EDIBLE PLANTS OF THE CHINANTLA, OAXACA, MEXICO WITH AN EMPHASIS ON THE PARTICIPATORY DOMESTICATION PROSPECTS OF *PERSEA SCHIEDEANA*

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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To the fruits of the past and future

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This thesis examines the edible plants in the Chinantla area of Oaxaca, Mexico. An inventory of the edible plants was compiled using interviews, surveys in the various agroecosystems, and by participant observation. A full list of the plants is presented.

This work set out to search for “Cinderella species”, species that are locally important but that are understudied and have under-exploited potential. Various species were identified, including a number of quelites (edible greens), two little studied species of Myrsinaceae, *Ardisia compresa* and *Parathesis psychotrioides*, a relative of cacao (*Theobroma bicolor*) and two relatives of avocado, *Beilschmiedia anay* and *Persea schiedeana*.

Persea schiedeana (chinene) was identified as warranting more investigation by the researcher and local communities. This species has high potential to play an expanded role as an agroforestry tree product (AFTP) in the Chinantla. It is also recommended for experimentation in other parts of the tropics.

An interview inquiring into the ethnobotanical knowledge and local management practices of *Persea schiedeana* was administered. A survey of all the fruiting *Persea schiedeana* trees found in each of the six villages of CORENCHI (Regional Council on Natural Resources of

the Chinantla, an indigenous Chinantec organization) was carried out using participatory research techniques to determine in which agroecosystems and ecological conditions these trees are encountered and to document and analyze the morphological diversity of the fruits. As this species is in the process of domestication, the hypothesis was tested that the purposely-planted trees (i.e. selected) should be superior in the characters listed by residents as desirable when compared to wild and/or feral individuals. This is proven true in the analysis of data.

A community project was undertaken in conjunction with the research. “Chinene Fairs” were held in each village, involving residents in the identification of superior fruited trees. The information generated in these fairs and in fruit morphological data collection was used to collectively select those trees deemed to produce the best fruits. These trees are being used to supply scions to graft onto rootstock planted during the research. A workshop was organized to teach grafting techniques to interested residents.

CHAPTER 1
CONTEXT: THE CHINANTLA, OAXACA

The Geography of the Chinantla

The Chinantla is a well recognized, though variably defined ecological and cultural zone in the Sierra Norte (or Sierra de Juarez) of Oaxaca, Mexico and along the Gulf-facing slopes of these mountains, which form part of the Sierra Madre Sur. Though not exclusively, the Chinantla area includes a very large part of the watershed of the Papaloapan, Mexico's second largest watershed, whose terminus is in the Gulf of Mexico (Poleman 1964).

Figure 1-1. Map of the Papaloapan Watershed (Wikipedia 2009)

Most authorities define the Chinantla broadly as "that territory currently inhabited by the people identifying themselves as Chinantecos who recognize a common origin and have a strong linguistic and territorial cohesion" (Beltran 2000). Meave et al. (2006) defined "La Chinantla sensu latu" as 17° 22-18°12'N and 95°43'-96°58'W, which "roughly corresponds to the geographical distribution of the Chinantec ethnic group."

The word *Chinantla* is believed to derive from the word *chinamitl*, a Nahuatl word meaning enclosed space, a reference to the many tight valleys in this mountainous region (Schultes 1941b). Schultes observed that in the *Relacion de Chinantla*, written in 1579, "Chinantla" is explained variously as the name of an old town, a new town, a river, and a region. The *Relacion* reads, "The town of Chinantla is called Chinantla because it is surrounded by towns and mountains, and the natives call any kind of enclosed space chinamitl... as well as because it lies on the banks of a swift-flowing river named Chinantla [now called the Rio Valle Nacional], rising eleven leagues from the town in a hill where was formerly situated a village named Chinantla, abandoned as the results of wars, and (finally) because the site was similar they called it, (the new town), Chinantla" (Bevan 1938). Schultes insists, however, that the proper use of the term "Chinantla" is much more limited in scope and refers to the south, southeastern part of the area more broadly referred to as the Chinantla, and calls for a more restricted use of the term to refer to a more concise ecological area (Schultes 1941b). Despite Schultes admonishments, the sensu latu definition appears, both popularly and in academia, to have prevailed (Meave et al. 2006).

