groups of two or three trees. The parts eaten are the leaves, particularly the young ones. These are taken and boiled, changing the water once, and then chopped up into “picadillo”. They can be then eaten accompanied with lime juice, or mixed with eggs and fried. *C. racemosum* is one of the most popular greens mentioned during the interviews. Sometimes the leaves are eaten fresh in the field. One advantage it has is that it provides a source of greens year round since it does not loose its leaves. The taste and texture are similar to those of spinach.

Theophrastaceae

***Clavija costaricana* Pittier.** (Dwo kri, musola). Two different varieties of *C. costaricana* were identified. Although telling them apart in the field is quite difficult when sterile, the Guaymi tell them apart through their distinct flowering period. These small shrubs tend to grow abundantly in the lowland primary forests. Often their presence in a secondary forest will show that it is starting to reach its maturity and becoming similar in structure to the older forests. They are both easily recognized by their single woody stem less than 2.5 m in height and its clumped leaves at the top. When flowering *C. costarricanaa* has extremely attractive flowers and produces very abundant fruits.

During the time of the study the plants were mostly in flower and no fruits were found. Its abundance and accessibility in the forest under story, however, show that, when in season, the fruits provide an abundant source of vitamins to the Guaymi. This is an interesting plant since there are not many under story plants that provide abundant harvests and synchronized harvests. There may be potential in managing this plant as a sub-canopy forest product if a market could be found for it. Studies concerning the nutritional value of these two species and possible products that could be derived from them would be an interesting line of study.

Urticaceae

Urera baccifera, Urera elata (Bugrun, bugo sali). To the horror of many outsiders, the Guaymi have a predilection for eating the urticating leaves of several species of *Urera,* known for their urticating leaves. Two species were collected and, of those two, *U. baccifera* is said to have two varieties: one that is arborescent and one that is more vine-like. The apparently inedible leaves are collected with much care and then boiled in water to eliminate the urticating substances. Once this is done, they become edible (with a slightly coarse texture reminiscent of sandpaper) and are very much favored by the Guaymi as a year-round green.

Unidentified plants two plants were included that could not be collected. The first one, identified as “za” is possibly a Sapotaceae of the genus *Manilkara*, judging by the description of the tree. It has edible fruits similar to zapote (*Pouteria sapota*.) but smaller, with milky sap. This plant was not found in the reserve but it may be common in other regions inhabited by the Guaymi,

The second plant, identified as “ka ñude” was mentioned by one reliable informant of Panamanian origin as being eaten in his homeland and also being present in the Coto Brus reservation. The name of the plant literally means “underwater plant” and it is a subacuatic herb that grows in larger rivers attaching itself to rocks. Its growth habit is said to be a cylindrical, fleshy herb of up to a meter in length. It is said to be cooked and served as a vegetable along with meals. The reason why it was included was because of the peculiarity of being a plant that thrives underwater. A crop that could be grown in rivers would be of interesting potential if it turned out to be confirmed.

No specimens were collected since the rivers were muddied and overflowing due to high rainfall during the study period.

CHAPTER 2
INTERNAL STRUCTURE OF THE WILD EDIBLE PLANTS COGNITIVE DOMAIN FOR THE GUAYMI OF COTO BRUS, COSTA RICA

A cognitive domain is not only composed of a list of items, or, in this case, species of wild edible plants. These species are held in a structured manner, with some having more importance than others; some are more prominent in the minds of the people that constitute the culture and some less obvious. There is also a relation between species in terms of how people think of them, this gives the cultural domain a structure that can be represented spatially through multidimensional scaling (MDS).

Since a cognitive domain is nothing tangible, it helps to model it to give a better idea of how it is structured. Mathematics and statistics are a good way of describing the prominence of different items within the domain. The percentage of informants that mention an item is, for example, a simple way of attributing importance to a single item. However, to see the relationships that exist among all items, a matrix is needed. The problem with matrices is that it is difficult for the human mind to accurately picture the structure when the matrix is composed of many items (for example the matrix showing the relation between 20 items would be a 20x20 matrix where it would be very difficult to see more than two relationships at the same time.

To make matrices more accessible to visual analysis, non-metric MDS was used in this study. This creates a spatial “map” of the cognitive domain using the mathematical information from the matrix (Bernard, 1994). In this chapter, the structure of the wild edible plants cognitive domain is reconstructed from the field information to analyze the prominence and relative importance of the different species used and how they are located within relation to one another in the context of Guaymi culture. The hypotheses are the following:

- The wild edible plants cognitive domain is such that it can accurately be mapped through non-metric multidimensional scaling in two dimensions with a stress level below 0.15.
- There exists a core of wild species, which hold a more important place as sources of food to the Guaymi of Coto Brus.
- The core plants of the wild edible plant domain have a greater diversity of uses than those in the periphery.

Methodology

The first step was to take the information from the free listings given by 46 different informants regarding wild edible plants. This information was analyzed using ANTHROPAC (Borgatti, 1996).

The basic statistics of the items were obtained. The data were then organized into a similarity matrix using positive matches as a measure of similarity. The principle behind this is that those items that are more important will tend to be mentioned more times than those of lesser importance. Items that are mentioned by more informants will have a higher probability of being mentioned together with all other items in the matrix. Less important items, on the other hand, will tend to have a lesser probability of being mentioned together with all other items. Therefore positive matches of important items will be higher than those of less important items. Hence, this MDS does not represent any kind of functional relationship between items, nor does it take into account the order in which items were mentioned.

To do this, the freelists were organized into a dichotomized matrix where rows were informants and columns represented each item. Here a value of one showed that the item was mentioned, while a value of 0 showed the item was not mentioned by that particular informant.

This dichotomized matrix was then analyzed for similarities amongst items. The measure was, as mentioned, the number of positive matches amongst items (positive match among items indicates that the items were mentioned together by a particular informant). The results were then represented in a spatial manner using non-metric MDS (Borgatti, 1996).

The MDS was then divided into three concentric circles, taking the distance to the furthest item as the radius for the largest one and the extent of the domain. The other circles were located using a radius of 1/3 and 2/3 the length of the first one. This was done to better show the structure of the domain. To confirm tendencies within the MDS, a cluster analysis of the data was also conducted. This was done again using the positive matches as a measure of similarity (Appendix C).

Results

The way the items in the free lists are related to one another, as well as their importance is portrayed in Figure 2-1. In this spatial representation patterns such as importance (closeness to the center) and tendency to be mentioned together (groupings of items) can be seen in Figure 2-1 and 2-2 with greater ease than in the original similarity matrices (Apendix C). Figure 2-2 is a cluster analysis showing the association of plant species according to their tendencies to be mentioned together by informants.

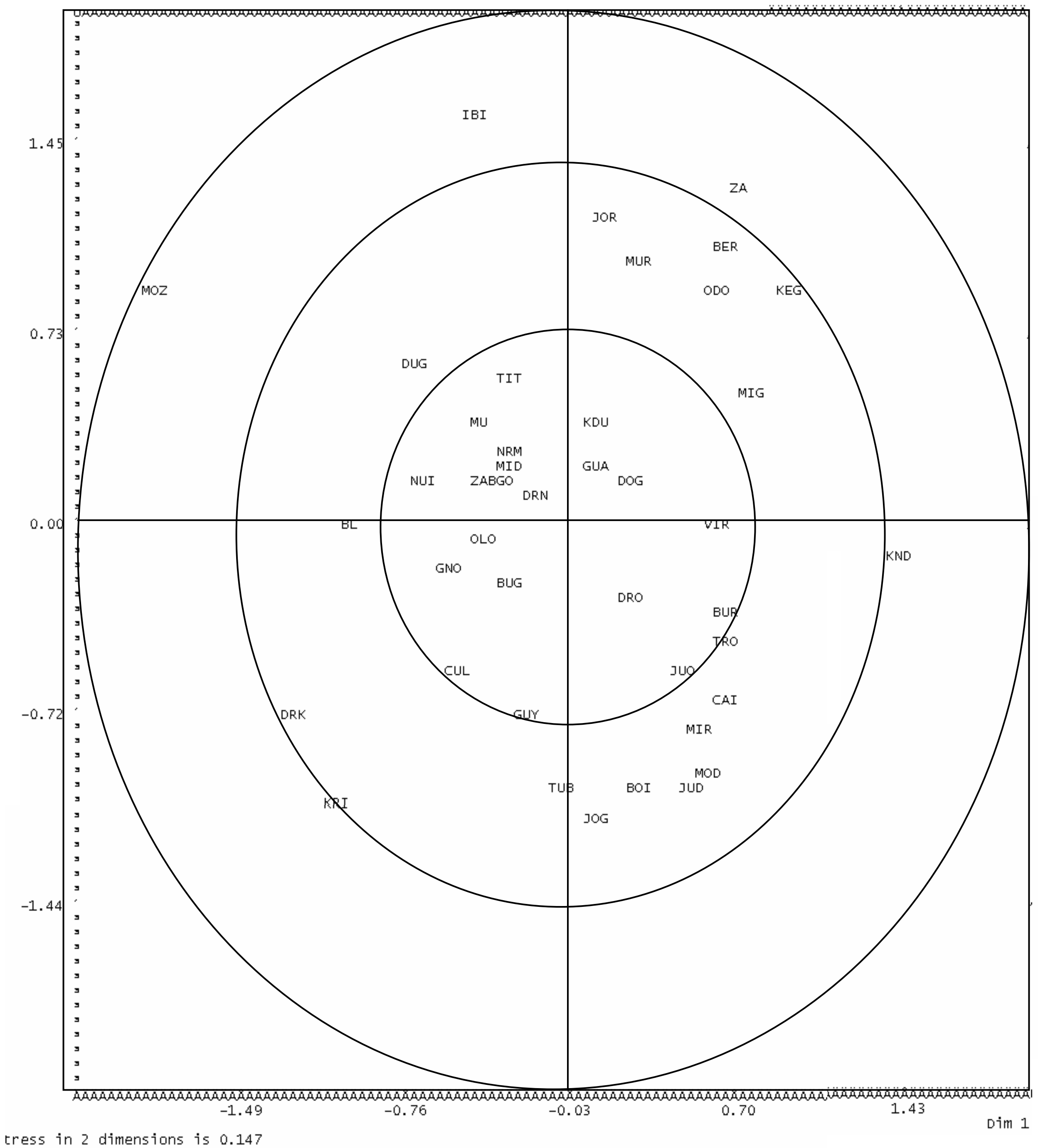


Figure 2-1. Non-metric multidimensional scaling (2 dimensions) of the wild edible plants cognitive domain of the Guaymi of Costa Rica, Coto Brus.

*Species symbol key in Appendix B.

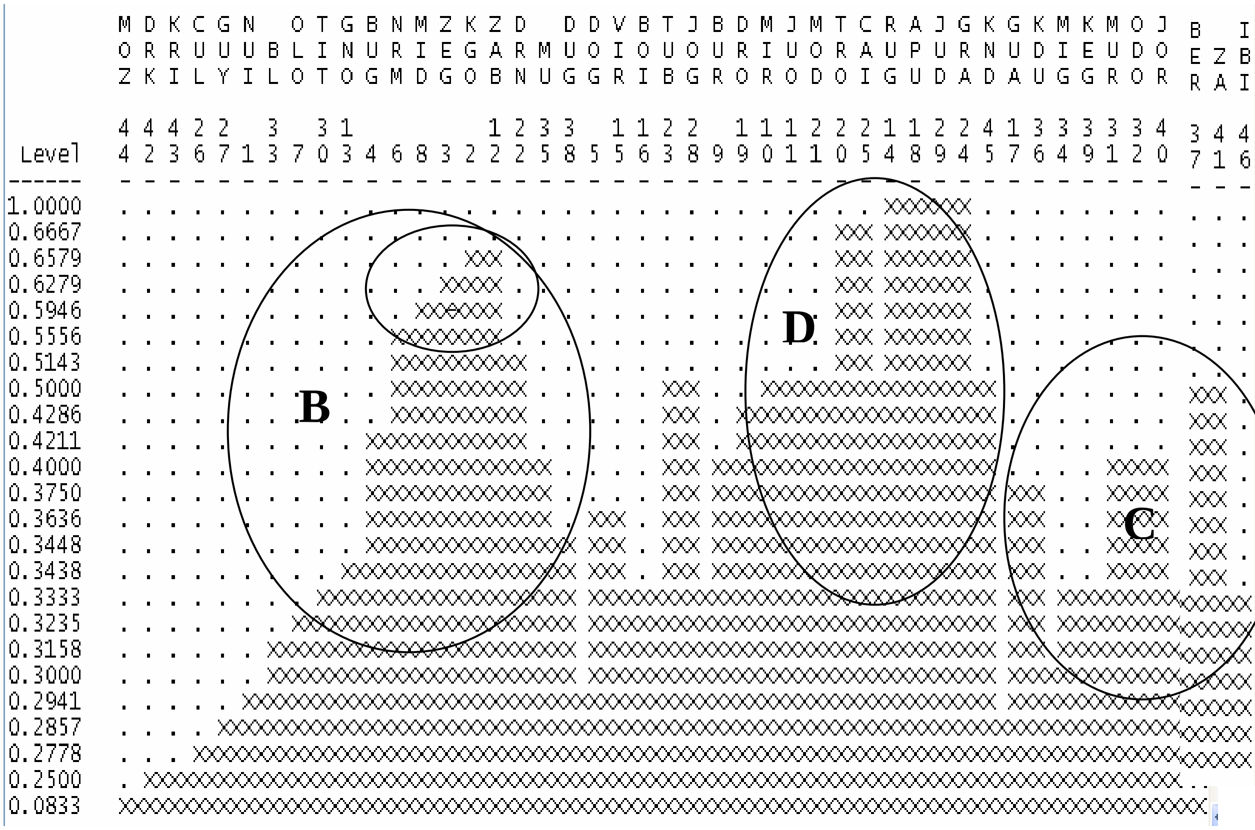


Figure 2-2. Cluster analysis of the wild edible plants cognitive domain of the Guaymi of Costa Rica, Coto Brus.

*Species symbol key in Appendix B.

Figures 2-1 shows the Non-metric MDS that shows the relation of species in the Guaymi cognitive domain of wild edible plants in terms of those most commonly. Figure 2-2 presents the cluster analysis that relates species using positive matches as a measure of similarity and importance.

Discussion

The MDS shows the importance of different plants in the cognitive domain as well as a certain degree of similarity with regards to which plants tend to be mentioned together. As the name implies, multidimensional scaling can order items in as many dimensions

(2,3,4,5…N) as needed. The more dimensions that are added the less “stress” that the diagram will have. Stress is a measure of how well the items are relating to each other in the diagram. A MDS with high stress is not a good representation of a cognitive domain, and if so more dimensions are needed to represent it graphically. Multidimensional diagrams (N>2) are more difficult to present in two dimensional format (paper) therefore it is better to use as few dimensions as possible. An acceptable level of stress is 0.15 (Bernard 2004).

In this particular case, two dimensions were needed to adequately place the items in a low stress distribution (0.147). A three dimensional diagram is the optimal way of describing the domain since it fits in the items with a minimal stress of 0.108, this however is less practical for displaying in a written document. The three-dimensional MDS is presented in Appendix D. This shows not only that the items within the domain are quite consistent in their relationships with each other, but that it can acceptably be represented in a two dimensional diagram on paper (even if a three dimensional diagram is ideal).

The units composing the MDS are arbitrary measures derived from the similarity matrix used to construct it, they hold no particular meaning for interpretation other than showing the position of the items with regard to each other. Distance within the MDS represents the degree of similarity amongst items in terms of which are mentioned more often and together by informants. Distance from the center of the MDS shows the importance of each item within the cognitive domain. In this manner, items closer to the center were mentioned more times by the informants, giving them a more prominent place within the domain. Items in the “core” of the MDS are those that hold a more important place in Guaymi culture and therefore had more probabilities of being mentioned together.

On the other hand, items on the fringes of the MDS would show that they are less important since they were mentioned fewer times and unrelated to the more important items. Most of these items are species only mentioned by one or two informants therefore they are not being a very important part of the culture being sampled.

Distance between items is a measure of similarity amongst them, the closer items are together the more times they coincided in being mentioned together by the informants. Items that are at a similar distance from the center, but in different quadrants within the circle show that, although they are equally, important, they were mentioned by different parts of the population, indicating that the knowledge of them is not evenly distributed within the population.

The core of the diagram, defined by those items falling within a radius of 1/3 that of the total domain, consists of 20 species (Figure 2-1). Among these there is a tight core of plants that not only were mentioned be many informants, but consistently mentioned together. These will be referred to as the inner core plants. The inner core consists of 5 species with a similarity of 0.5949 or more (Figure 2-2). These species are: *Hypolepys repens, Phytolacca rivinoides, Euterpe precatoria, Licania belloii* and *Chamadorea tepejilote*.

The results coincide with field observations since these plants are among the favorite wild foods of the Guaymi. In some cases, like *L. belloii* and *E. precatoria*, the plants are not very easily accessible, but the Guaymi will make time to go and collect them because of their palatability. As for the other plants, not only are they palatable to their taste, but they are abundant throughout the reserve and provide a good source of vegetables and greens without much extra labor.

The secondary core plants are composed of plants that are commonly eaten, but are either not as tasty or available as those in the central core. Although not as favored as the core plants, it is common to see people collecting them in their fields or on roadsides when they happen to run into them.

The whole core of the domain contains most of the plants that play an important role in the Guaymi diet. It provides them with a year-round source of vitamins and minerals not available to them from other sources.

The second circle of the domain is composed of plants that are only occasionally eaten, mostly fruits. These plants are not an important part of the Guaymi diet, yet they still serve to give them a varied diet. Many of these plants are eaten mostly by children, or sometimes by adults as a snack when out in the fields. Some of these plants are also not found near settlements but far into the forests of the southern part of the reserve making them less accessible to the community in general.

Finally, the third circle of the domain is composed of four species. These species are not important since the knowledge of them is held only by a few individuals. Two of these plants, identified as “za” and “ka ñude” were not found to collect as specimens, however were included because of the credibility of the sources. Za could to be a tree from the family Sapotaceae, possibly *Manilkara* sp, by the description of the fruit, yet this is not certain. This one was included since it may be more abundant in other Guaymi territories than in Coto Brus. Ka ñude is a subacuatic plant found in the river (during the time of the study it was not possible to go into the rivers due to heavy rains). This plant was included since it is not common to find edible plants that grow subacuatically.

The other plants in the outer ring are plants that, while they can be eaten (*Triumphetia* sp and *Begonia* sp), are considered more medicinal than edible, hence they are a transition between the wild edible plant domain and the medicinal plant domain.

The variety of edible parts used is greater for the core of the domain compared with the outer rings. What this shows is that there is a need for variety in types of foods (fruits, fungi, leaves, shoots, roots, and flowers), Figure 2-3 presents these proportions.

Most of the plants in the outer rings are fruits. They are mostly plants from the primary forests with which only a limited part of the population comes in contact with (mostly men hunting), or plants that are sometimes cultivated and therefore not considered by many as wild.

Since the plants in the inner core are the ones mostly used by the Guaymi, the great variety of edible uses shows the varied needs that they have for vegetable supplements in their diet.

Examining the types of plants in the central core of the domain reveals that there is a preference for species that produce fruits, leaves and shoots. While there is only one species of fungi, this one appears in a central position indicating that it is a preferred food. Also, there is only one type of root; while it holds a prominent position in the diagram, the main source of roots for the Guaymi is cultivation and not foraging. On the other hand, plants with edible stems are only present in the outer rims of the domain.

In summary, the Guaymi have a group of species of greater importance to them that are composed of a very varied assortment of edible uses. There is a less important group of plants, less diverse in terms of uses, composed mainly of fruits. Stems are the least preferred plant part eaten by the Guaymi.

Clusters of species, or species that consistently were mentioned together can be seen on the MDS (Figure 2-4) and on the cluster analysis (Fig 2-2). These clusters show plants that were consistently mentioned together. The closeness to the center of the MDS shows that the cluster was consistent for a greater number of informants while those further from the center signify a consistent agreement but by a smaller number of informants.

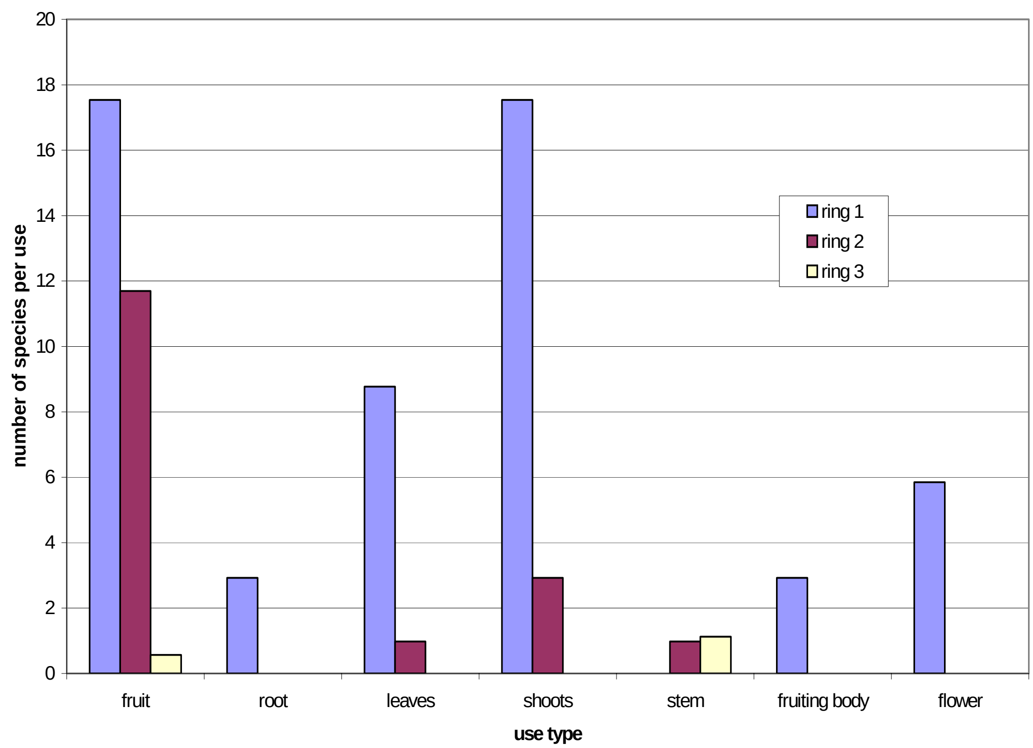


Figure 2-3. Proportional number of species according to their use with regards to distance from the center of the cognitive domain for wild edible plants used by the Guaymi of Costa Rica.

The cluster analysis gives a measure of how similar the items in the freelists are. An agreement of one between species shows that every time one was mentioned the other one was present. Clusters, however, do not take into account the number of informants that actually mentioned the plants, nor the order in which they were mentioned, therefore they cannot be used to attribute importance to some species

What clusters do reveal is the distribution of the knowledge of certain plants within the population. For example, in Figure 2-4, and 2-2, clusters C represents species that were mentioned consistently by the same informants. The closeness with cluster B shows that some of the informants that mentioned these plants, likely mentioned the ones form group B. Cluster D,

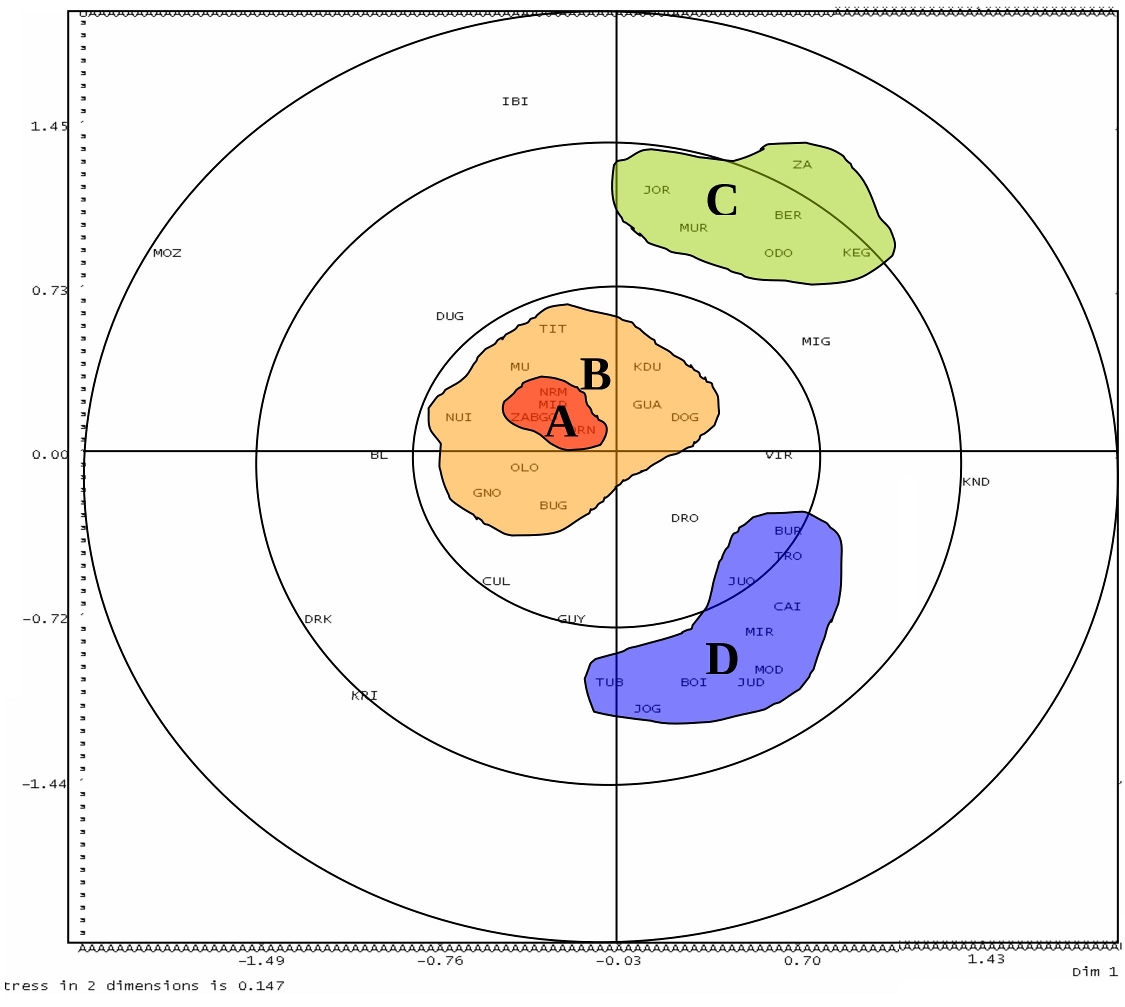


Figure 2-4. Non-metric multidimensional scaling (2 dimensions) of the wild edible plants cognitive domain of the Guaymi of Costa Rica, Coto Brus showing the more prominent clusters.

*Species symbol key in Appendix V.

however, is very distant from cluster C, this shows that the informants that did mention plants in this second cluster, were unlikely to mention the plants in the first.

The cognitive domain is thus composed of a group of plants that is known by most of the population (Clusters A & B) and two major groups known only by some portions of the population. These secondary groups (D & C) are a more diffuse, or patchy part of the cultural knowledge. This may be due to differences in knowledge possessed by age groups as will be seen in later chapters.

The cluster analysis procedure allows me to introduce numbers and measures to the tendencies that can be seen in the MDS. Group C is the most constant of all groups, some species have an agreement of 1.00, that is they were always mentioned together. However, the fact that only a few informants mentioned these species, and in this way did not match positively with the greater part of the species, makes this cluster of tertiary importance in spite of its high agreement. Group A, on the other hand, consists of species with a high incidence with each other as well as species that were mentioned by a large proportion of informants. It has an agreement of more than 0.51 and as high as 0.6579. group B is an extension of group A, with a sporadic agreement between 0.50 and 0.33.

Group D is a more spread up group with little agreement (represented in the cluster analysis by several peaks) in general it has an agreement of about 0.31.

Finally, there are several scattered species with little similarity to the other groups. These are either species mentioned alone and in an isolated manner, or species that serve as transitional points between the main groups.

Conclusions

The wild edible plant cognitive domain of the Guaymi culture of Coto Brus Costa Rica can accurately be represented spatially in two dimensions through non metric MDS with a stress level of less than 0.15 (0.149). A three-dimensional MDS is optimal and allocates all species with a stress of 0.108

The core of the cognitive domain is composed of a group of plants with a diverse set of uses while the outer rims of the domain are composed mainly of fruits and edible stems.

Plants in the border of the domain are those that are known by a very small portion of the population or have other uses more common than their edible properties.

Cluster analysis confirms the existence of similar groups in terms of positive matches during the interviews. Since similarity among species shows importance in this case. Using the MDS as and cluster analysis the species that form the core, or more important group of plants are: *Chamadorea tepejilote, Cookenia tricholoma, Dioscoria trifida, Euterpe precatoria*, *Hypolepys repens, Licania belloii, Phytolacca riviniodes, Urera spp.*

CHAPTER 3
ETHNIC IMPORTANCE AND DIVERSITY OF SUCCESSIONAL STAGES, PLANT PARTS, BOTANICAL FAMILIES AND LIFE FORMS AS SOURCES OF WILD FOODS TO THE GUAYMI

As is well known, tropical rainforests possess a high biodiversity. This biodiversity has a potential to satisfy a variety of human needs such as medicine, building materials, food, fiber, etc. Yet extraction of these products is not dependant only on the forests' biodiversity but on the knowledge of the cultures that come in contact with it. In this way, a person belonging to city culture would probably not be able to obtain food from a rainforest since the knowledge on how to use the available resources is not present to allow their adequate use.

This ethnic or cultural viewpoint serves as a filter for the humans that interact with different ecosystems. Even among cultures adapted to the rainforest, some may have different uses for the same species and rely more on one or another type of vegetation to satisfy their needs. In this way it is impossible to calculate the value of a certain type of vegetation or land use without taking into account the cultural perspective from which it is being approached. A western culture like the Latin culture in Costa Rica does not posses the ethnobotanical knowledge that indigenous cultures have regarding uses of local flora. This is why, even if the Costa Rican scientific community may know most of the species common in its territory, it may see them as useless for practical purposes. Indigenous communities such as the Guaymi, on the other hand, may know the same species as botanist do, yet through centuries of trial and error, have found uses that currently are still not known to scientists and the general Costa Rican population.

Studying this knowledge of cultures that are more adapted to tropical environments than current Latin American westernized societies may be a great aid in finding new crops and land use techniques to improve living conditions and the economy of these countries. Using the knowledge accumulated through trial and error by generations of aboriginal cultures may save time and money in researching these topics, and helping to find a practical use for the vast biodiversity of the tropics. Preserving this fragile knowledge for which the traditional means of oral transmission are being lost because of modern education and aculturization, is an important step in reaching the most efficient use of the tropics' biological resources.

The methodology used in this research is designed to evaluate ecosystems not only from a biological perspective but from the human perspective of a certain group. Knowing what the values of certain ecosystems are to a culture or group are important for planning land use change and other development policies. For example, certain types of secondary forests and fallows that are products of shifting cultivation are not viewed as productive by western agronomists. This makes shifting cultivation seem like a wasteful technique that requires leaving land in "unproductive" stages for a long period of time.

From the Guaymi perspective, like many other indigenous cultures (Harris D.R ,1971, Alcorn 1984, Manner, H.I, 1981, Nyerges, A, 1989) however, fallows are not only used to return fertility to soils but are also a source of vegetables, fruits, medicine and game to natives that are normally inaccessible to them elsewhere.

The Ethnobotanical Importance (EI) presented in this methodology is a means to evaluate the importance of different categories such as successional stages, life form, parts used, and botanical families to a particular culture. It facilitates comparison of different ecosystems for ethnobotanical uses such as medicine, craft material, fiber, building materials, etc. (in this case limited to edible plants). It also helps to compare the usefulness of an ecosystem between different cultures or groups within cultures (age and gender groups for example).

The EI also helps obtain data that cannot be directly obtained in a quantitative manner. This refers to the fact that often the value of specific successional stages is not recognized by people and cannot be easily seen. During the interviews, a large number of informants would not specify the origin of the species they used. Answers were general and often encompassing many successional stages as a whole. Although they were very specific on plant names and preparation methods, many would not place individual species in a particular successional stage. With few exceptions, most plants were said to grow “just anywhere (in the wild)”, or “in all types of forests”. This makes it hard to obtain the true value of successional stages if it cannot be accessed in detail through informants.

Through the EI, the true value of successional stages as a source of food plants can be determined by putting together cultural data and direct field observation.

Hypotheses:

- Diversity of wild edible plants is significantly higher in mature forest edges than in other types of vegetation.

- Mature forest edges have higher cultural importance than other types of vegetation as sources of wild food plants.
- Mature forests play a central role in the provision of wild food plants to the Guaymi.
- Greens are the most important product obtained from wild edible plants by the Guaymi.
- Shoots are preferred by the Guaymi as a source of food.
- There are certain life forms that are culturally more important than others.
- The ethnobotanical knowledge of wild plant species as a source of food by the Guaymi is a function of their shifting cultivation practices and its elimination may cause knowledge to be lost.

Methodology

To determine which plants are being used by the Guaymi free listing of wild edible plants was used with 46 informants until the informant-species curve leveled off (see Chapter 1). The salience of each species (see Appendix E) was used to give each species a cultural importance value for the Guaymi culture.

Then informal interviews were conducted to find out the Guaymi perspectives on ecological succession. Visits throughout the reserve were conducted to determine the main types of vegetation present. These were: early secondary succession (0-6 years), late secondary succession (7-20 yrs), mature forest (20+ years), mature forest edge, late secondary succession edge. By edge, we mean the area where the specific successional stage meets a road, farming field or any other major open area. The reason for including the edges of mature and secondary forests was that, according to informants and through direct observation, this is where most edible plants are commonly collected. The edges of early succession were not sampled since their exposure to light, and environmental conditions do not vary greatly whether on the edge or center of the succession with regards to the rest of the vegetation.

Similarities in Species Composition of Successional Stage

After the main successional stages were determined they located in the field and sampled using 10 x 10 m plots to determine the frequency, abundance and diversity of the plant species that exist there. Sixty such plots were used in this analysis for each successional stage (300 total).

To compare the species composition of each successional stage, the abundance of all species was compared amongst successional stages to determine the similarity between them. This was determined by comparing, for each species present in each pair of successional stages, the number of individuals per hectare. This was done by finding the degree of dissimilarity dividing the absolute value of the difference in individuals of each species by the total number of individuals of that same species in both successional stages. This dissimilarity was then subtracted from one to determine similarity. In this way a value of 1 would show that the specie in question was exactly as abundant in both successional stages making them 100% similar, while a value of 0 would show that the species is not at all present in one of the successional stages making them 0% similar. All values in between would show the degree of similarity between the two successional stages regarding that species.

The similarities of all species present in the successional stages were averaged to obtain an average similarity between successional stages according to their composition and abundance of edible species. Equation 3-1 shows the steps taken to calculate similarities.

Equation 3-1.

$$\text{Similarity (S)} = 1 - \frac{|Vn_1 - V\,n_2|}{V\,n_1 + V\,n_2}$$

$$\text{Average similarity} = \frac{\Sigma\,(S_1, S_2, S_3, \ldots\ldots S_N)}{N}$$

Vt1 = number of individuals of species n in successional stage 1
Vt2 = number of individuals of species n in successional stage 1
N = number of species being compared

Ethnic Importance of Successional Stages

From the ecological and ethnic data the Ethnobotanical Importance (EI) was determined by combining ecological data from the field plots with ethnic information from the free listing interviews.

Other research methods have been used to measure the cultural importance of specific plants regarding their popularity and uses (Martin 1995, Alexeides 1996). Many others methodologies have been created to evaluate the abundance of species in a particular habitat. However no methods for evaluating the cultural value of the habitats themselves, based on the importance of plants they contain could be found. Hence this methodology was designed to fill that gap in a practical manner.

The Ethnobotanical Value for habitats has the advantage that it combines cultural and ecological data in a straight forward manner. It gives the researcher an idea of what a specific habitat's value is to a particular culture in terms of how they value those products. It also weighs each species independently against its own population, allowing a comparison species with very diverse survival strategies (for example grasses and trees). It also does not require long term evaluation of production and phenology of the species and in that way allows for the use of many species without having to research each in detail.

The EI does have its disadvantages though. First of all it does not take into account the size and production per individual, which may skew the data (for example a certain species of plant may be equally abundant in two habitats but produce more fruits in one of them). Also, the use of salience as a measure of cultural importance may lead to attribute more importance to overly abundant or notorious plants which may not be very important in terms of uses (for example a bitter berry bearing vine which is edible but is more notorious because its spiny stems are difficult to remove from fields).