The city of Tuxtepec is the de facto capital of the Chinantla, and Oaxaca's second largest city. Other important centers of transportation and commerce, providing goods and services to those who live in the surrounding villages (some accessible and some inaccessible by road), are Valle Nacional, Ojitlan, and Usila.

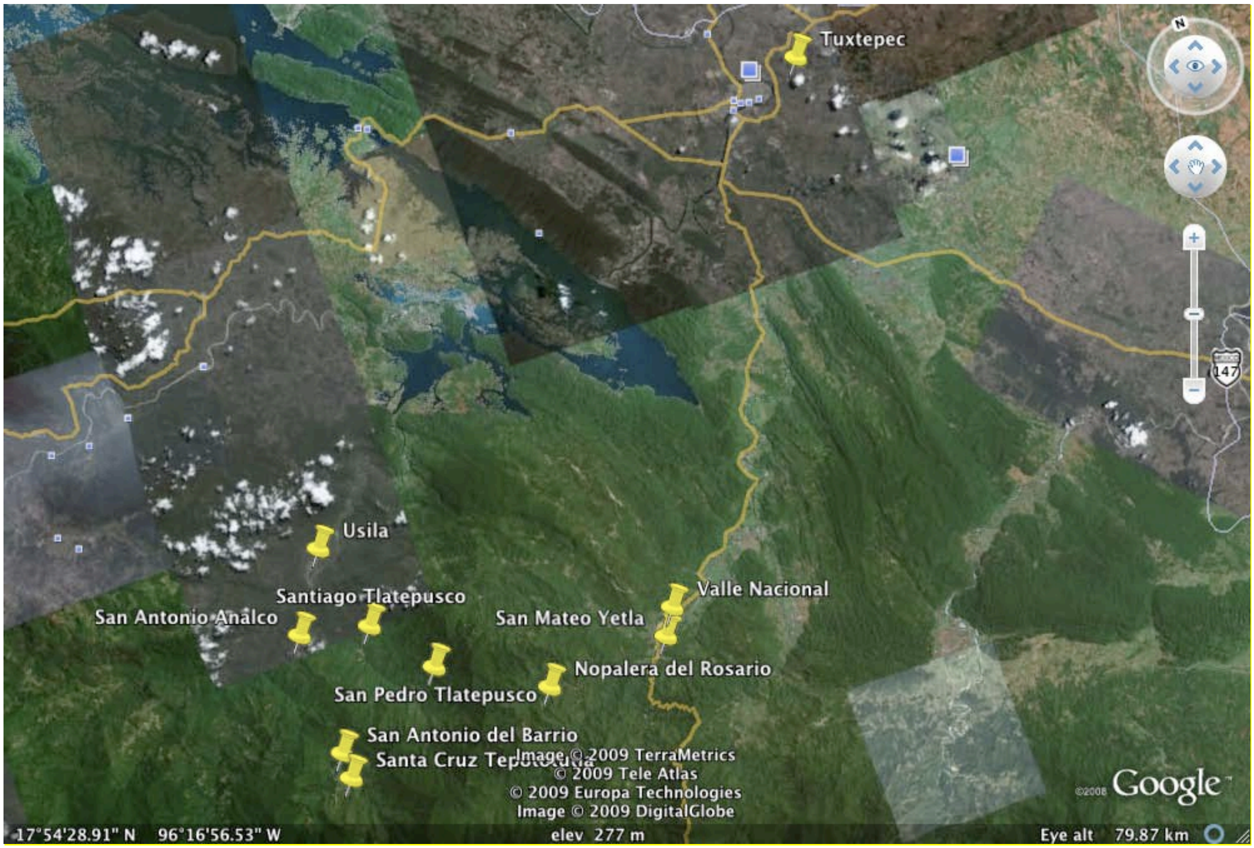

Figure 1-2. Map of the Chinantla Region

Ecology

Ecologically, the Chinantla is recognized for its complexity and very high levels of diversity, owing to the extreme topography and the mingling of numerous bioregions (Martin 1996, Meave et al. 2006, Bray et al. 2008). It is considered the most ecologically complex part of the state of Oaxaca, which itself is recognized as the most diverse state of Mexico (Oviedo 2002, García-Mendoza et al. 2004) harboring nearly half of the plant species of Mexico with the state's heterogeneous territory (Oviedo 2002). Diverse forest formations are found in altitudinal bands as one leaves the Gulf Coastal Plain near sea level and ascends to the crest of the Sierra Norte, one hundred and twenty of whose peaks are higher than 2500m (Meave et al. 2006). Within less than 30km heading southwest from Valle Nacional at 65m one ascends to Humo Chico peak, the highest point of the Sierra Norte at around 3200m. Owing to these rapid changes in altitude, steep slopes characterize the area. Ortiz-Perez et al. (2004) have studied the topography of the area and present the following frequencies of slope angles; with 17.3% of slopes between 0-6 degrees, 38.3% between 6-18 degrees, 43.3% between 18-45 degrees, and 1% greater than 45 degrees.

Tropical Evergreen Forest is found from 100m to 1200m, Montane Cloud Forest at 1200m to 2250m (often referred to as Bosque Mesofilio), Evergreen Conifer Forest from 2750m to 3400m, and Pine-Oak Forest from 1000m to 2750m (Martin 1996).

Due to its high levels of diversity and the fact that it contains the most intact tracts of Montane tropical forest and Cloud Forest in Mesoamerica, the WWF has declared the Chinantla/Sierra Norte as one of the 200 Priority Conservation areas (Oviedo 2002) and the National Commission for Biodiversity Conservation of Mexico has declared it as a priority area (2000). The Chinantla is home to many endemic species, particularly in the Cenozoic relict forest of *Engelhardtia* (*Oreomunnea*) first described by Rzedowski and Palacios-Chavez (1977).