In summary this is a proposed method for easily estimating the importance that habitats (types of ecosystems, types of forests, types of successional stages) have for a particular culture for one or more uses: as a source of edible plants, game animals, fishes, fibre plants, types of clays, or any other product that is produced in a wild state.

The EI is calculated as follows. From the free listing a value of Salience was calculated for each species using Anthropac (Borgatti, 1996). This value was used as a measure of importance of each species to Guaymi culture. This assumes that the salience of each species is linked to its importance as a food plant (which was the topic of the free list) and not to other qualities of the plant.

The number of individuals per hectare of each species was determined by extrapolating the individuals found in the sampling plots.

Next, the proportion of the population of each species that exists in each type of vegetation was determined by dividing the number of individuals found in each type by the total of individuals found during the sampling. This would show what percentage of the population of each species is found in each type of vegetation.

These proportions where then multiplied by the Salience of each species to weigh them with a value of ethnic importance. The resulting numbers show the importance of each successional stage with regards to its content of plants pertaining to one particular species. The use of proportions helps to compare populations of different types of plants (for example large fruit trees with low frequency and abundance vs. small leafy herbs with high frequency and abundance). The sum of the products of all the species proportional populations and their salience values is the ethnobotanical importance of that type of vegetation (EI). This can be interpreted as the importance of each type of vegetation in providing food plants according to the culture's value of the plants. For this purpose Equation 3-2 was used to determine the importance of each habitat.

Equation 3-2.

$$EI = \sum_{x=1}^{N} (S)(n_x/N_x)$$

Where:

EI = ethnobotanical importance for a particular successional stage
S = Salience
x = the individual species
N = the total number of species
n = the number of plants per hectare of each species

The EI allows for permits comparison of the value that particular successional stages have to different gender, age or cultural groups.

Equation 3-2 was repeated to compare the importance of botanical families, plant parts and life forms. The categories used for life form were: herb, shrub, palm, tree, fungus, and vine. The categories used for uses were: leaves, shoots, roots, immature flowers, stems, seeds, and fruits. The only difference is that the EI did not include a value for n (number of individuals per category). the calculation of the EI for each category was calculated using Equation 3-3.

Equation 3-3

$$EI = \sum_{x=1}^{N} (S)$$

Where:
S = Salience
x = the individual species
N = the total number of species

The accuracy of these results depends on the accuracy of the free listing as well as that of the sampling plots (See Appendix F). The average probability of the species not having significant differences amongst successional stages was 0.074. As for the accuracy of the cognitive data, the informant/species curve shows that about 84.12% of the species composing the cognitive domain were covered. In this way, the results for the Ethnobotanical Importance can be described as having a significance of 0.074 and covering about 84.12% of the edible plant species in the Guaymi's edible plant cognitive domain.

Diversity

Diversity was calculated using both Simpson's and Shannon's diversity indices. Simpson's diversity index was calculated using the Equation 3-4.

Equation 3-4

$D = 1- (\Sigma ((n)(n-1)))/ ((N)(N-1)))$

Where:
N = the total number of species
n = the number of plants per hectare of each species

This shows the probability of two individuals taken from that sample of belonging to different species. Shannon's index, which is another measure of diversity, was calculated using Equation 3-5.

Equation 3-5.

Shannon's Index (H) = $(n/N)*\ln(n/N)$

Where:
N = the total number of species
n = the number of plants per hectare of each species

These results analyzed through a Kruskal-Wallis test for significant differences (Höft, 1999).

Spatial Relation Between Abundance of Wild Edible Plants and the Distance to Habitation

To determine if there is a relationship between the abundance of wild edible plants and the distance to the nearest point of habitation, a linear regression was run using 180 field plots located in mature forests.

All plots, households and internal roads within the reserve were georeferenced using a GPS. Based on this data, the distance from each plot to the nearest point of habitation was calculated. A linear regression using the abundance of each one of the edible plant species found in each plot and the distance from the plot to the nearest household was calculated.

Results

The average similarities between successional stages regarding species composition are presented in Table 3-1. Similarities take into account the number of individuals of each species that the habitat has in common.

Table 3-1. Average similarities between successional stages regarding species composition.

	Early secondary succession	Old secondary succession	Mature forest	Mature forest edge	Secondary forest edge
Early secondary succession	100%	25%	11%	14%	30%
Old secondary succession	25%	100%	22%	32%	40%
Mature forest	11%	22%	100%	24%	17%
Mature forest edge	14%	32%	24%	100%	41%
Secondary forest edge	30%	40%	17%	41%	100%

The Simpson's diversity index for wild edible plants was calculated and compared through an Kruskal-Wallis analysis (Table 3-2) and the results are presented in Figure 3-1. Significant differences were found for diversity as measured by Simpson's diversity index

Table 3-2. Simpson's diversity index for species of wild edible plants used by the Guaymi in five different types of vegetation (Kruskal-Wallis analysis).

treatment	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score	actual value
early secondary succession	60	7322	11280	767.30	122.0	0.30

Table 3-2. Continued.

older secondary succession	59	9976	11092	762.09	169.08	0.42
primary forest	112	21663	21056	957.91	193.413	0.47
primary forest edge	60	14233.5	11280	767.30	237.22	0.56
older secoonndary succesion edge	84	17305.5	15792	872.61	206.01	0.47

Figure 3-1 presents the differences in Simpson's biodiversity indices for the five different types of vegetation sampled. Figure 3-1 shows that the vegetation with the greatest biodiversity was the mature forest edge. It is followed by mature forests and secondary forests and their edges which have similar values. The least diversity is found in the early secondary forest. Shannon's diversity index gave similar results regarding significant differences between habitats.

Figure 3-2. presents the Ethnobotanical Value for each of the successions that were evaluated according to the value that the Guaymi attribute to the plants that grow in them.

The Kruskal-Wallis analysis shown in table 3-3 shows that there are significant differences for the ethnobotanical importance of the different types of vegetations. Further analysis for these variables showed there are three groups with significant differences among them (Figure 3-2).

Figure 3-3 presents the ethnobotanical importance of the different life forms used by the Guaymi. According to these results, Guaymi culture values palms and vines more than any other life form. Fungi and shrubs were the least important life forms used as sources of food.

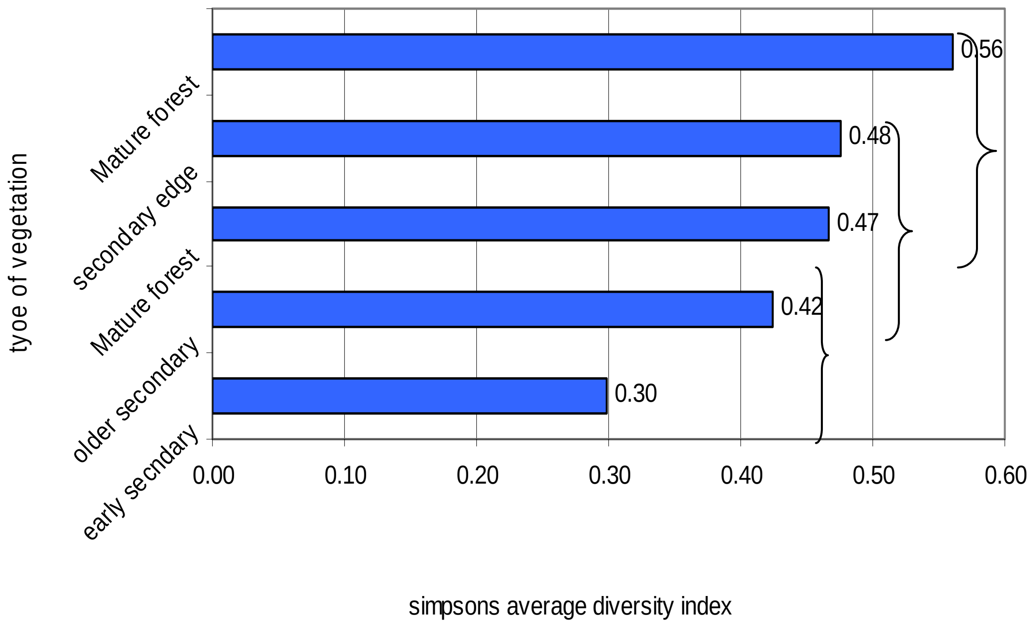


Figure 3-1. Average of Simpson's diversity index for edible plants calculated for five types of vegetation. Brackets show groups with no significant differences among them.

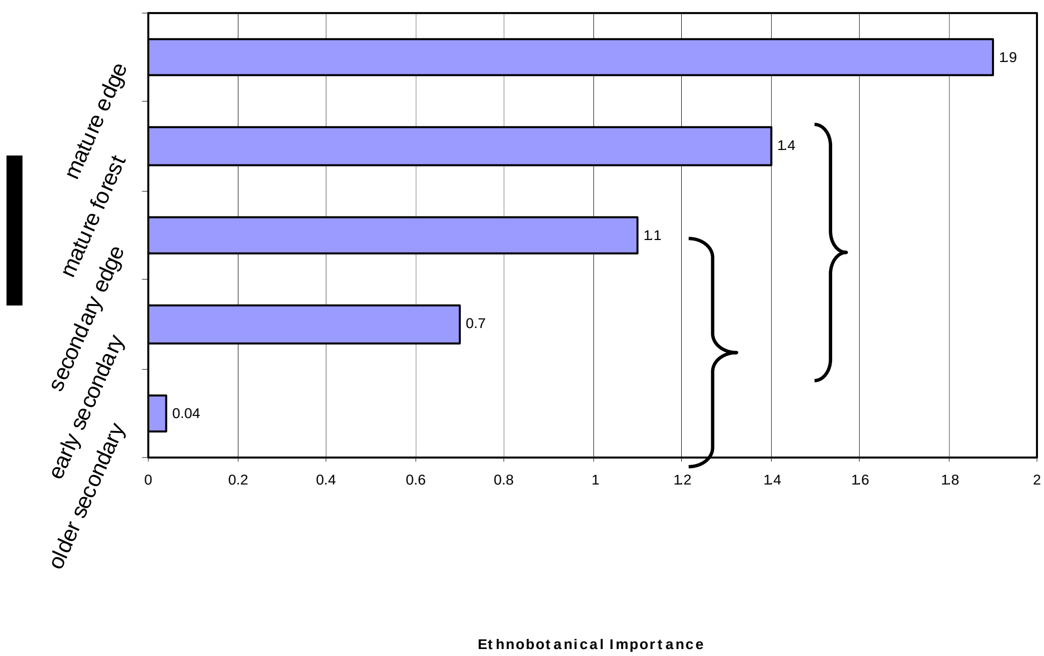


Figure 3-2. Ethnobotanical importance of five different successional stages of vegetation as sources of wild edible plants for the Guaymi of Costa Rica. Brackets show the groups with no significant differences among themselves.

Table 3-3. Ethnobotanical Importance of five different types of successions (Kruskal-Wallis analysis).

treatment	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Early secondary growth	60.00	8,427.50	11,310.00	771.78	140.46
Older secondary succession	59.00	10,094.50	11,121.50	766.54	171.09
Mature forest	113.00	22,843.00	21,300.50	966.26	202.15
Mature forest edge	60.00	15,127.50	11,310.00	771.78	252.13
Older secondary succession edge	84.00	14,383.50	15,834.00	877.82	171.23

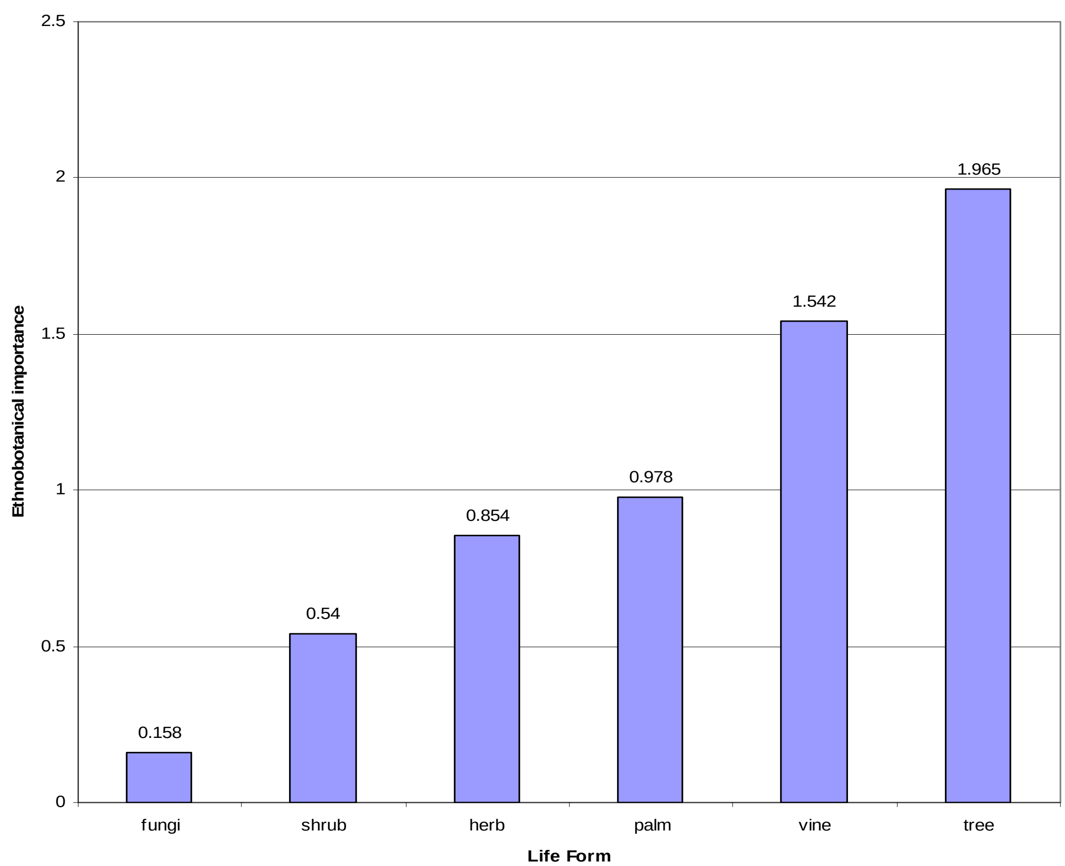


Figure 3-3. Ethnobotanical importance of life forms used by the Guaymi for food.

Figure 3-4 presents the ethnobotanical importance of the different types of foods (parts used) provided by wild edible plants to the Guaymi. According to these results fruits and shoots are the most culturally important plant parts used. Seeds and stalks, on the other hand were not very important to the Guaymi in the sense that there were not many species that provided them and also that the ones that did, were not very prominent in the free-listings.

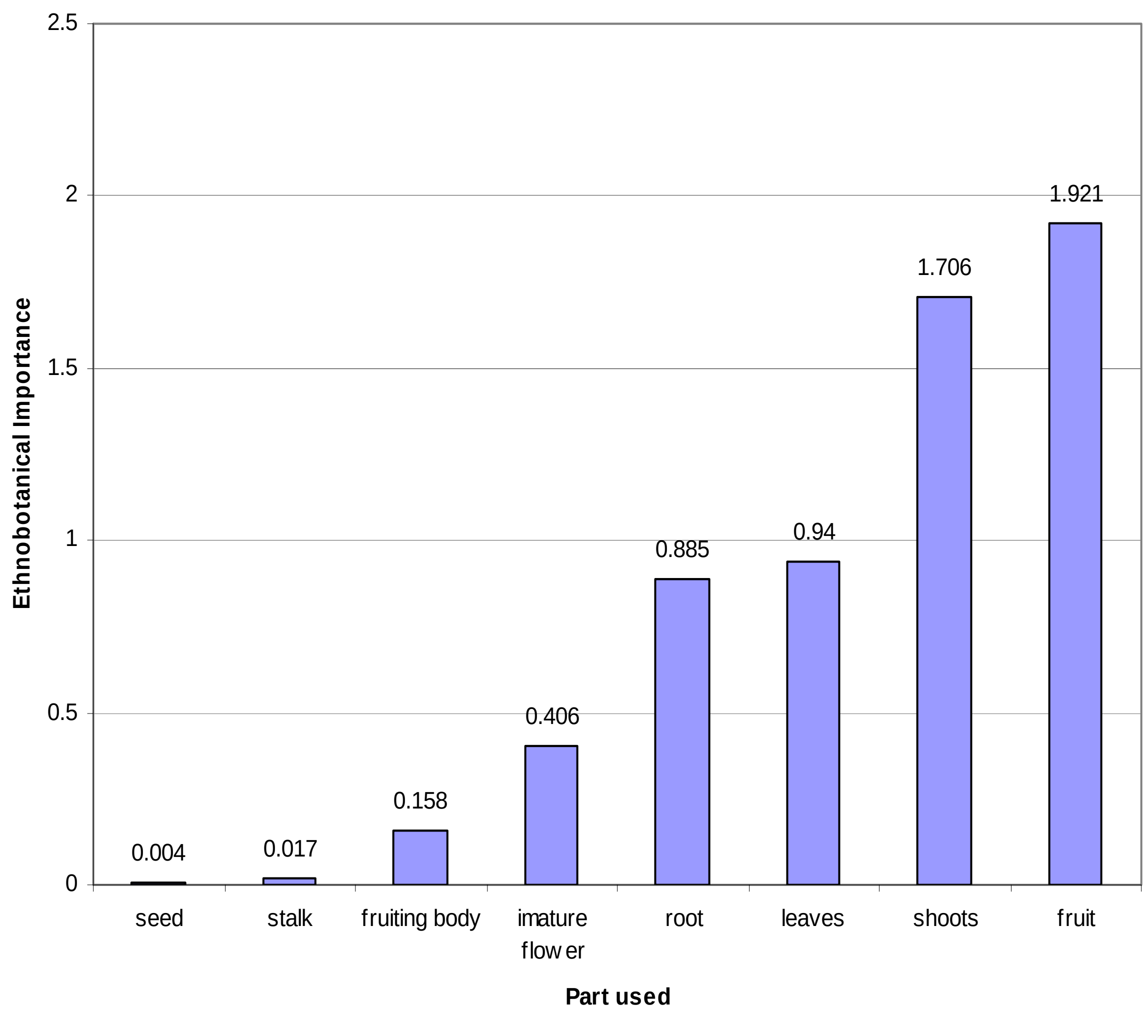


Figure 3-4. Ethnobotanical importance of plant parts used by the Guaymi.

Spatial Relation Between Abundance of Wild Edible Plants and the Distance to Habitation.

No significant relationship was found between the abundance of edible plant species and the distance to habitation. All the R^2 values for the species studied were less than 0.08.

There are to many external factors that influence the distribution of species that were not taken into account in this study; for example a constant elevation change from 500 to 1500 meters above sea level, differences in humidity, differences in soil types, and presence of seed dispersal vectors. There was insufficient data to conclude if whether there is or not a relationship and a more detailed study with this objective would need to be conducted to determine the role of distance from habitation on the abundance of edible plant species.

Discussion

Similarities in species composition

Taking into account the successional stages' species composition and the number of individuals per species, the edges of both mature and secondary forests are the most similar types of vegetation, with 41% similarity in their composition.

On the other hand the most dissimilar successional stages are mature forest and its edges with regard to early secondary growth (11 and 14% respectively), which makes them the most dissimilar successional stages.

The reason for this is that the main limiting environmental condition is sunlight. Plants that grow in the mature forest and its edges are subjected to greater amounts of shade than those in early growth. When comparing older secondary successions and their edges to early successional vegetation, a great number of species are still present and thriving from the early stages, this gives them a 25% and 30% similarity respectively. Also, the environmental conditions of light, humidity and temperature are more similar between these successional stages and early successional stages.

In this manner, older secondary forests provide a transition in terms of species composition between mature forests and early growth. Even so, the edible plants that grow in secondary forests are only 25% similar to those in early successional stages and 22% similar to those of mature forests. This means that none of them can fully substitute for the other as a source of wild food plants and that, although secondary forests are a transitional phase between early successions and mature forests, they provide the successional stage for particular species that are not provided by either of the two extremes.

Mature forest edges are, on the average (18%), the least similar to other successional stages. This interphase between the closed canopy of the forest and the clear cut farming fields or provides the necessary variation in successional stage for plants with very different environmental needs to coexist in a small area. Both K strategy species (shade tolerant and with slower growth rates) and R strategy species (fast growing and dependant on bright light) can be found here in extended areas not normally found in natural forest gaps. This coexistence between plants with different survival strategies makes mature forest edges much less similar to all other types of vegetation where only one survival strategy predominates.

Secondary forest edges are very similar to mature forest edges (41%), but very different from mature forests (17% similarity). The reason for this is that they started off as an early secondary forest where all the species from the older growth were removed without having had the conditions to regenerate. This is why secondary forest edges show so much similarity to other successional stages (32% on the average) and so little similarity to mature forests.

One important aspect of forest edges is not only their abundance of species, but the fact that they are the most accessible source of food plants for the Guaymi. With few exceptions such as *Licannia* sp and hearts of palm, few Guaymi will actually go into the forests with the purpose of seeking wild food plants. As mentioned before, incursions into the mature and older secondary forests are done either for hunting or for clearing for new plots. Instead it is at forest edges where most of the wild plant collecting is done.

One of the most noticeable features of mature forest edges is the presence, in great abundance (up to 1623 individuals per ha), of *Phytolacca riviniodes*. This is among the most important plants used by the Guaymi, and, although it was found in secondary forest edges as well, it was only found in large quantities on mature forest edges. Early and late secondary growth, as well as the mature forest itself, contained this species only in isolated individuals. A similar, if not so dramatic case is that of *Brossimum guianense*, *Inga* spp, *Dioscoria trifida*, *Passiflora* spp, *Spondias mombin*, *Tetragastris panamensis, Carica cauliflora*, *Byrsonyma crasifolia*, *Thobroma bicolor*, and *Chamadorea tepejilote.* These plants have a greater abundance in mature forest edges than in any other successional stage.

Secondary forest edges are somewhat similar to mature forest edges, and some important food plants find them to be an optimal successional stage. Such is the case *of Carludovica palmata*, *Cestrum racemosum*, *Heliconia* spp, and *Urera* spp.

Early successional stages are not particularly diverse, however they do provide the successional stage for certain plants such as *Hypolepys repens*, and also for the seedlings of plants that are typical of the older secondary forests.

Certain plants, even if they are found in the mature forest edges, are only found in their greatest abundance in the inner mature forest. Such is the case of *Clavija costaricana,* Licania *belloii, Pouteria sapota*, *Garcinia madruno* and all the heart of palms.

Species Diversity of Successional Stages.

The biodiversity of food plants used by the Guaymi was calculated using Simpson's diversity index. According to the Kruskal-Wallis test for this index (Table 3.2) for a 0.95 significance, there were three main groups that did not show significant differences in theirs of species diversity (Figure 3-1).

The first group is composed only of the early secondary growth and older secondary growth, with the lowest diversities at 0.30 and 0.42. Although both of these successions have a great abundance of biomass, the edible species found there are not very diverse.

Secondly there is a middle group composed of older secondary growth (0.42), mature forests (0.47), and edges of older secondary growth (0.48). This group has a mean Simpson's index of 0.46 and moderate diversity of edible plants.

The final and most diverse group is the edges of secondary forests which have no significant differences with the mature forest and secondary forest edges. As mentioned before, mature forest edges provide an area where species from all other successional stages can be found coexisting in a relatively small area. Its diversity of 0.56 is due to the combination of pioneer plants taking advantage of the cleared space and bright sunlight, mature forest plants which appear as remnants of the original vegetation, and older secondary growth plants that can thrive in the transition between cleared and closed canopy. The main difference between this type of vegetation and the secondary forest edges is the absence of remnant plants from mature growth, hence its superior diversity.

It is noteworthy that a higher diversity in a successional stage does not necessarily mean it is more important in ethnobotanical terms, it merely shows that there are many useful plant species in it. A less diverse area could be more important ethnobotanically than a more diverse one if those few species were of wider use. To do this, the cultural importance is a variable that must be added into the analysis.

Also, the diversity indices are not only related to the ecological conditions of the vegetation, but also (if not more so) to the culture that is being studied. This means that diversity of wild edible plants is also dictated by the preferences of the culture that uses the plants. In this case, the adequate interpretation of Simpson's diversity index is that the plants used by the Guaymi are more diverse in the disturbed successional stages, particularly mature forest edges. This means that their knowledge is richer in such types of vegetation.

Ethnobotanical importance of successional stages as sources of food plants

After evaluating each type of vegetation according to the edible plant species and their respective salience values in Guaymi culture, I found that the most important sources of plant food for the Guaymi are mature forests and their edges (Figure 3-3). Of these types of successional stages, edges in particular, have a very high ethnobotanical importance to Guaymi culture. This is confirmed through the Kruskal –Wallis analysis shown in Table 3.3. Mature forest edges have significantly more importance ($\alpha = 0.05$)

with all other successions. Mature forests, older secondary edges and early successions have no significant differences between and are therefore considered equally important. Finally, the least important succession in terms of wild food plants provided is the older secondary growth, which is significantly different from the mature forest and primary forest edges in this respect.

While edges combine the plants from mature forests with those from early successions in a small area, mature forests contain several plants which are found scarcely or not at all in any other successional stages.*Licania belloi*, and all the hearts of palm are good examples of this.

The existence of mature forest edges is rooted in the agricultural cycle of shifting cultivation. The fact that most of the plants that the Guaymi value come from it is not a coincidence but more likely an adaptation of their culture to the part of the forest that they come in contact with more often. The constant clearing of forest patches for farmlands implies that the Guaymi will spend most of their working days in contact with mature forest edges more than with other types of natural vegetation cover. This comes from the fact that the shifting cultivation cycle favors the clearing of mature forests over younger ones to provide richer soils that have had a greater fallow period. Hence, cleared fields are more likely to border mature forests rather than secondary ones.

Early and older secondary forests are not commonly entered but are still in accessible places where the Guaymi pass on the way to their active fields. Mature forests, however are usually not entered unless for specific reasons, such as hunting, which is not an everyday activity. Even if it is not as common for the Guaymi to enter the mature forests, the plants there are highly valued foods (hearts of palm and fruits for the most part).

As the Guaymi have adapted to modern conditions and technology, their contact with the mature forest and their dependence on it have diminished and they spend their time farming rather than hunting and foraging. This implies that their contact with natural vegetation covers is more often because of its role in the farming cycle. As a result their contact with disturbed vegetation (forest edges) has increased. The diversity indices and the EI show the culture's focus on mature forest edges.

In this way, it is probably not that disturbed vegetation produces more plants that are edible to humans, rather that the modern day Guaymi, thorough their more constant interaction with disturbed vegetations, have come to use more of the plants that grow in them. As can be seen in Figure 3-1, the diversity of edible plants from the mature forest is high (0.47), this means that the knowledge of edible plants from it exists and quite abundantly, it is just that, as is the these species are not considered to be as important for every day consumption as plants found in more accessible parts of the forest. Many of the plants in the mature forests are considered delicacies, such as heart of palm and *Licania belloi*, or snacks such as *Inga* spp., and *Clavija costaricana*. This is why even if mature forests and secondary forest edges have similar diversities of edible plants, the value of mature forests is still higher. On the other hand, plants from the mature forest edges such as *Cestrum racemosum*, *Phytolacca riviniodes*, *Hypolepis repens*, and *Urera* spp. among others, are part of every day diet since people can bring them from the fields or roadsides at any time.

Although mature forests do not have as much importance as their edges, they are essential in an indirect way. First of all, there would be no mature forest edges if there were no mature forests. This means that although the forest itself is not as important source of food (since it does not provide everyday foods but rather specialty foods), it is essential in creating the unique edge environmental conditions that are required to maintain the most important and diverse source of food plants and that cannot be found elsewhere. Also, many of the species found as remnants in the edges, only regenerate under mature forest conditions (hence the lack of similarity between secondary and mature forest edges). Mature forests also serve as sources of seeds for plants in secondary successions. Clearings within the forests are populated with small colonies of secondary forest plants that serve as a source of germplasm needed for the succession cycle of shifting agriculture.

One good example of this is the distribution of *P. riviniodes*. Even though it is a plant that thrives in highly disturbed sites, it is only found in great abundance as a pioneer at the edges of mature forests. It is not found in early successions since it does not seem to compete very well with more aggressive species, and it is seldom found in older secondary successions. In contrast, it can be found sporadically in gaps within mature forests from where it seems to spread fairly quickly when a farm plot is opened near it.

In the cycle of shifting cultivation the most productive stages in terms of wild food plants are the extremes: the mature forest and their edges and the early secondary growth. The older secondary forests serve as a gap, or transition for mature forest species to regenerate yet they do not provide the proper conditions for disturbance vegetation to thrive.

In conclusion, under the Guaymi perception of importance of plants, it is not possible to identify one type of vegetation as a more important source of food plants than others without looking at the fact that all these are linked to one another in the cycle of shifting cultivation. Mature forests are a source of seeds and K strategy species, early successional stages provide the successional stage for pioneer species and for the seedlings of important species of the older stages. Secondary forests provide their own assortment of edible plants while creating conditions for the K strategy plants of the mature forest. Finally, the edges of these successional stages, provided by constantly opened shifting cultivation plots, not only provide a combination of all these environments but an interphase where humans commonly interact with them and obtain their products.

The role of shifting cultivation is central to this system in that it is the main source of disturbance, creating the successional stages for the species to grow as well as preserving areas in various regeneration stages. Furthermore, it is also the source of contact between the Guaymi and the vegetation since it creates the edges that are most important for the Guaymi as a source of food plants. The variety of plants favored by the Guaymi are those that are also promoted by the slash and burn cycle.

A culture's farming techniques shape the environment and vice versa. The high rainfall, high diversity of pests, soils with rapid loss of fertility of the area have led the Guaymi to favor shifting cultivation as a technique. This practice, in turn, has affected the environment by creating sharp gradients between disturbed and undisturbed vegetation. As a reaction, the Guaymi culture has also adapted to these self generated changes by using the diversity of plants found in these types of vegetation.

The growing demand for land by the increasing Guaymi population and their incorporation into the market economy dictates the adoption of more permanent uses of the land such as cattle, coffee, cacao and other cash crops, and also immigration to urban areas. This means the current system, where the mixture of disturbed and mature vegetation creates the environment for these wild edible plants, may be endangered and with it the ethnobotanical knowledge of these and other non timber forest products.

This is the case of the Guaymi of Coto Brus, Costa Rica, but the principle could be extrapolated to other cultures reliant upon shifting cultivation and under similar socioeconomic conditions as the Guaymi. It is likely that other cultures would have developed a similar relationship with their environment relying more on the vegetation of the forest edges than on exclusively mature or secondary forests. Further studies are needed to confirm this hypothesis.

As with the case of the Huastecs in Mexico (Alcorn 1981), the successional stage that surrounds the Guaymi, even that considered as mature forest, is an anthropogenic vegetation. Even though the management for wild resources may not be as conscious as that of the Huastecs, or as it might have been in the past of the Guaymi, the plants that compose each successional stage are all influenced by the swidden cycle of agriculture. If this management could become more conscious to Guaymi society, then a better utilization of resources could be achieved.

Ethnobotanical Importance of Life Forms and Uses of Wild Edible Plants

Life forms with greater importance for the Guaymi as sources of food are herbs and trees. Herbs contain important, commonly used plants with a prominent place in the edible plants cognitive domain. Trees, although in general have a lower cultural importance than herbs, are very numerous in terms of species. The large number of tree species that are used as sources of food (Figure 1-5) put this life form category in a prominent place. Tree products seem to increase as the succession matures, and inversely, the importance of successional stages decreases as this happens. Vines are the third most important life form. The palm category, although abundant and with important uses, possesses few species, therefore its importance is diminished as a source of food. Finally, shrubs and fungi are the least important life forms in Guaymi culture.

The importance of herbs as a source of food is also linked to the Guaymi's preference for plants from disturbed vegetation. Most of the herbs used for food are pioneer species that thrive in the edges of forests.

The plant parts that the Guaymi favor as food and collected from the wild are shoots, fruits and leaves (Figure 3-4). The inaccessibility of vegetables and fruits from outer markets probably plays an important role in this choice of products. Most of the crops the Guaymi grow are roots, grains, or cash crops. The need for greens and vegetables is supplied by the wild vegetation.

Seeds and stems are the least favored plant part by the Guaymi. This may be due either to the lack of edible stalks and seeds, or to the satisfaction of this necessity from domesticated crops.

Conclusions

- Mature forest edges are the richest type of vegetation in terms of being a source of food to the Guaymi.
- Primary forests and their edges are the most important types of vegetation that serve as sources of wild food plants to the Guaymi.
- Since the most important sources of wild food plants are the mature forest edges, the cycle of shifting cultivation plays an important role in providing these foods to the Guaymi since it is what generates this type of vegetation.

- Trees, although individually do not tend to be very important wild food plants, have a diversity of species such that they are the most important source of wild foods for the Guaymi.
- Fruits, because of the high number of species available to produce them, are the most culturally important source of wild foods.
- Shoots, although not as diverse as fruits in terms of species that produce them, hold significant importance to the Guaymi and are the second most important (culturally) source of wild food plants.

CHAPTER 4
PERCEPTIONS OF IMPORTANCE OF SUCCESSIONAL STAGES AS A SOURCE OF WILD FOOD PLANTS AMONG DIFFERENT AGE AND GENDER GROUPS

During the field work for this research, differences in the knowledge of wild food plants were observed among age and gender groups. It is logical to think that the Guaymi, as many other indigenous cultures are losing their ethnobotanical knowledge. The reasons for these are many: aculturization of younger generations, the breaking of oral transmission systems for information, the incorporation into a market economy that favors monocropping of more valuable cash crops over diverse subsistence crops. These are only a few examples of possible reasons for the loss of traditional ecological knowledge. As a result of this loss of knowledge, it is hypothesized that younger generations will tend to value wild vegetation less than their elders since they lack the information needed to transform the plants therein into useful products.

As for gender as a factor of ethnobotanical knowledge, it was observed that Guaymi culture in particular, does not promote the incursions of women into more forested areas. Instead, they are limited to farm fields, home gardens, and secondary vegetation of roadsides. Men, on the other hand, are the ones who commonly bring in wild foods, and go into the forests to hunt and gather. Based on this observation, it was hypothesized that men would posses a higher degree of knowledge of edible plants in general and value the mature forest as a source of food plants than women.

To test these hypotheses it was necessary to quantify ethnobotanical knowledge and ethnic importance attributed to different successional stages by each group. Using the data from the interviews of 46 informants, and the data taken from 60 forest plots to determine the frequency and abundance of wild edible plants, the Ethnobotanical importance (EI) (see Chapter III) and average number of species mentioned per person of each group were calculated. Although the number of species mentioned per individual is not a direct measure of the species actually known by the individual, it is assumed that it reflects that knowledge in that individuals who know more about edible plants will tend to mention more than individuals who do not.The means for these variables were compared through a two tail T test to determine any significant differences that might exist.

Hypotheses:

- Older people in the Guaymi culture tend to value mature forests more as sources of wild foods than younger generations.
- In Guaymi culture, there exist differences in the importance attributed by different gender groups to vegetation as a source of wild foods plants.
- There exist significant differences in the average number of species mentioned per individual between three different age groups.
- There exist significant differences in the average number of species mentioned per individual between gender groups.

Methodology

The groups used for the analysis were as follows:

- Gender: male (22) female (24)

- Age: Young (17 individuals betweens15-29 years) Middle (14 individuals between 30 –44 years) elder (15 individuals of age 45+).

Average Number of Species Mentioned per Person

To determine the average number of species mentioned per person, the total number of species mentioned per person were averaged for each group and the means compared using a two tail T-test for a significance of 0.05.

Ethnobotanical Importance

To measure the importance successional stages hold as sources of wild food plants to each of the groups, the procedure explained in Chapter III to calculate the EI was repeated for each one. This time, however, the values of each species varied from the general population since there are differences in the ranking and frequency with which plants were mentioned by different groups.

The accuracy of these results depends on the accuracy of the free listing as well as that of the sampling plots. The average probability of the species not having significant differences amongst successional stages was 0.074. As for the accuracy of the cognitive data, the informant/species curve shows that about 84.12% of the species composing the cognitive domain were covered. In this way, the results for the Ethnobotanical Importance can be described as having a significance of 0.074 and covering about 84.12% of the edible plant species in the Guaymi's edible plant cognitive domain.

Results

The results of the analysis were as follows (details on the salience, average rank, number of times each species was mentioned are found in Appendix VI):

Average Number of Species Mentioned per Person

Figure 4-1 shows the relation between the age of the informant and the number of species he or she mentioned. Although there is variation in the number of species mentioned, there is a tendency for older informants to mention more species.