The geology of the Chinantla is complex, with a long history of uplift reported, and predominately metamorphic parent material, consisting of chlorite and mica shales, with minor inclusions of quartzite (Álvarez Arteaga and García Calderón 2008).

The soils of the Chinantla are not well studied, though most are derived from metamorphic parent material (Álvarez Arteaga and García Calderón 2008), are shallow, and are referred to as lithosols (leptosols) (Alfaro-Sanchez and Briones-Salas 2004). Pockets of well developed soils with high amounts of organic matter, N and P at lower elevations (below1600m) are reported, as are the wide occurrence of Oxisols, while above 1600m soils are predominantly spodosols with a transition zone of “podzolic” soils found in intermediate altitudes (van der Wal 1996). Recent work describes the soils of the Montane Forest zone (Álvarez Arteaga and García Calderón 2008).

Climatically, the Chinantla is recognized as hyper-humid with 2000-5500mm of rainfall reported, depending upon elevations, including some of the wettest areas in all of Mexico (Meave et al. 2006). The high precipitation is the result of the movement of moist air off the Gulf and its subsequent adiabatic cooling as it rises up the slopes of the Sierra Juarez, with the highest precipitation at middle elevation around 1500m (Meave et al. 2006). Most precipitation occurs from May through February, though the "dry" period of March and April, experienced elsewhere in Mexico is here relieved by cool, wet northern fronts, "*nortes*".

Temperature regimes are also affected by altitude. Zones of Tropical Evergreen Forest between 100m and 1200m typically experience lows between 15° and 21° centigrade and highs between 27° and 30° centigrade. These temperatures, along with the high levels of precipitation, result in the classification of these zones as hot and humid, Af in the Koppen system (Martin 1996). The Montane Cloud Forest experiences cooler temperatures, with lows between 12° and 15° centigrade and highs between 21° and 26° centigrade, and higher precipitation, resulting in its classification as humid montane, Cf in the Koppen system (Martin 1996). Pine-oak forest, and oak forests in particular, are much more variable in their altitudinal distribution (typically from 1000m to 2750m, but sometimes as low as 700m on specific truncated oxisols) and can be variably classified as temperate or tropical and humid to sub-humid in the Chinantla (Meave et al. 2006, van der Wal 1996).