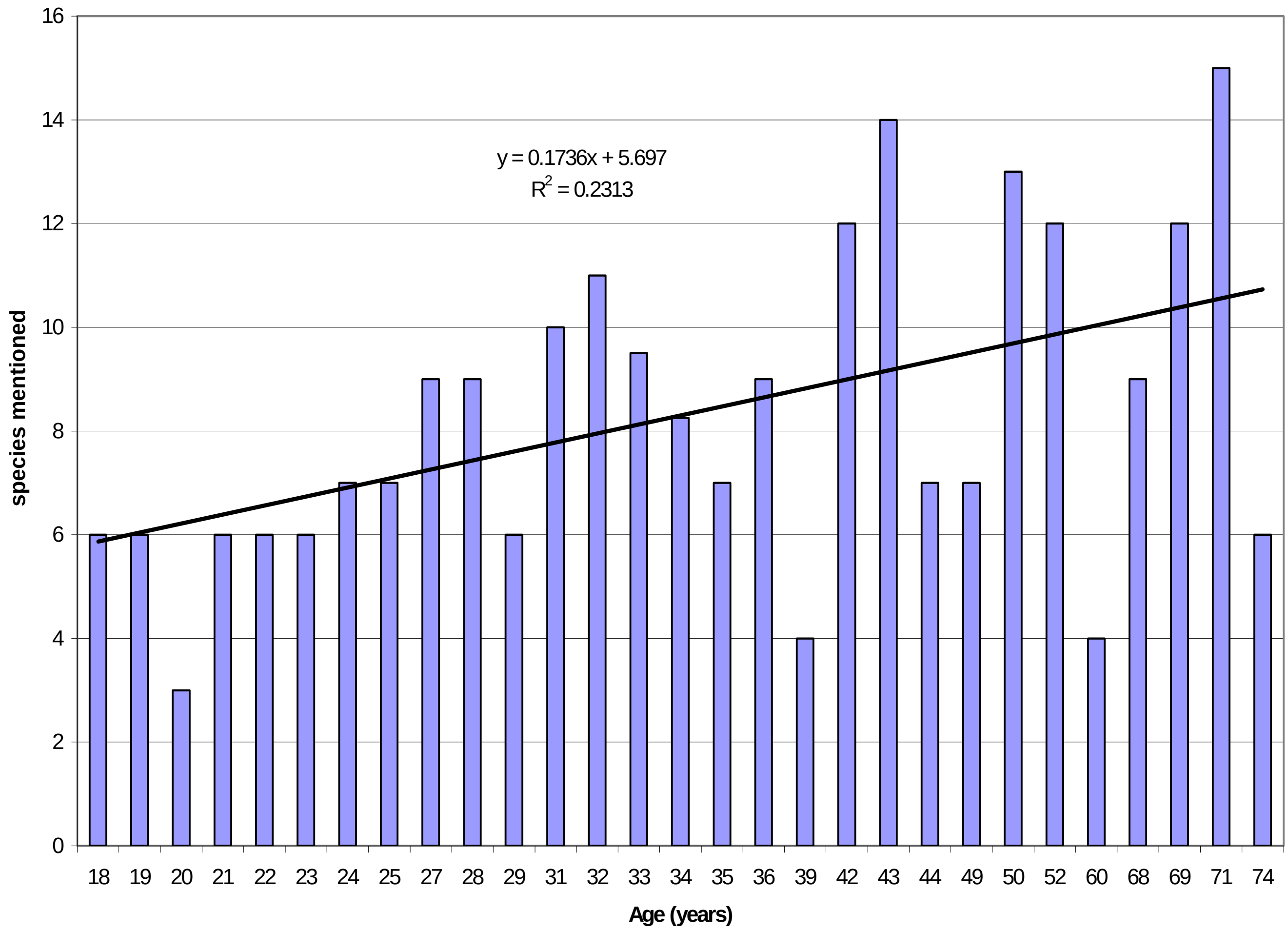


Figure 4-1. Average number of edible plants species mentioned according to informant age.

Figure 4-2 shows the average number of edible plant species mentioned by the informants of three different age groups (young: 18- 29 years, middle: 30-44 years, and elder 45+ years). Following the tendency presented in Figure 4-1. Older people, on average, mentioned more species than younger people. The average for the whole population was of 8.6 species per person. Both the elder and middle age groups mentioned more than the total mean. The young group, however, was in general well below this average (6.2 species per informant).

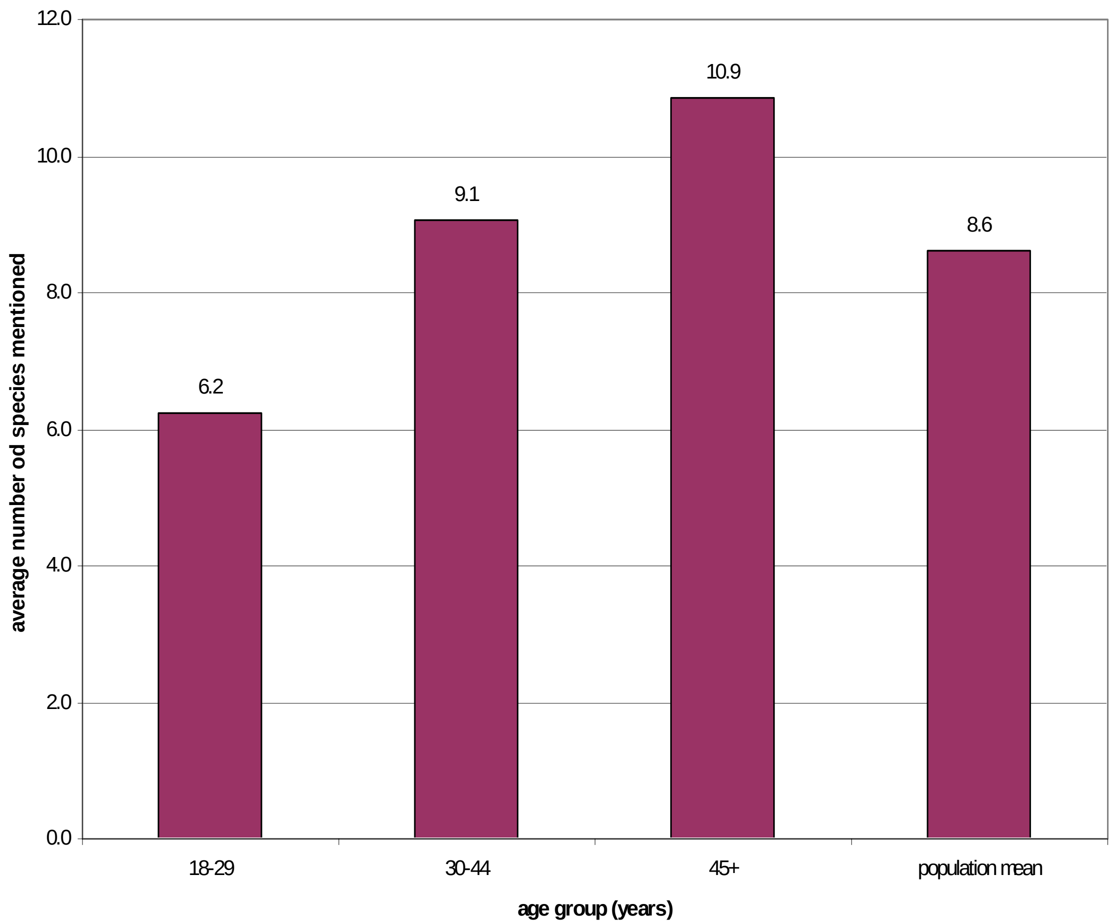


Figure 4-2. Mean number of species mentioned by different age groups

Table 4-1 T tests for the means of the number of species mentioned per informant for three different age groups for alpha = 0.05.

	young/middle		young/elder		middle/elder	
	young	*middle*	*young*	*elder*	*middle*	*elder*
Mean	6.23	9.07	6.23	9.57	9.07	9.57
Variance	4.81	14.22	4.81	15.49	14.22	15.49
Observations	17	14	17	14	14	14
grouped variance	9.03		9.60		14.86	
Degrees of freedom	29		29		26	
T	-2.61		-2.98		-0.34	

Table 4-1 Continued

P(T<=t) two tails	0.014		0.005		0.739	
Critical T values t	2.04523076		2.04523076		2.05553079	

According to Table 4-1. there were no significant differences between the number of species mentioned by the middle group (30 – 44 years of age) and elder group (45 + years of age). However there were significant differences between these two groups and the young group (18 – 29 years of age).

Figure 4-3 shows the results of comparing the number of wild edible food species mentioned by female and male informants. In general, male informants tended to mention more plants than female informats.

Females, on the average mentioned about 7.42 species per informant, while males on the average mentioned 9.91 species per informant. To determine the significance of these results, a comparison of means (Table 4-2) was conducted. The results show that this difference is only significant for an α =0.07.

On the average, male informants tended to mention more plants than female informants. The explanation for this may lie in the gender roles of Guaymi society and the areas that each gender tends to frequent the most. In general males are exposed tro a greater variety of habiats than women. Men usually come into contact with vegetatin when travelling to their fields, during ativities such as hunting, clearing new land for farming, or while working in existing fields near forests or fallows. Women in Guaymi society do not usually have as much participation as men do in such activities

Table 4-2 presents the comparison of means used to determine the significance of.

these results. Since the variability of answers was great. It was determined that the results are only significant for alpha = 0.10.

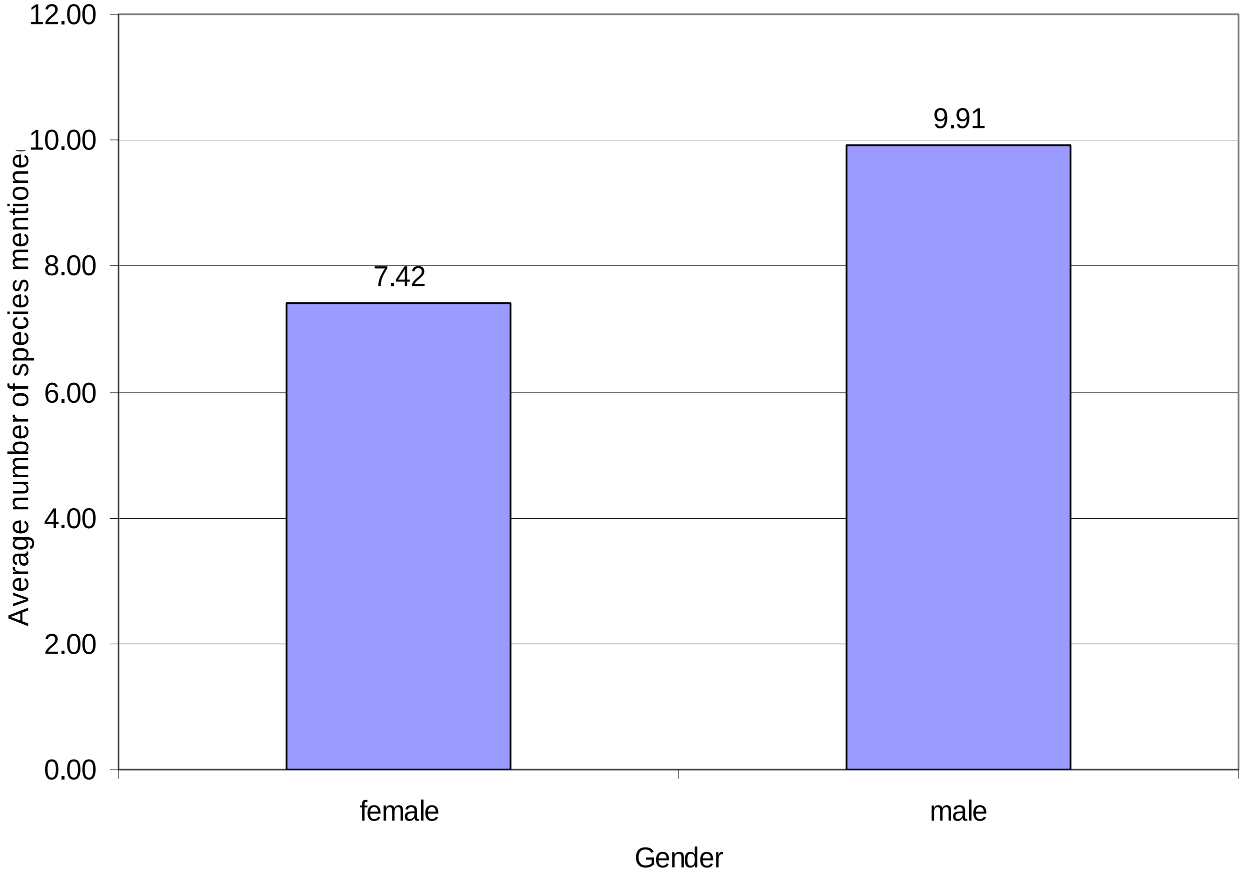


Figure 4-3. Average number of species mentioned by informants of different genders.

Table 4-2 T tests for the means of the number of species mentioned per informant for male and female informants with alpha = 0.10.

	female	*male*
Mean	7.42	9.91
Variance	10.25	32.56
Observations	24	22
Grouped variance	20.90	
Hypothetical difference in mean	0	
Degrees of freedom	44	
T	-1.85	

Table 4-2 Continued

P(T<=t) two tailed	0.07	
Critical T value (two tails)	2.01	

Table 4-1 shows that for alpha = 0.05, there are no significant differences in the number of species mentioned by men and women. The probability of there being a difference is of 0.071.

Ethnobotanical Importance

The results for the ethnobotanical importance that the different successional stages hold for different age groups is presented in Figure 4-4. These results show a tendency that the importance attributed to successional stages as sources of food plants is directly proportional with the informants' age.

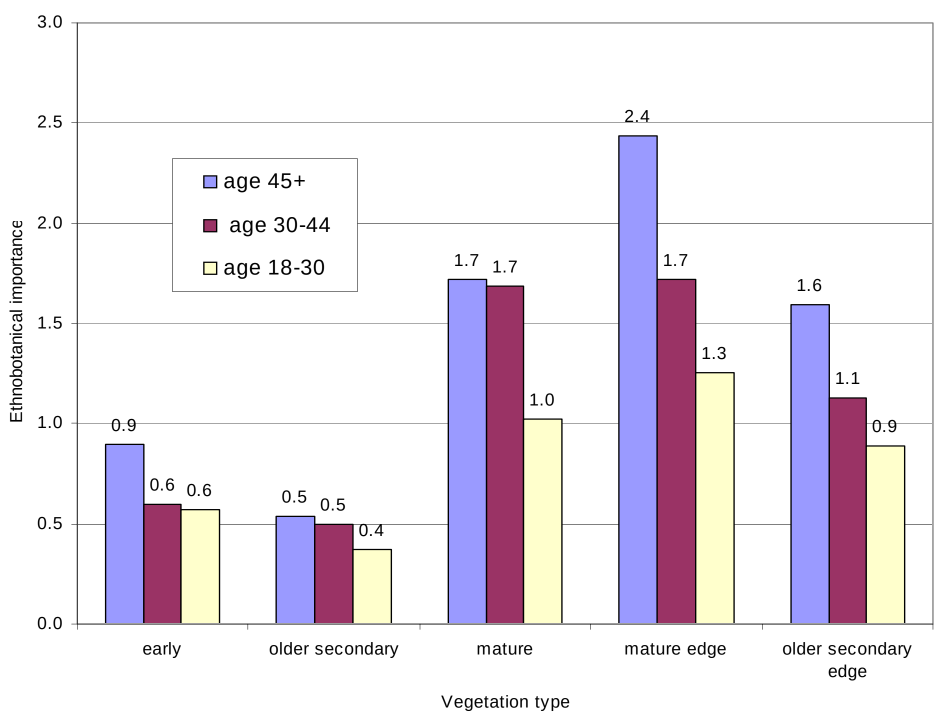


Figure 4-4. Differences among different age groups regarding Ethnobotanical Importance of successional stages as sources of wild food plants.

Figure 4-5 presents the Ethobotanical importance value attributed by informants of different genders to different successional stages as sources of wild food plants. The general tendency is that males tend to value more than women the older secondary forests and their edges and mature forests. Women attribute greater value to early secondary vegetation. Finally, mature forest edges are the most important successional stage and are valued almost equally by both genders.

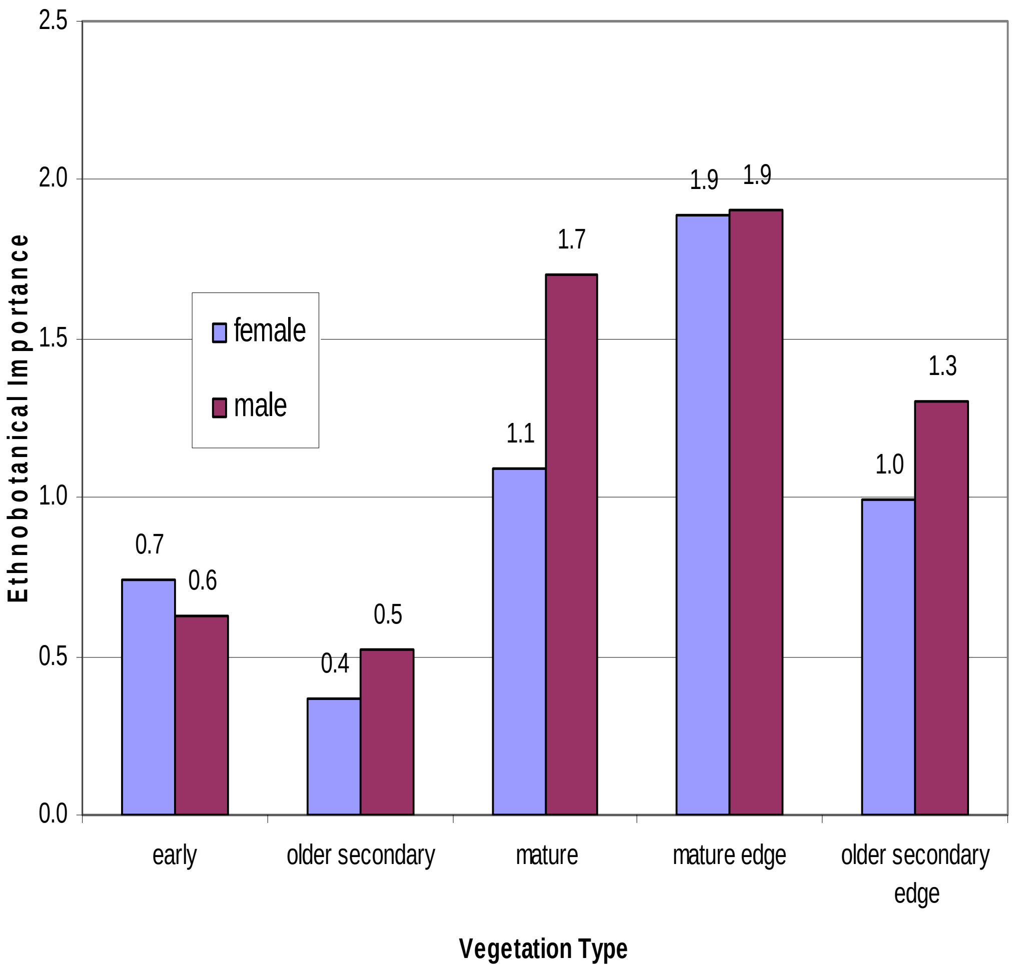


Figure 4-5. Differences between genders regarding the Ethnobotanical importance of different successional stages as a source of wild food plants in Guaymi society.