Culture

The Chinantec people inhabit the Chinantla area. They are speakers of various dialects of Chinanteco, a member of the Otomanguean language family. This language family appears to have ancient roots in and around the area currently inhabited by its speakers, including adjacent areas of Puebla, such as Tehuacan, where some of the earliest signs of agriculture in Mesoamerica are found (MacNeish 1967). Parts of the Chinantla are thought to have been inhabited since at least 500 B.C., though most likely even earlier by cultures part of (or in contact with) the Olmec who were flourishing on the coastal plains and Gulf coast (Martin 1996). While the first settlements appear to have been in the lowlands, it is thought that by around 500 B.C. settlement by Chinantec speakers was occurring in the mountains (Winter 1989). Little archaeological work has been carried out in the Chinantla, partly owing to hyper humid conditions, which provide poor conditions for archaeological work and preservation of archaeological remains. However, ceramic and gold artifacts found demonstrate that during the reign of the Aztec, interaction in the form of control or trade was occurring between the Chinantla and Tenochitlan, the Aztec capital (Martin 1996). In the Codice Mendocino, tribute goods sent from the Chinantla to Moctezuma are enumerated, including garments and fabric made from cotton, Liquidambar balsam, cacao, vanilla, and rubber from *Castilla elastica* (Bevan 1938). The various Relaciones written by early Spanish in the Chinantla, provide insight into early colonial Chinantla and suggest that by the time of the arrival of the Spanish, the Chinantla was slipping out of control of the Aztec (Bevan 1938). Much remains to be learned in regards to pre-Colombian history of the Chinantla. Within the area of fieldwork for this study, numerous as of yet unstudied structures were pointed out by local inhabitants, who have also encountered ceramics, sculptures, obsidian, and jade in agricultural and dwelling areas. From the available scant evidence, it would appear that the middle to upper elevations of the Chinantla have been inhabited at least for 1000 years and probably much longer (Bray et al. 2008, Martin 1996).

The history of the Conquest in the Chinantla is also poorly documented. Owing to the well-watered and relatively fertile lowlands, agricultural production under the *encomienda* system expanded into the lower areas and focused upon sugar cane and cotton. Meanwhile, less accessible areas in the mountains, continued to focus their agriculture on subsistence crops.

In the modern era, a number of phenomena have left their mark on the Chinantla, many of them part of the efforts of the Mexican federal government to develop the area, through the Papaloapan Project (Poleman1964).

The first was the expansion of coffee cultivation in the area in the 1960's by the Mexican coffee institute, INMECAFE (Beltran 2000). Although coffee was grown previously, it was in this era that it became a corner stone of the economy of the Chinantla and growers became accustomed to the set prices, guaranteed market, transportation of goods and assistance provided by INMECAFE.

The second event was the construction of two large dams in the Papaloapan river basin in the middle of the 20th century, which displaced thousands of Chinatec and Mazatec people and, affecting most of the villages in this study, permanently disrupted migration patterns of aquatic species, thus robbing many villages of important, traditional sources of protein. The large reservoirs created are visible in Firgure 1-1. and Figure 1-2.

The third event was the leasing of enormous tracts of the Sierra Norte by the federal government (although the lands are titled to indigenous communities) to FAPATUX, a timber and paper mill operation in Tuxtepec. FAPATUX began road building in the Sierra, which resulted in the opening of parts the Chinantla, formerly extremely isolated, to motorized transportation. This effort continues today in the study area, where only one of the six villages of CORENCHI is presently accessed by road, though two others will be by 2010. Indigenous communities resisted the renewal of the leases of their forests to FAPATUX and have since begun remarkable community forestry enterprises and community conservation strategies (Bray et al. 2008).

Study Sites

Field work for this thesis was conducted in the village of San Mateo Yetla (located near Valle Nacional) and in the six villages composing CORENCHI (Consejo Regional de Recursos Naturales de la Chinantla, Regional Coucil on Natural Resources of the Chinantla); Analco, Nopalera del Rosario, Santiago Tlatepuso, San Pedro Tlatepusco, Santa Cruz Tepetotutla, and San Antonio del Barrio. All are inhabited by Chinatec speaking Chinantec indigenous people, with dialects varying between villages.

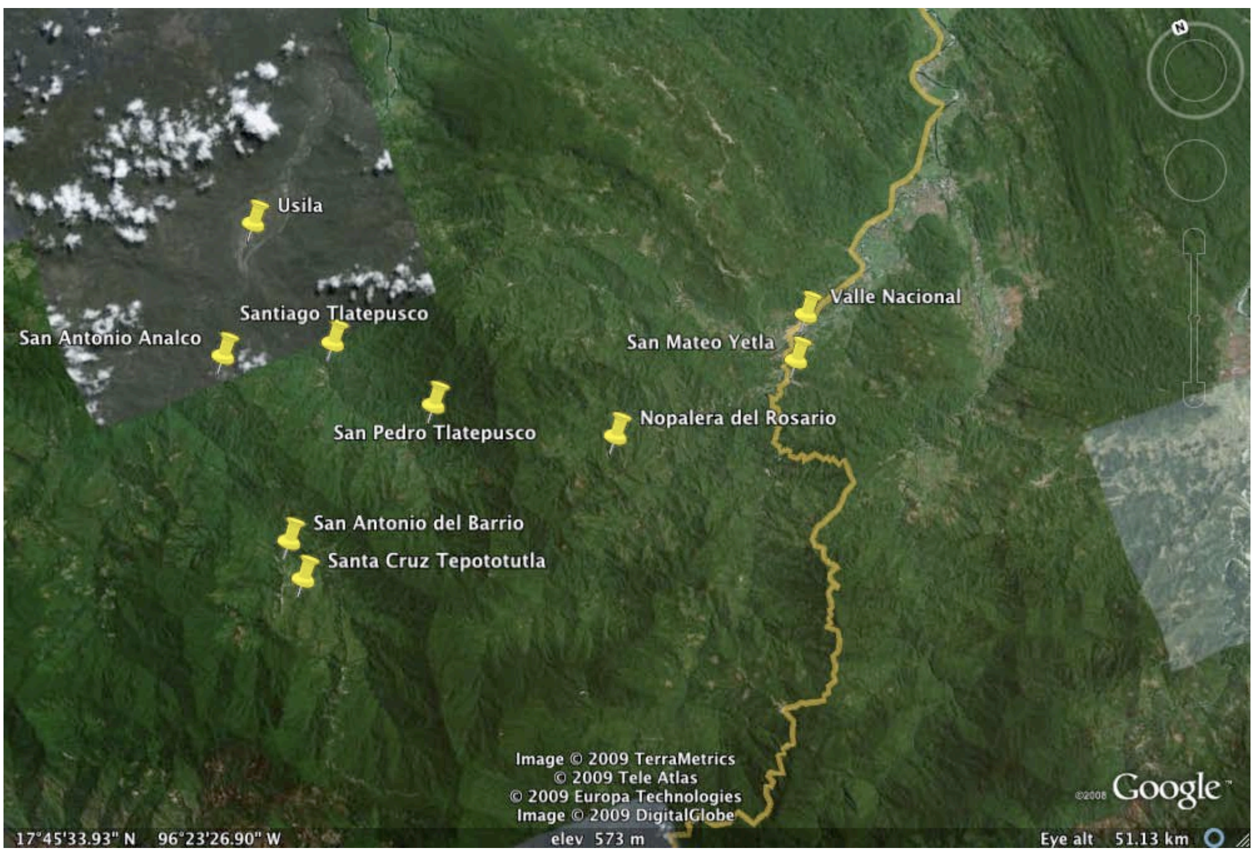

Figure 1-3. Map of study area

Initial work was largely carried out in San Mateo Yetla, owing to its ease of access and the congenial relationship formed with a number of inhabitants. An introduction into the edible plants and agroecosystems of the area was achieved here. An initial ten-day trip through three of the CORENCHI villages was made in March 2008, followed by five weeks passed among all six villages in June and July during the harvest of *Persea schiedeana*, and follow up work in November 2008 and January 2009.