Discussion

Average Number of Edible Plant Species Mentioned per Person In Different Age and Gender Groups.

Age: As Figure 4-1 shows, there is a lot of variability in the number of plant species mentioned and the age of the informants. There is, however, a tendency for the number of species to increase proportionately with age. According to a liner regression, age is responsible for about 23.13% of the variance in the number of species mentioned. Other variables that are likely to be affecting the regression are the informant's closeness to roads and town centers, their cultural background, personal history, economic status, and personal characteristics of each individual (intelligence, aculturization, interest in wild foods, willingness to cooperate, etc.).

To be able to determine differences between age groups, three groups were created to compare possible differences in age groups. Figure 4-2 presents the average number of species mentioned by informants in the three different age groups.

Although there was no significant difference between the middle aged group and the elder group, both of these groups did show significant differences with regards to the younger group. While the middle and elder groups mentioned an average of 9.1 and 10.9 species respectively, the younger people mentioned only an average of 6.2 species.

Also, both the elder and middle groups mentioned more species over all (32 and 34 respectively) than the young group (24 species). Although the number of species mentioned does not directly reflect the number of species known (there might be more species known and not mentioned) a higher number does reflect a certain degree of knowledge or of importance given to the topic by the group in general. In this case, the data point to the diminishing of knowledge, particularly in recent times among the adults between ages 18 and 29. As found by Zarger & Stepp (2004) for the Tletzal maya, by this age it is expected that the individual's ethnobotanical knowledge is complete in cultures with oral transmission of knowledge. If this is the case, the Guaymi are likely experiencing degradation in such knowledge since the free listing reflects that younger generations know significantly less plant species.

During informal interviews, informants mentioned that they learned about plants by seeing what their parents brought home and by collecting with their parents when in the fields. There is no formal instruction about these subjects. If this is the case, it is probable that the access to outside foods such as pasta, canned tuna and sardines, and occasional vegetables such as cabbage which are sold in the town center at La Casona, may be substituting traditional foods in that they are seen as "better" than foods from the wild.

While older people were in general proud to mention wild edible plants and the frequency they ate them, many of the middle age group and most of the young preferred to mention them as what used to be eaten in the past, often hinting that they now obtained better foods from the store.

The problem in this is that the food sold in the local stores is mostly composed of canned goods and pasta, which are not a substitute for fresh vegetables and greens. It is not to say that wild foods are the only source of plant foods, starchy crops, grains and fruits are often cultivated, but they are a valuable complement to their often limited diet.

Gender: Differences between male and female informants were very slight. As predicted, men tended to mention a slightly higher average (9.91) number of species than women (7.42). This results were only significant to an alpha of 0.10 ($P = 0.07$). This does not necessarily mean that men know more plants than women; only that it is likely that men are in more contact with wild foods and have them more present in their minds than women since they are more in contact with them.

Women were more eager to talk about how the plants are prepared than where they are collected from. This comes probably from the marked division of labor in Guaymi society.

Men mentioned a total of 46 plants species while women altogether only mentioned 35 pointing to a difference in knowledge, or at least in the familiarity with the plants (Appendix VI).

Ethnobotanical Importance of Successional Stages to Different Age and Gender Groups.

Age: The ethnobotanical importance of the different successional stages has a tendency that follows throughout all the age groups. The tendency is similar as that presented in Figure 3-2. All groups attribute the most importance to the mature forest edge followed by the mature forest, secondary forest edges, early secondary growth, and older secondary forest in that order.

Despite the shared tendency, however, there exist differences in the importance that each group attributes to the plants that exist in each successional stage. Older people seem to give more importance to them than both the middle and young groups. This is particularly significant in the importance attributed to mature forest edges, early secondary growth and secondary forest edges in particular. The difference in importance between the older and middle group is less obvious with regards to the mature forest and the older secondary growth. This means that older people tended to mention plants from these successional stages more times and in with more salience than the middle and young groups.

From these results it can also be concluded that the older generation, those of 45+ years of age, in general placed more importance on vegetation as a source of wild food than the other two groups. This importance, derived indirectly from the salience values of each species and combined with the data from the sampling plots, gradually diminishes as the age of the informants.

This does not necessarily mean a loss in knowledge since the number of species mentioned is not significantly different (Table 4.1) between the middle and older group. Rather, it reflects a shift on the focus of which plants are more important (measured by the salience of each species in each group). Another way of looking at this is that although more or less the same plant species were mentioned by both groups, the plants that occur in older secondary forests and their edges, and those from early secondary growth, were mentioned in less prominent positions more often by the middle and young groups.

Regarding the loss of importance for these types of vegetation between the older and the young group, it can be said that the loss of knowledge does play a role in the loss of importance. Since there is a significant difference (Table 4.1) between the number of species mentioned by these groups, it may be possible that the lesser number of species mentioned by the young group also diminishes the probability of a successional stage of containing plants that add to its ethnobotanical importance.

The successional stages that have lost more importance (those is which the EI value difference is far greater between the older and young groups) is in the mature forest and mature forest edge. Also, the middle and younger groups attribute far less importance to the plants provided by early succession than the older group.

It can be said that the loss of importance of foods provided by the early secondary growth happened at an earlier time than in the other successional stages. This can be seen in the abrupt change in the EI from the older to the middle and young groups, which is not present in the other successional stages (these present a gradual decrease instead). The explanation of this could very well lie in the types of plants that early secondary growth provides. These, in general are less important occasional greens (*Sechium* spp, *Heliconia* spp) which can be obtained easier from other sources with easier access such as mature forest edges. Other food plants typical of early vegetation have also been either domesticated or have direct domesticated substitutes. Such is the case of *Dioscoria trifida*. the most important of the early succession food plants. This plant is commonly found in gardens and sometimes in monocropped fields. Also, it being a root crop, it can be substituted by *Manihot esculenta, Xanthosoma vileaceum,* and *Dioscoria alata*, which are easier to cultivate than the wild yams. Perhaps these plants were of greater importance before the Guaymi had access to fertilizers and other crops. Plants from other successional stages are, in general, harder to domesticate since they require lower temperatures and more shade than is available in Guaymi crop fields or home gardens.

The loss of importance is less apparent in older secondary forest, however, this was not, to begin with, a very important source of wild foods as is shown by the low EI it held even to the older generation. As has been mentioned before, this successional stage is a transitional phase where many plants from early succession are lost and plants form the mature forest are not yet abundant.

The only age group where the middle aged informants and the older ones showed no difference is in the mature forest. Both groups present a similar EI with no significant differences meaning that for these groups, mature forests has not lost any of its ethnobotanical (edible) value. On the other hand, there is a large difference in the value that the younger generation attributes to mature forest species. This tendency can be interpreted as loss of value occurring in the younger generation. The middle group may still consider the foods from the mature forests as part of their diet, while younger generations are only recently starting to lose interest in this type of vegetation as is often the case when indigenous societies are exposed to new products and opportunities from market economies as found by Cadelina (1988) in the Philippines.

As for mature forest edges, these keep showing prominence in terms of providing wild food plants in terms of diversity, importance, and number of species for all age groups even if there is a marked decline it its EI. Again, the fact that the Guaymi culture practices shifting cultivation, and currently in the process of adopting permanent cultivation brings it today, as it has in the past, in constant contact with abrupt forest edges created by the clearing of new fields. This condition has not varied very much between the life spans of the different age groups. Disturbance seems to favor most of the plants favored by the Guaymi of all generations as food (or vice versa, the Guaymi tend to favor the plants from disturbed vegetations). Most of the more salient species for all the groups appear in this disturbed vegetation, although the individual importance attributed to each by the age groups varies.

In this type of vegetation, there seems to have been a loss of knowledge in terms of species known, but this is compensated by the attribution by younger generations of more importance to plants that grow in it over less disturbed vegetations.

On a broader perspective, and as with the case of wild edible plant diversity (Chapter 3) mature forest play an indirect role by contributing to the diversity of plants on its edges. Mature forest edges are, for all groups, the successional stage of most EI. This means to protect the species of most value to Guaymi culture, mature forests should be preserved so that they can keep providing the rich edge environment. Also, education through local schools about the ethnobotanical knowledge may help raise the decreasing EI of other successional stages. The challenge lies in how to preserve the forests under the growing population pressures and the gradual shift from rotational to permanent agriculture. Otherwise, the value of the resources they already possess may be lost.

If the traditional use of wild foods is to be preserved, these results show that helping preserve the knowledge of plants from the mature forest and its edges, as well as those from the edges of secondary forests is key since these are the successional stages that are the ones that are losing their cultural importance at a faster rate.

One last interesting aspect of the value of successional stages is that it is not a conscious value. In this case it had to be derived through anthropological and ecological methods, trying to coax it out directly from informants proved impossible and often misleading and contradictory. Making this concept conscious, not only with regards to food plants, but also handicraft material, medicine, fibers and building materials is an important part of helping the Guaymi and other native cultures to take advantage of and protect their own resources.

Gender: The Ethnobotanical importance attributed to different successional stages by members of different genders presents one overriding tendency (Figure 4-5). With the exception of early secondary growth and mature forest edges, men seemed to attribute more importance to all other vegetations types as sources of food than women. It is probable that this has a lot to do with the difference in time actually spent in contact with these successional stages between men and women. Since women tend to remain closer to the household and nearby fields, their contact with wild food plants is mostly in early successional types of vegetation. Older secondary growth and mature forests are found further away from the households where shifting cultivation is performed. Near the households there are mostly permanent fields or fields with very short rotation times. Home gardens are also a place where women usually come into contact with vegetation. Here they mostly keep domesticated crops and handicraft sources (fiber and dyes). Occasional pioneer species here such as *Eryngium foetidum*, *Heliconia* spp. and *Dioscoria trifida* all are typical of early successions.

Men on, on the other hand, come into contact with mature forests, older secondary growth and their edges. Here there are more wild plant foods that can be consumed on the spot as snacks on the spot rather than having to be taken home for preparation. Although women probably do know about these plants, it is likely that they know less about them than the domesticated plants and the plants form early secondary growth they come in contact with more often around their homes.

One particular couple that was interviewed illustrated this when they argued about which type of zapote was better. The woman assured me that the domesticated zapote (*Pouteria sapota*) was far superior from the mountain zapote (*Licania belloii*) while her partner argued the opposite saying the wild fruit was tastier than the other.

Importance attributed to the mature forest edges was practically the same for both genders. Although women do not come into contact with this type of forest, many of the plants from this successional stage are greens that must be cooked. Therefore, although men are usually the ones that collect them, women come into contact with them when they prepare them. This further supports the importance of this type of vegetation and the role of the mature forests in providing wild food plants to the Guaymi.

Conclusions

- Younger generations (ages 18 – 29) tend to mention significantly less wild edible plant species than older generations (ages 30 +) indicating a loss of knowledge is occurring.
- Guaymi men tend to mention significantly more plants than women (alpha =0.10) indicating that they are probably more in contact with them than women are.
- According to the plant species that grow in them, early secondary growth, older secondary forests and their edges significantly hold more importance as a source of wild food plants to the older Guaymi (ages 45 +) than to the middle and younger generations (ages 18 – 44).
- Mature forests are losing their importance as a source of wild food plants to younger generations (ages 18 – 29) compared to the importance they hold for older generations (30 + years)
- Mature forest edges are the most important type of vegetation in terms of supplying wild food plants to the Guaymi. Although variability is high among individuals, there does not seem to be a significant loss of importance for this type of vegetation according to a person’s age.
- All successional stages, with exception of mature forests and older secondary growth, hold equal ethnobotanical importance as a source of wild food plants for both

Guaymi men and women. Mature and older secondary forests are significantly more important to men than to women.

APPENDIX A : WILD EDIBLE PLANTS QUESTIONNAIRE

Encuesta sobre plantas comestibles y tipos de bosque

Informant No. ________________

Name:____

Age: _________ Gender: M F

Other data ____

GPS point __________________________

1. Do you recognize different types of forests, what are their names?

2. What do you call a lot that was used for farming but is currently abandoned?

3. How long does it take for an abandoned field to turn into a forest?

4. What do you call the vegetation that appears during this time?

5. What edible plants do you know grow in the wild?

	Ngobere name	Spanish name	Where does it grow	Do you take care of it?
1.				
2.				
3.				
4.				
5.				
6 ….				

APPENDIX B: PLANT SPECIES CODE NAMES

Family	Code	*Species*
Anacardiaceae	jog	*Spondias mombin* L
Apiaceae	cul	*Eryngium foetidum* L.
Arecaceae	nrm	*Chamaedorea tepejilote* Liebm. ex Mart
Arecaceae	Bur	*Socratea exorrhiza* (Mart.) H. Wendl
Arecaceae	juo	*Geonoma interrupta* (Ruiz & Pav.) Mart.
Arecaceae	mid	*Euterpe precatoria* Mart.
Arecaceae	tit	*Prestoea acuminata* (Willd.) HE Moore
Arecaceae	jor	*Oenocarpus mapora* H. Karst
Begoniaceae	ibi	*Begonia sp.*
Bignoniaceae	boi	*Mansoa hymenaea* - (DC.) AH Gentry
Bromeliaceae	vir	*Bromelia pinguin* L.
Burseraceae	jud	*Tetragastris panamensis* (Engl.) Kuntze
Caricaceae	keg	*Vasconcella cauliflora* (Jacq.) A. DC
Chrysobalanaceae	zab	*Licania belloi Prance*
Clusiaceae	tro	*Garcinia madruno* (Kunth) Hammel
Convolvulaceae	drk	*Maripa nicaraguensis* Hemsl.
Cucurbitaceae	kdu	*Sechium pittieri* (Cogn.) C. Jeffrey
Cucurbitaceae	kdu	*Sechium tacaco* (Pittier) C. Jeffrey
Cyclanthaceae	dog	*Carludovica palmata Ruiz & Pavon*
Dennstaedtiaceae	kgo	*Hypolepis repens (Linnaeus) C. Presl.*
Dioscoriaceae	drn	*Dioscorea trifida* Lf
Dioscoriaceae	drn	*Dioscorea alata* L
Dioscoriaceae	drn	*Dioscorea trifida* Lf
Fabaceae	bl	*Inga spectabilis* (Vahl) Willd.
Fabaceae	bl	*Inga cotobrucencis*.
Fabaceae	bl	*Inga hibaudiana*.
Heliconiaceae	mu	*Heliconia pogonantha* Cufod.
Heliconiaceae	mu	*Heliconia danielsiana* W.J. Kress
Heliconiaceae	bid	*Heliconia latispatha* Benth.
Lauraceae	dug	*Persea sp.*
Lecythidaceae	tub	*Gustavia superba* (Kunth) O.Berg
Malpighiaceae	mig	*Byrsonima crassifolia* (L.) Kunth.
Malvaceae	moz	*Triumffeta sp.*
Malvaceae	mur	*Theobroma bicolor* Bonpl. in Humb. & Bonpl.
Malvaceae	odo	*Theobroma angustifolium* Sessé & Moc. ex DC.
Maranthaceae	apu	*Hylaeanthe hoffmannii* (K. Schum.) A.M.E. Jonker & Jonker ex H. Kenn.
Family	**Code**	***Species***