San Mateo Yetla

San Mateo Yetla sits on the main highway (175) linking Oaxaca city to Tuxtepec, the de facto capital of the Chinantla, and Oaxaca's 2nd largest city. San Mateo Yetla is located at an altitude of 120m and has a population of near 700. San Mateo Yetla straddles modern and traditional, with easy road access from the village to Valle Nacional and its shops, schools, and modest medical facilities. At the same time, most members of older generations (and some, though proportionally fewer, young people) work in the "*campo*" a fifteen minute to two or three hour walk, where milpas for growing maize, beans, squash, and other crops are cleared and coffee groves are managed with machete. All harvests and firewood are hauled out on back, as there are no secondary roads emanating from the village. Subsistence agriculture is still the most important agricultural activity in the area, accompanied by the production of coffee, limited cacao production, and a growing involvement with cattle.

Consejo Regional de Recursos de la Chinantla (CORENCHI)

The villages of CORENCHI collectively have a population of 2,039 and occupy 33,921 ha of rugged forested land stretching from 200m to 2900m. The villages of CORENCHI are each internally governed according to traditional governing forms as recognized by the state government of Oaxaca in the Law of Traditions and Customs (Eisenstadt 2007). The six villages have voluntarily formed a larger regional organization (CORENCHI) to enable them to more effectively interact with NGOs, governmental organizations, and to coordinate their activities, both commercial and cultural, most specifically those activities geared towards conservation and payments for ecological services. Four of the villages now have around 20,000 hectares declared community conservation areas and certified as such (Camacho et al. 2007), with the other two communities in the process of gaining such certification. 7,860 hectares have been receiving payment for hydrological services from the Mexican forestry service (CONAFROR) and are slated to renew the payments from 2009 until 2014 for a total of 1.5 million dollars (Bray et al. 2008). Additional ways to “make conservation pay” are being explored, including carbon credits, ecotourism, and scientific tourism.

Context of Research

As remarkable as the conservation achievements and the securing of temporary payments for environmental services by CORENCHI are, the fact remains that income generation within the villages is problematic. Since the 1960s coffee has been the main income source in the area, with most other agriculture aimed at subsistence. The “coffee crisis” of recent decades has resulted in considerable economic instability in these villages, first because of the dissolution of INMECAFE which had provided a stable market and price, and secondly because of gluts of coffee on the global market. The result of this instability has been some abandonment of coffee groves and a considerable spike in out migration from villages in the Chinantla to Oaxaca, Mexico City, and the United States. The culture of coffee production remains strong in these villages (though it is declining). The coffee groves are in many cases in need of attention and await improvement and enrichment. In contrast to some other land use alternatives, i.e. cattle ranching, coffee groves are relatively ecological benign and contribute to nutritional security through their high diversity of edible plants.

In informal discussions with residents during preliminary visits in 2007, local people noted two crucial steps necessary to make the coffee groves more profitable. The first step is securing a higher percentage of the price that the consumer ultimately pays through more direct marketing. Second, producing and marketing other products from the coffee groves, as shade trees and crops in the shade. This thesis focuses upon the second point, seeking to identify products that are produced in coffee groves (and/or in other agroecosystems) that could, with improved management and selection produce a marketable product, in the coffee growing system. This research further seeks to contribute to the knowledge of one such species in particular, Persea schiedeana, which is a candidate for enriching coffee groves in the Chinantla, and a candidate for introduction in other coffee growing areas of the world with similar conditions.

CHAPTER 2
AGROFORESTRY, NTFPS/AFTPS AND "CINDERELLA SPECIES"

The important role that agroforestry has to play in conservation and in poverty alleviation is increasingly recognized and has fueled a burgeoning literature (Anderson 1990, Nair 1998, Garrity et al. 2006, Schreckenberg et al. 2006). The ideal is that it is possible to achieve "simultaneous use and conservation of the rain forest" (Anderson 1990). It is also recognized that there are numerous benefits in terms of nutrient cycling, disease repression, and shade crop quality improvement to be had in multistrata agroforestry systems (Ewel 1986, Muschler 1997). The key role that indigenous fruit trees have to play as potentially important non-timber forest products (NTFP) in such endeavors has been widely discussed (Leakey and Newton 1994, Prance 1994, Leakey et al. 1996, Leakey and Simons 1997, Schreckenberg et al. 2006, Akinnifesi et al. 2008). While some such NTFP species are principally wild harvested (such as Brazil nuts, *Bertholletia excelsa*), many have long been part of traditional agroforestry systems, involving various forms and intensities of management and selective pressure. Other species, such as camu-camu (*Myrciaria dubia*) in the Peruvian Amazon (Penn 2008, Clement et al. 2008), which were once only wild harvested, have recently been brought into cultivation due to over harvesting, a low natural population, and/or success in the marketplace. Simmons & Leakey (2004) propose the term Agroforestry Tree Product (AFTP) to distinguish species produced under more intensive management in agroforestry settings versus those species that are principally wild harvested (NTFPs).

Many indigenous fruit trees are locally important, but remain unknown outside of local subsistence settings or regional markets, though they are thought to have a high potential for further development. Such species have been coined "Cinderella species" (Leakey and Newton 1994) "a phrase applicable to traditionally important indigenous species that have been overlooked by science for agroforestry and forestry" (Leakey and Simons 1997). Most of these "Cinderella species" have long been integrated into local agroforestry systems, such as home gardens and coffee or cacao groves and are important in local diets and/or very regionalized markets (Haq et al. 2008, Wiersum 2008). However, due to variable quality, unpredictable supply, lack of market access and/or experience, transportation issues, and/or lack of consumer familiarity with these products, the full potential of these fruit species both for local nutritional security and for income generation by accessing extra local markets is frequently not achieved, and many fruits are either left un-harvested or suffer high rates of post harvest loss (Haq et al. 2008).

Most indigenous fruit trees, while having a long history of wild harvest, management, and/or cultivation, have out crossing pollination strategies and are seed propagated and thus highly variable in a number of characteristics (Wiersum 2008). Models of the important steps in further improvement of indigenous fruit trees have been proposed, with one of the most important aspects being to identify superior individuals and the development of vegetative propagation to capture and spread these superior, marketable genotypes (Leakey and Akinnifesi 2008). While long recognized as key to improving tropical fruit culture (Popenoe 1952) most indigenous fruit trees have not been exploited in this fashion, except for those few that have become plantation crops such as avocado, mango, and litchi. The success of these commercially viable fruit crops without really any breeding per se, but rather a focus on the clonal propagation of superior individuals, bodes well for the potential held by Cinderella species. Recently, new work along these very lines is being carried out with indigenous fruit species, in the most focused fashion in work carried out in West and South Africa, as well as Australasia (Leakey et al. 2004, Franzel et al. 2008, Leakey et al. 2008). Both the International Centre for Underutilized

Crops (ICUC) and the World Agroforestry Centre (ICRAF) have become increasingly involved in promoting projects aimed at better utilizing indigenous fruit tree species.

At the same time that the importance of promoting indigenous fruits is being recognized, it is being recognized that the most appropriate avenue for improving these "Cinderella species" is through participatory domestication projects (Akinnifesi et al. 2008). As Clement et al. (2008) summarize, "The basic premise of participatory plant breeding is that by involving farmers in such a way that they can express their preferences and *their local knowledge can be effectively used*, the relevance of research projects to the needs of small farmers will be increased" (emphasis mine). Thus, though infrequently explicitly recognized by its practioners, participatory domestication sits at the exciting crossroads of horticulture, breeding, and ethnoecology/ethnobotany. At its best, it represents a true sharing between scientists and experienced rural people, with both acknowledging that they have much to learn from each other. Most "Cinderella species" will not become international trade items, such as acai (*Euterpe oleracea*) and camu camu (*Myrciaria dubia*) have become (Penn 2008), though some may, but the ability of local and regional markets to generate income for small holders is increasingly acknowledged and, importantly, is recognized as more stable than export markets (Shackleton et al. 2007).

The Domestication Continuum: "Cinderella species" range from "wild" to "domesticated" along the various models of plant management intensity. And the species are found in varying agroecosystems, which themselves can be regarded as "wild", in the case of unmanaged or little managed forest stands, to systems of intermediate management intensity such as coffee and cacao groves, to the domesticated agroecosystem of home gardens.