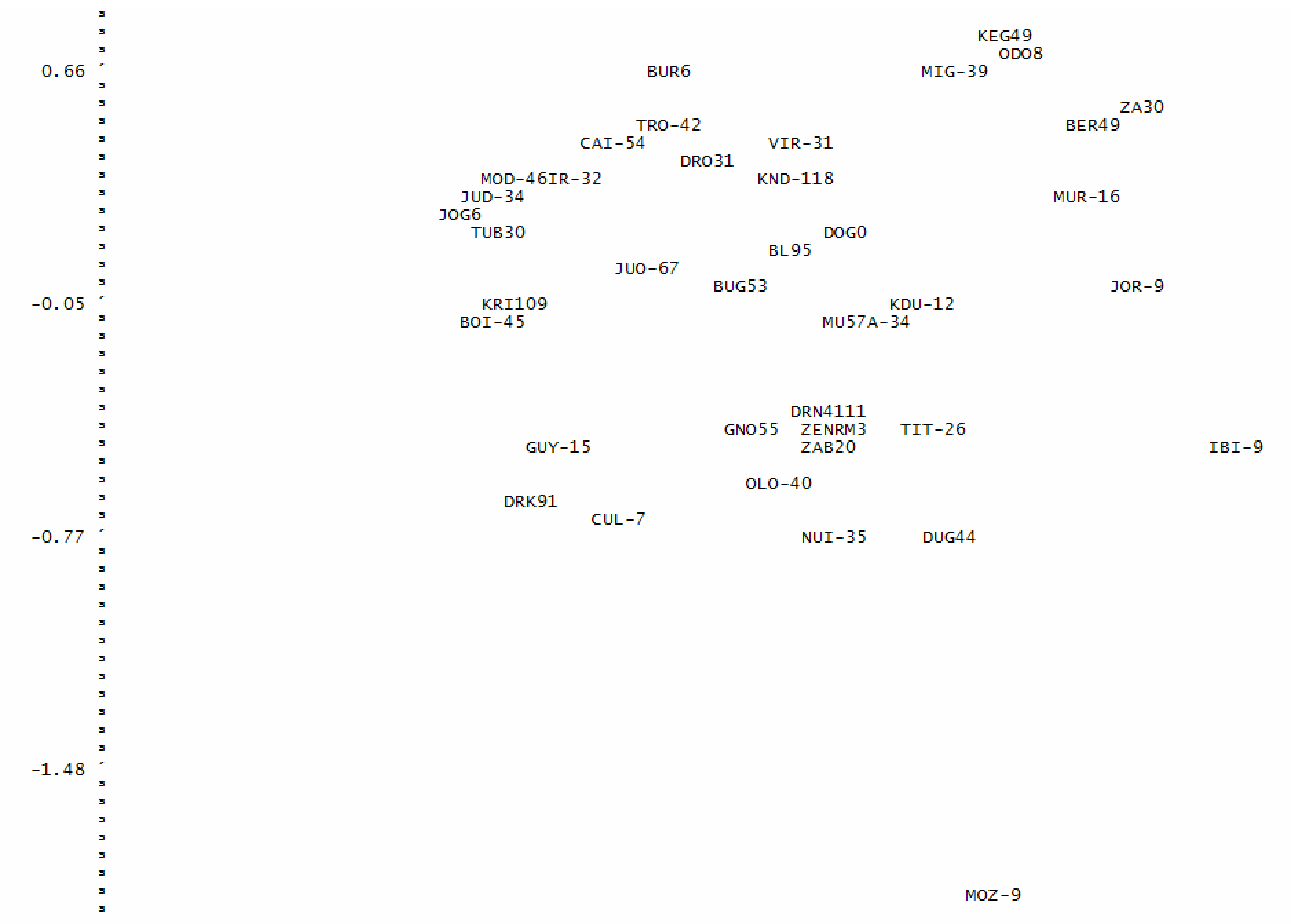
Maranthaceae	kri	*Calathea crotalifera* S. Watson
Moraceae	ber	*Brosimum alicastrum* Sw.
Myrtaceae	guy	*Psidium guajava* L.
Passifloraceae	gua	*Passiflora vitifolia* Kunth
Passifloraceae	gua	*Passiflora quadrangularis* L.
Passifloraceae	gua	*Passiflora* sp.
Phytolaccaceae	zeg	*Phytolacca rivinoides* Kunth & C.D. Bouché
Sapotaceae	cai	*Chrysophyllum brenesii* Cronquist
Sapotaceae	gno	*Pouteria sapota* (Jaq.) H.E. Moore & Stream
Sarcoscyphaceae	olo	*Cookeina tricholoma* (Mont.) Kuntz
Simaroubaceae	rug	*Simarouba glauca* DC.
Solanaceae	nui	*Cestrum* sp. *Cestrum racemosum* Ruiz & Pav.
Theophrastaceae	dro	*Clavija costaricana* Pittier
Urticaceae	bug	*Urera baccifera* (L.) Gaudich. ex Wedd.
Urticaceae	bug	*Urera elata* (Sw.) Griseb
unknown	gra	
unknown	knd	

APPENDIX C:
SIMILARITY MATRIX FOR POSITIVE MATCHES FOR WILD EDIBLE PLANTS USED BY THE GUAYMI

	1 NUI	2 KGO	3 ZEG	4 BUG	5 DOG	6 NRM	7 OLO	8 MID	9 BUR	10 MIR	11 JUO	12 ZAB	13 GNO	14 RUG	15 VIR	16 BOI	17 GUA	18 APU	19 DRO	20 TRO	21 MOD	22 DRN	23 TUB
1 NUI	1.00	0.25	0.24	0.07	0.16	0.28	0.18	0.25	0.06	0.07	0.13	0.29	0.14	0.08	0.06	0.07	0.19	0.08	0.05	0.07	0.07	0.13	0.07
2 KGO	0.25	1.00	0.63	0.30	0.24	0.56	0.32	0.59	0.09	0.06	0.13	0.66	0.29	0.03	0.15	0.06	0.22	0.03	0.15	0.06	0.03	0.51	0.09
3 ZEG	0.24	0.63	1.00	0.42	0.21	0.51	0.31	0.51	0.08	0.05	0.08	0.57	0.32	0.03	0.13	0.05	0.28	0.03	0.18	0.08	0.05	0.40	0.08
4 BUG	0.07	0.30	0.42	1.00	0.19	0.14	0.21	0.26	0.18	0.06	0.18	0.27	0.22	0.06	0.10	0.06	0.22	0.06	0.28	0.19	0.06	0.19	0.19
5 DOG	0.16	0.24	0.21	0.19	1.00	0.27	0.22	0.20	0.18	0.22	0.08	0.14	0.24	0.11	0.36	0.09	0.24	0.11	0.07	0.09	0.10	0.20	0.09
6 NRM	0.28	0.56	0.51	0.14	0.27	1.00	0.28	0.55	0.12	0.08	0.04	0.41	0.29	0.04	0.20	0.13	0.24	0.04	0.11	0.08	0.08	0.45	0.04
7 OLO	0.18	0.32	0.31	0.21	0.22	0.28	1.00	0.25	0.13	0.15	0.13	0.22	0.09	0.08	0.12	0.07	0.14	0.08	0.11	0.14	0.07	0.13	0.07
8 MID	0.25	0.59	0.51	0.26	0.20	0.55	0.25	1.00	0.15	0.04	0.15	0.57	0.30	0.04	0.18	0.11	0.26	0.04	0.26	0.11	0.07	0.30	0.07
9 BUR	0.06	0.09	0.08	0.18	0.18	0.12	0.13	0.15	1.00	0.20	0.14	0.06	0.07	0.25	0.25	0.17	0.07	0.25	0.38	0.40	0.20	0.09	0.17
10 MIR	0.07	0.06	0.05	0.06	0.22	0.08	0.15	0.04	0.20	1.00	0.20	0.03	0.08	0.50	0.33	0.25	0.17	0.50	0.13	0.25	0.33	0.10	0.25
11 JUO	0.13	0.13	0.08	0.18	0.08	0.04	0.13	0.15	0.14	0.20	1.00	0.13	0.07	0.25	0.25	0.17	0.14	0.25	0.22	0.40	0.20	0.04	0.17
12 ZAB	0.29	0.66	0.57	0.27	0.14	0.41	0.22	0.57	0.06	0.03	0.13	1.00	0.34	0.03	0.12	0.06	0.26	0.03	0.15	0.06	0.06	0.33	0.10
13 GNO	0.14	0.29	0.32	0.22	0.24	0.29	0.09	0.30	0.07	0.08	0.07	0.34	1.00	0.08	0.06	0.15	0.20	0.08	0.19	0.07	0.08	0.32	0.25
14 RUG	0.08	0.03	0.03	0.06	0.11	0.04	0.08	0.04	0.25	0.50	0.25	0.03	0.08	1.00	0.17	0.33	0.08	1.00	0.14	0.33	0.50	0.05	0.33
15 VIR	0.06	0.15	0.13	0.10	0.36	0.20	0.12	0.18	0.25	0.33	0.25	0.12	0.06	0.17	1.00	0.13	0.29	0.17	0.18	0.29	0.33	0.17	0.13
16 BOI	0.07	0.06	0.05	0.06	0.09	0.13	0.07	0.11	0.17	0.25	0.17	0.06	0.15	0.33	0.13	1.00	0.07	0.33	0.11	0.20	0.25	0.09	0.20
17 GUA	0.19	0.22	0.28	0.22	0.24	0.24	0.14	0.26	0.07	0.17	0.14	0.26	0.20	0.08	0.29	0.07	1.00	0.08	0.19	0.15	0.08	0.22	0.07
18 APU	0.08	0.03	0.03	0.06	0.11	0.04	0.08	0.04	0.25	0.50	0.25	0.03	0.08	1.00	0.17	0.33	0.08	1.00	0.14	0.33	0.50	0.05	0.33
19 DRO	0.05	0.15	0.18	0.28	0.07	0.11	0.11	0.26	0.38	0.13	0.22	0.15	0.19	0.14	0.18	0.11	0.19	0.14	1.00	0.43	0.13	0.12	0.25
20 TRO	0.07	0.06	0.08	0.19	0.09	0.08	0.14	0.11	0.40	0.25	0.40	0.06	0.07	0.33	0.29	0.20	0.15	0.33	0.43	1.00	0.25	0.04	0.20
21 MOD	0.07	0.03	0.05	0.06	0.10	0.08	0.07	0.07	0.20	0.33	0.20	0.06	0.08	0.50	0.33	0.25	0.08	0.50	0.13	0.25	1.00	0.05	0.25
22 DRN	0.13	0.51	0.40	0.19	0.20	0.45	0.13	0.30	0.09	0.10	0.04	0.33	0.32	0.05	0.17	0.09	0.22	0.05	0.12	0.04	0.05	1.00	0.14
23 TUB	0.07	0.09	0.08	0.19	0.09	0.04	0.07	0.07	0.17	0.25	0.17	0.10	0.25	0.33	0.13	0.20	0.07	0.33	0.25	0.20	0.25	0.14	1.00
24 GRA	0.08	0.03	0.03	0.06	0.11	0.04	0.08	0.04	0.25	0.50	0.25	0.03	0.08	1.00	0.17	0.33	0.08	1.00	0.14	0.33	0.50	0.05	0.33
25 CAI	0.07	0.06	0.05	0.13	0.10	0.04	0.07	0.07	0.20	0.33	0.50	0.06	0.08	0.50	0.33	0.25	0.17	0.50	0.29	0.67	0.33	0.05	0.25
26 CUL	0.15	0.20	0.23	0.18	0.12	0.17	0.28	0.16	0.08	0.20	0.17	0.17	0.16	0.10	0.14	0.18	0.16	0.10	0.06	0.08	0.09	0.24	0.08
27 GUY	0.20	0.12	0.10	0.05	0.08	0.12	0.13	0.10	0.13	0.17	0.29	0.09	0.13	0.20	0.10	0.14	0.06	0.20	0.20	0.14	0.17	0.13	0.14
28 JOG	0.07	0.06	0.08	0.19	0.09	0.04	0.07	0.03	0.17	0.25	0.17	0.06	0.15	0.33	0.13	0.20	0.07	0.33	0.11	0.20	0.25	0.09	0.50
29 JUD	0.08	0.03	0.03	0.06	0.11	0.04	0.08	0.04	0.25	0.50	0.25	0.03	0.08	1.00	0.17	0.33	0.08	1.00	0.14	0.33	0.50	0.05	0.33
30 TIT	0.23	0.24	0.33	0.20	0.10	0.27	0.23	0.32	0.06	0.00	0.20	0.25	0.08	0.00	0.18	0.00	0.18	0.00	0.11	0.13	0.07	0.13	0.00
31 MUR	0.06	0.09	0.08	0.05	0.18	0.12	0.13	0.15	0.14	0.00	0.00	0.09	0.07	0.00	0.11	0.00	0.14	0.00	0.10	0.17	0.00	0.04	0.00
32 ODO	0.00	0.06	0.08	0.06	0.09	0.13	0.07	0.07	0.17	0.00	0.00	0.06	0.07	0.00	0.13	0.00	0.07	0.00	0.11	0.20	0.00	0.09	0.00
33 BL	0.15	0.11	0.20	0.18	0.00	0.10	0.05	0.16	0.17	0.00	0.08	0.17	0.16	0.00	0.00	0.00	0.10	0.00	0.21	0.08	0.00	0.11	0.08
34 MIG	0.06	0.06	0.10	0.05	0.17	0.16	0.13	0.10	0.13	0.17	0.00	0.06	0.06	0.00	0.22	0.14	0.13	0.00	0.09	0.14	0.00	0.08	0.00
35 MU	0.08	0.27	0.36	0.29	0.26	0.22	0.17	0.40	0.19	0.00	0.12	0.28	0.29	0.00	0.11	0.00	0.17	0.00	0.29	0.13	0.00	0.20	0.00
36 KDU	0.21	0.27	0.23	0.18	0.27	0.21	0.15	0.28	0.00	0.09	0.17	0.21	0.16	0.00	0.23	0.00	0.38	0.00	0.21	0.08	0.00	0.19	0.08
37 BER	0.00	0.06	0.05	0.00	0.10	0.08	0.00	0.07	0.00	0.00	0.00	0.06	0.08	0.00	0.14	0.00	0.08	0.00	0.13	0.00	0.00	0.10	0.00
38 DUG	0.25	0.29	0.25	0.12	0.17	0.29	0.14	0.34	0.00	0.00	0.00	0.26	0.33	0.00	0.00	0.00	0.14	0.00	0.06	0.00	0.00	0.27	0.00
39 KEG	0.07	0.06	0.03	0.00	0.20	0.08	0.00	0.07	0.17	0.00	0.00	0.06	0.00	0.00	0.29	0.00	0.07	0.00	0.00	0.00	0.00	0.09	0.00
40 JOR	0.14	0.09	0.08	0.06	0.20	0.13	0.07	0.11	0.00	0.00	0.00	0.06	0.07	0.00	0.13	0.00	0.25	0.00	0.00	0.00	0.00	0.09	0.00
41 ZA	0.00	0.03	0.03	0.00	0.11	0.04	0.00	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.17	0.00	0.08	0.00	0.00	0.00	0.00	0.05	0.00
42 DRK	0.07	0.03	0.08	0.12	0.00	0.04	0.00	0.07	0.00	0.00	0.00	0.06	0.15	0.00	0.00	0.00	0.07	0.00	0.11	0.00	0.00	0.04	0.20
43 KRI	0.00	0.03	0.05	0.13	0.10	0.00	0.07	0.04	0.00	0.00	0.00	0.03	0.08	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.05	0.25
44 MOZ	0.08	0.03	0.03	0.00	0.00	0.04	0.08	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45 KND	0.00	0.03	0.03	0.06	0.00	0.00	0.00	0.04	0.00	0.00	0.25	0.03	0.00	0.00	0.17	0.00	0.08	0.00	0.14	0.33	0.00	0.00	0.00
46 IBI	0.08	0.03	0.03	0.00	0.11	0.04	0.08	0.04	0.00	0.00	0.00	0.03	0.08	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00

	24 GRA	25 CAI	26 CUL	27 GUY	28 JOG	29 JUD	30 TIT	31 MUR	32 ODO	33 BL	34 MIG	35 MU	36 KDU	37 BER	38 DUG	39 KEG	40 JOR	41 ZA	42 DRK	43 KRI	44 MOZ	45 KND	46 IBI
1 NUI	0.08	0.07	0.15	0.20	0.07	0.08	0.23	0.06	0.00	0.15	0.06	0.08	0.21	0.00	0.25	0.07	0.14	0.00	0.07	0.00	0.08	0.00	0.08
2 KGO	0.03	0.06	0.20	0.12	0.06	0.03	0.24	0.09	0.06	0.11	0.06	0.27	0.27	0.06	0.29	0.06	0.09	0.03	0.03	0.03	0.03	0.03	0.03
3 ZEG	0.03	0.05	0.23	0.10	0.08	0.03	0.33	0.08	0.08	0.20	0.10	0.36	0.23	0.05	0.25	0.03	0.08	0.03	0.08	0.05	0.03	0.03	0.03
4 BUG	0.06	0.13	0.18	0.05	0.19	0.06	0.20	0.05	0.06	0.18	0.05	0.29	0.18	0.00	0.12	0.00	0.06	0.00	0.12	0.13	0.00	0.06	0.00
5 DOG	0.11	0.10	0.12	0.08	0.09	0.11	0.10	0.18	0.09	0.00	0.17	0.26	0.27	0.10	0.17	0.20	0.20	0.11	0.00	0.10	0.00	0.00	0.11
6 NRM	0.04	0.04	0.17	0.12	0.04	0.04	0.27	0.12	0.13	0.10	0.16	0.22	0.21	0.08	0.29	0.08	0.13	0.04	0.04	0.00	0.04	0.00	0.04
7 OLO	0.08	0.07	0.28	0.13	0.07	0.08	0.23	0.13	0.07	0.05	0.13	0.17	0.15	0.00	0.14	0.00	0.07	0.00	0.00	0.07	0.08	0.00	0.08
8 MID	0.04	0.07	0.16	0.10	0.03	0.04	0.32	0.15	0.07	0.16	0.10	0.40	0.28	0.07	0.34	0.07	0.11	0.04	0.07	0.04	0.04	0.04	0.04
9 BUR	0.25	0.20	0.08	0.13	0.17	0.25	0.06	0.14	0.17	0.17	0.13	0.19	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10 MIR	0.50	0.33	0.20	0.17	0.25	0.50	0.00	0.00	0.00	0.00	0.17	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11 JUO	0.25	0.50	0.17	0.29	0.17	0.25	0.20	0.00	0.00	0.08	0.00	0.12	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
12 ZAB	0.03	0.06	0.17	0.09	0.06	0.03	0.25	0.09	0.06	0.17	0.06	0.28	0.21	0.06	0.26	0.06	0.06	0.03	0.06	0.03	0.03	0.03	0.03
13 GNO	0.08	0.08	0.16	0.13	0.15	0.08	0.08	0.07	0.07	0.16	0.06	0.29	0.16	0.08	0.33	0.00	0.07	0.00	0.15	0.08	0.00	0.00	0.08
14 RUG	1.00	0.50	0.10	0.20	0.33	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15 VIR	0.17	0.33	0.14	0.10	0.13	0.17	0.18	0.11	0.13	0.00	0.22	0.11	0.23	0.14	0.00	0.29	0.13	0.17	0.00	0.00	0.00	0.17	0.00
16 BOI	0.33	0.25	0.18	0.14	0.20	0.33	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17 GUA	0.08	0.17	0.16	0.06	0.07	0.08	0.18	0.14	0.07	0.10	0.13	0.17	0.38	0.08	0.14	0.07	0.25	0.08	0.07	0.00	0.00	0.08	0.08
18 APU	1.00	0.50	0.10	0.20	0.33	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19 DRO	0.14	0.29	0.06	0.20	0.11	0.14	0.11	0.10	0.11	0.21	0.09	0.29	0.21	0.13	0.06	0.00	0.00	0.00	0.11	0.13	0.00	0.14	0.00
20 TRO	0.33	0.67	0.08	0.14	0.20	0.33	0.13	0.17	0.20	0.08	0.14	0.13	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00
21 MOD	0.50	0.33	0.09	0.17	0.25	0.50	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22 DRN	0.05	0.05	0.24	0.13	0.09	0.05	0.13	0.04	0.09	0.11	0.08	0.20	0.19	0.10	0.27	0.09	0.09	0.05	0.04	0.05	0.00	0.00	0.00
23 TUB	0.33	0.25	0.08	0.14	0.50	0.33	0.00	0.00	0.00	0.08	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.20	0.25	0.00	0.00	0.00
24 GRA	1.00	0.50	0.10	0.20	0.33	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25 CAI	0.50	1.00	0.09	0.17	0.25	0.50	0.07	0.00	0.00	0.00	0.00	0.06	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00
26 CUL	0.10	0.09	1.00	0.25	0.08	0.10	0.14	0.00	0.00	0.11	0.07	0.09	0.05	0.00	0.10	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00
27 GUY	0.20	0.17	0.25	1.00	0.14	0.20	0.12	0.00	0.00	0.15	0.00	0.05	0.15	0.17	0.06	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
28 JOG	0.33	0.25	0.08	0.14	1.00	0.33	0.06	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29 JUD	1.00	0.50	0.10	0.20	0.33	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30 TIT	0.00	0.07	0.14	0.12	0.06	0.00	1.00	0.20	0.13	0.20	0.12	0.21	0.26	0.07	0.24	0.06	0.21	0.07	0.06	0.00	0.07	0.07	0.07
31 MUR	0.00	0.00	0.00	0.00	0.00	0.00	0.20	1.00	0.40	0.08	0.29	0.12	0.17	0.20	0.14	0.17	0.40	0.25	0.00	0.00	0.00	0.00	0.25
32 ODO	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.40	1.00	0.18	0.33	0.13	0.08	0.25	0.00	0.20	0.20	0.33	0.00	0.00	0.00	0.00	0.00
33 BL	0.00	0.00	0.11	0.15	0.08	0.00	0.20	0.08	0.18	1.00	0.07	0.32	0.05	0.00	0.10	0.08	0.00	0.00	0.18	0.00	0.00	0.00	0.00
34 MIG	0.00	0.00	0.07	0.00	0.00	0.00	0.12	0.29	0.33	0.07	1.00	0.05	0.15	0.17	0.00	0.14	0.14	0.20	0.00	0.00	0.00	0.00	0.00
35 MU	0.00	0.06	0.09	0.05	0.00	0.00	0.21	0.12	0.13	0.32	0.05	1.00	0.19	0.06	0.29	0.06	0.06	0.00	0.06	0.06	0.00	0.07	0.07
36 KDU	0.00	0.09	0.05	0.15	0.00	0.00	0.26	0.17	0.08	0.05	0.15	0.19	1.00	0.20	0.16	0.08	0.30	0.10	0.08	0.20	0.00	0.10	0.10
37 BER	0.00	0.00	0.00	0.17	0.00	0.00	0.07	0.20	0.25	0.00	0.17	0.06	0.20	1.00	0.08	0.25	0.25	0.50	0.00	0.00	0.00	0.00	0.00
38 DUG	0.00	0.00	0.10	0.06	0.00	0.00	0.24	0.14	0.00	0.10	0.00	0.29	0.16	0.08	1.00	0.00	0.15	0.00	0.07	0.00	0.08	0.00	0.08
39 KEG	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.17	0.20	0.08	0.14	0.06	0.08	0.25	0.00	1.00	0.20	0.33	0.00	0.00	0.00	0.00	0.00
40 JOR	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.40	0.20	0.00	0.14	0.06	0.30	0.25	0.15	0.20	1.00	0.33	0.00	0.00	0.00	0.00	0.33
41 ZA	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.25	0.33	0.00	0.20	0.00	0.10	0.50	0.00	0.33	0.33	1.00	0.00	0.00	0.00	0.00	0.00
42 DRK	0.00	0.00	0.18	0.14	0.00	0.00	0.06	0.00	0.00	0.18	0.00	0.06	0.08	0.00	0.07	0.00	0.00	0.00	1.00	0.25	0.00	0.00	0.00
43 KRI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.20	0.00	0.00	0.00	0.00	0.00	0.25	1.00	0.00	0.00	0.00
44 MOZ	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
45 KND	0.00	0.50	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.07	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
46 IBI	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.25	0.00	0.00	0.00	0.07	0.10	0.00	0.08	0.00	0.33	0.00	0.00	0.00	0.00	0.00	1.00

APPENDIX D
THREE DIMENSIONAL MDS FOR THE WILD FOOD PLANTS COGNITIVE DOMAIN



APPENDIX E: SALIENCE (SMITHS'S S) VALUES FOR EDIBLE PLANTS

ALL INFORMANTS

	ITEM	TIMES MENTIONED	%	AVERAGE RANK	Smith's S
1	ZEG	38	83	3.184	0.623
2	KGO	32	70	3.688	0.489
3	ZAB	31	67	5.387	0.339
4	MID	27	59	4.741	0.376
5	NRM	24	52	4.75	0.334
6	DRN	21	46	4.762	0.292
7	BUG	16	35	4.563	0.211
8	MU	15	33	6.133	0.167
9	TIT	14	30	5.429	0.16
10	NUI	13	28	4	0.179
11	OLO	13	28	5.308	0.158
12	GNO	12	26	7.167	0.114
13	DUG	12	26	6.667	0.113
14	GUA	12	26	7.583	0.117
15	BL	10	22	5.1	0.118
16	CUL	10	22	6.1	0.115
17	KDU	10	22	6.2	0.126
18	DOG	9	20	8	0.072
19	DRO	7	15	8.571	0.067
20	VIR	6	13	9.667	0.054
21	MIG	5	11	7	0.05
22	GUY	5	11	0	0.049
23	JUO	4	9	0.5	0.027
24	BUR	4	9	6.25	0.05
25	MUR	4	9	0.25	0.036
26	ODO	3	7	9	0.034
27	JOR	3	7	9.333	0.031
28	JOG	3	7	2.333	0.022
29	TUB	3	7	1	0.031
30	DRK	3	7	4.667	0.04
31	TRO	3	7	4	0.021
32	KEG	3	7	9.333	0.014
33	BOI	3	7	9	0.023
34	BER	2	4	0.5	0.016
35	MOD	2	4	2	0.022
36	CAI	2	4	8	0.011
37	KRI	2	4	7	0.02
38	MIR	2	4	1	0.017
39	GRA	1	2	4	0.004
40	JUD	1	2	9	0.001
41	APU	1	2	8	0.009
42	RUG	1	2	4	0.012

	ITEM	TIMES MENTIONED	%	AVERAGE RANK	Smith's S
43	ZA	1	2	2	0.021
44	MOZ	1	2	9	0.004
45	KND	1	2	8	0.012
46	IBI	1	2	7	0.001

Salience values for informants between 18 and 30 years of age

	ITEM	FREQUENCY	%	AVERAGE RANK	Smith's S
1	ZAB	13	76	4.077	0.431
2	ZEG	13	76	3.385	0.509
3	KGO	10	59	3.7	0.358
4	NRM	7	41	3.714	0.257
5	DRN	7	41	3.286	0.262
6	MID	6	35	3.667	0.216
7	NUI	6	35	3.333	0.215
8	CUL	5	29	4.6	0.122
9	GNO	5	29	6.4	0.111
10	BL	4	24	4.75	0.126
11	MU	4	24	4.75	0.14
12	DUG	4	24	6	0.102
13	OLO	4	24	3.5	0.133
14	GUA	3	18	5	0.094
15	BUG	2	12	3	0.092
16	GUY	2	12	3.5	0.076
17	DRK	2	12	4.5	0.07
18	TIT	2	12	3	0.075
19	MIG	2	12	3	0.059
20	ODO	1	6	1	0.059
21	BOI	1	6	6	0.01
22	DOG	1	6	4	0.039
23	KEG	1	6	4	0.015
24	MUR	1	6	2	0.047

Salience values for wild edible plants for informants between 30 and 44 years.

ITEM	SPECIES	FREQUENCY	%	AVERAGE RANK	Smith's S
1	KGO	12	86	4.083	0.586
2	ZEG	12	86	3.167	0.649
3	NRM	10	71	6	0.418
4	MID	10	71	4.4	0.491
5	ZAB	9	64	5.667	0.294
6	OLO	7	50	6.714	0.231
7	TIT	6	43	5.833	0.237
8	BUG	6	43	3.167	0.278

ITEM	SPECIES	FREQUENCY	%	AVERAGE RANK	Smith's S
9	DRN	5	36	4.8	0.216
10	NUI	5	36	5.8	0.191
11	DUG	5	36	6.4	0.165
12	KDU	4	29	5.5	0.185
13	DOG	4	29	8.5	0.081
14	MU	4	29	9.5	0.085
15	GUA	4	29	5.25	0.139
16	CUL	3	21	2.667	0.179
17	GNO	3	21	7	0.094
18	MIG	2	14	8	0.069
19	MUR	2	14	1	0.053
20	BL	2	14	7.5	0.068
21	JUO	2	14	8	0.038
22	BUR	1	7	1	0.071
23	GUY	1	7	3	0.056
24	DRO	1	7	9	0.031
25	TRO	1	7	0	0.026
26	ODO	1	7	8	0.036
27	VIR	1	7	8	0.03
28	MIR	1	7	2	0.006
29	MOZ	1	7	9	0.014
30	JOR	1	7	4	0.017
31	IBI	1	7	7	0.004

Salience values for wild edible plants according to informants more than 45 years of age.

	ITEM	FREQUENCY	%	AVERAGE RANK	Smith's S
1	ZEG	13	87	3	0.728
2	MID	11	73	5.636	0.45
3	KGO	10	67	3.2	0.548
4	ZAB	9	60	7	0.278
5	DRN	9	60	5.889	0.396
6	BUG	8	53	6	0.284
7	MU	7	47	5	0.275
8	NRM	7	47	4	0.344
9	DRO	6	40	8.5	0.178
10	KDU	6	40	6.667	0.215
11	TIT	6	40	5.833	0.183
12	VIR	5	33	10	0.137
13	GUA	5	33	11	0.121
14	BL	4	27	4.25	0.156
15	DOG	4	27	8.5	0.102
16	GNO	4	27	8.25	0.136
17	TUB	3	20	11	0.094

ITEM	SPECIES	FREQUENCY	%	AVERAGE RANK	Smith's S
19	DUG	3	20	8	0.077
20	BUR	3	20	8	0.085
21	BOI	2	13	10.5	0.061
22	OLO	2	13	4	0.12
23	NUI	2	13	1.5	0.128
24	JOR	2	13	7	0.08
25	BER	2	13	10.5	0.049
26	MOD	2	13	12	0.068
27	GUY	2	13	20	0.012
28	JUO	2	13	13	0.048
29	KEG	2	13	12	0.026
30	CAI	2	13	18	0.034
31	CUL	2	13	15	0.047
32	KRI	2	13	7	0.063
33	TRO	2	13	16	0.041
34	APU	1	7	18	0.028
35	GRA	1	7	24	0.014
36	JUD	1	7	29	0.002
37	ZA	1	7	2	0.063
38	MIG	1	7	13	0.022
39	MUR	1	7	17	0.007
40	ODO	1	7	18	0.004
41	RUG	1	7	14	0.037
42	DRK	1	7	5	0.044
43	MIR	1	7	10	0.046
44	KND	1	7	8	0.036

Salience values for wild edible plants for female informants.

	ITEM	FREQUENCY	%	AVERAGE RANK	Smith's S
1	ZEG	18	75	2.167	0.631
2	KGO	16	67	2.75	0.503
3	ZAB	14	58	5.286	0.272
4	DRN	13	54	3.769	0.361
5	MID	12	50	4.75	0.302
6	NRM	11	46	4.545	0.294
7	BUG	9	38	4.556	0.207
8	GNO	7	29	7	0.111
9	CUL	7	29	3.857	0.162
10	OLO	6	25	5.833	0.096
11	BL	5	21	6.6	0.09
12	MU	5	21	5.2	0.137
13	TIT	5	21	4	0.109
14	DUG	5	21	7.6	0.071
15	GUA	4	17	5.5	0.087

	ITEM	FREQUENCY	%	AVERAGE RANK	Smith's S
16	DRO	4	17	8.25	0.067
17	DOG	3	13	8	0.023
18	MIG	3	13	6.333	0.068
19	KDU	3	13	5.667	0.077
20	BUR	3	13	5.333	0.065
21	VIR	3	13	6	0.057
22	KEG	2	8	6	0.02
23	MUR	2	8	4.5	0.057
24	GUY	2	8	8	0.031
25	JOG	2	8	4.5	0.039
26	DRK	2	8	4	0.062
27	NUI	2	8	2.5	0.052
28	BOI	2	8	5.5	0.025
29	TUB	2	8	5	0.049
30	BER	1	4	11	0.01
31	MOD	1	4	3	0.03
32	MIR	1	4	12	0.003
33	ODO	1	4	8	0.021
34	KRI	1	4	12	0.003
35	TRO	1	4	10	0.015

Salience values for wild edible plants for female informants.

	ITEM	FREQUENCY	%	AVERAGE RANK	Smith's S
1	ZEG	20	91	4.1	0.615
2	ZAB	17	77	5.471	0.412
3	KGO	16	73	4.625	0.474
4	MID	15	68	4.733	0.457
5	NRM	13	59	4.923	0.378
6	NUI	11	50	4.273	0.317
7	MU	10	45	6.6	0.2
8	TIT	9	41	6.222	0.215
9	DRN	8	36	6.375	0.217
10	GUA	8	36	8.625	0.149
11	BUG	7	32	4.571	0.216
12	KDU	7	32	6.429	0.18
13	OLO	7	32	4.857	0.226
14	DUG	7	32	6	0.158
15	DOG	6	27	8	0.126
16	GNO	5	23	7.4	0.117
17	BL	5	23	3.6	0.149
18	JUO	4	18	10.5	0.057
19	JOR	3	14	9.333	0.065
20	GUY	3	14	11.333	0.068
21	CUL	3	14	11.333	0.063
22	VIR	3	14	13.333	0.05

	ITEM	FREQUENCY	%	AVERAGE RANK	Smith's S
23	DRO	3	14	9	0.067
24	CAI	2	9	18	0.023
25	ODO	2	9	9.5	0.048
26	TRO	2	9	16	0.028
27	MIG	2	9	8	0.03
28	MUR	2	9	16	0.013
29	JOG	1	5	28	0.003
30	RUG	1	5	14	0.025
31	MOD	1	5	21	0.014
32	BUR	1	5	9	0.033
33	MIR	1	5	10	0.031
34	TUB	1	5	23	0.011
35	GRA	1	5	24	0.009
36	ZA	1	5	2	0.043
37	BER	1	5	10	0.023
38	BOI	1	5	16	0.022
39	KEG	1	5	16	0.008
40	JUD	1	5	29	0.002
41	APU	1	5	18	0.019
42	KRI	1	5	2	0.039
43	DRK	1	5	6	0.017
44	MOZ	1	5	9	0.009
45	KND	1	5	8	0.024
46	IBI	1	5	17	0.003

APPENDIX F
PROBABILITY OF SPECIES HAVING A SIGNIFICANT DIFFERENCE IN THEIR ABUNDANCE BETWEEN DIFFERENT VEGETATION TYPES.

Species	*F*	*Probability*
Brosimum alicastrum Sw.	2.913859949	0.02
Heliconia sp.	21.54622553	0.00
Inga sp.	8.915570425	0.00
Urera sp.	6.055040496	0.00
Urera sp.	1.321177425	0.26
Socratea exorrhiza (Mart.) H. Wendl	4.314528059	0.00
Chrysophylum sp.	1.381810716	0.24
Carludovica palmata Ruiz & Pavon	6.775861573	0.00
Maripa nicaraguensis Hemsl.	1.468834346	0.21
Dioscorea trifida Lf	4.463315466	0.00
Dioscorea trifida Lf	1.321177425	0.26
Dioscorea trifida Lf	0.710701533	0.59
Clavija sp.	12.80409708	0.00
Heliconia sp.	0.94089238	0.44
Passiflora sp.	7.874547806	0.00
Passiflora sp.	1.152019557	0.33
Passiflora sp.	1.005460723	0.40
Psidium guajava L.	4.373670296	0.00
Begonia sp.	1.324936631	0.26
Spondias mombin L	5.737528407	0.00
Oenocarpus mapora H. Karst	1.736595745	0.14
Tetragastris panamensis (Engl.) Kuntze	8.468151338	0.00
Geonoma interrupta (Ruiz & Pav.) Mart.	8.451567135	0.00
Sechium pittieri (Cogn.) C. Jeffrey	5.599536432	0.00
Vasconcella cauliflora (Jacq.) A. DC	11.80383172	0.00
Hypolepis repens (Linnaeus) C. Presl.	5.665578148	0.00
Euterpe precatoria Mart.	3.291217261	0.01
Byrsonima crassifolia (L.) Kunth.	1.321177425	0.26
Triumpheta sp.	4.924249489	0.00
Heliconia sp.	6.236924914	0.00
Theobroma bicolor Bonpl. in Humb. & Bonpl.	1.355946167	0.25
Chamaedorea tepejilote Liebm. ex Mart	6.994622931	0.00
Cestrum sp.	8.778463366	0.00
Prestoea acuminata (Willd.) HE Moore	6.562686515	0.00
Garcinia sp.	5.498512858	0.00
Licania belloi Prance	4.436126732	0.00
Phytolaca sp.	11.61043588	0.00

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BIOGRAPHICAL SKETCH

Héctor Castaneda was born in El Salvador. He completed his bachelor's degree in forestry at the Instituto Tecnológico de Costa Rica in 1999. For one year after this, he moved to El Salvador and worked at the Fundación Salvadoreña para el Desarrollo Económico y Social (FUSADES). Here he worked as Junior Environmental Analyst and participated in the coordination of a country wide survey of rural poverty and development, a joint effort between FUSADES and Ohio State University.

After this experience, he worked in at La Laguna Botanical Gardens (El Salvador) as chief of research in the Scientific section of the garden. During this period he participated not only in the care and enrichment of the garden's living and herbarium collections, but as a representative of the institution to the Ministry of the Environment for consultations and workshops regarding conservation policies.

In 2002, after obtaining a Fulbright fellowship, he moved to Gainesville, Florida to pursue his Master's degree in Interdisciplinary Ecology in the School of Natural Resources & Environment. Here he took part as an active member of the Ethnoecology society. He also conducted his research, under the supervision of Dr. Hugh L. Popenoe, in Costa Rica working with the ethnobotany of wild edible plants used by the Guaymi indigenous group.

Currently Héctor is President of the Ethnoecology Society at UF, and is collaborating with Dr. John Richard Stepp research projects regarding the relationship between mountains and biocultural diversity.