Before proceeding into further discussion of the work of this thesis on the edible plants in the Chinantla, specifically its Cinderella species, and in particular *Persea schiedeana*, it is worth reviewing some ideas on plant domestication and some reflections on the fuzzy zone between wild ecosystem and domesticated ecosystem where many of the species of interest, including *Persea schiedeana* are encountered in the Chinantla.

Various authors have pointed out that not only does the biology and genetics of the particular plant species in the process of domestication need to be considered but also the agroecological setting within which plant management changes (Clement 1999, Wiersum 2008). As Wiersum (2008) states,

> In a more comprehensive sense, the concept of domestication refers to processes operating at both species and agroecosystem level. In this interpretation the concept refers to the changes in the plant's morphological and genetic properties brought about by changes in exploitation and management practices. Concomitant with changes in the biological properties, changes in a plant's growing environment occur as well as a gradual intensification in cultivation practices. Thus, in its comprehensive sense, domestication is considered as a multidimensional process in which a progressively closer interaction between people and plant resources take place. The process of domestication can be considered as an evolutionary process from gathering to breeding, during which changes at the level of both the production system and the plant species occur.

Wiersum (2008) further elaborated, "The dichotomy between wild and domesticated species has a long history. In the past, this dichotomy has often been used by archaeologists, anthropologists, and historians to denote a state of being. However, since the 19^{th} century, biologists have started to use the term domestication as a dynamic term referring to a process rather than a state of existence. At present this dynamic interpretation of domestication is scientifically generally accepted."

Many of the plants encountered during field work, in particular the Cinderella species, force one to look beyond a dichotomy of wild versus domesticated, as they are used, managed, manipulated, and presumably genetically affected by human influence, yet all of these influences are subtle enough and/or off-set by the near presence of wild or unmanaged populations so that the species cannot be truly regarded as domesticated. They are certainly not dependent upon human intervention for their success, as the case with a highly domesticated species such as *Zea mays*. They are however, in the incipient stages of domestication, frequently having been subjected to truncated selection (Leakey et al. 2004). Truncated selection takes place when in each generation the most desirable individuals of a species are promoted (and the less desirable ones eliminated). Thus, in each generation the superior selections cross with each other and the frequency of desirable traits is increased and the frequency of the less desirable traits is reduced. In various studies of the incipient domestication of economic species, morphological and genetic changes are detectable as a result of human selection through this process (Lovett and Haq 2000, Leakey et al. 2004, Casas et al. 2007).

Clement (1999) proposed a useful model addressing the pertinent categories of stages along the continuum between wild and domesticated, pointing out "domestication is a continuum of human investment in selection and environmental manipulation, so its subcategories are merely constructs that imperfectly reflect the real world." In his model Clement (1999) presents the following categories with explanation:

WILD. A naturally evolved population whose genotypes and phenotypes have not been modified by human intervention.

INCIDENTALLY CO-EVOLVED. A population that volunteers and adapts in a human disturbed environment, possibly undergoing genetic change, but without human selection. This definition corresponds approximately to Rindos' (1984)"incidental domestication." Many weeds are examples of incidentally co-evolved species, which can also enter the domestication process if humans start to select for their useful traits and start to manage or cultivate them (Harlan 1992)

INCIPIENTLY DOMESTICATED. A population that has been modified by human selection and intervention (at the very least being promoted), but whose average phenotype is still within the range of variation found in the wild population for the trait(s) subject to selection. The variance of this average is probably smaller than that of the original wild population, however, as selection has started to reduce genetic variability. This definition corresponds roughly to Rindos' (1984) "specialized domestication."

SEMI-DOMESTICATED. A population that is significantly modified by human selection and intervention (at the very least being managed) so that the average phenotype may diverge from the range of variation found in the wild population for the trait(s) subject to selection. The variance of this phenotypic average may be larger than that of the wild population, because the phenotypic variation now includes both types that are common in the wild population and types that are novel. Underlying genetic variability [e.g., isozyme variation (Doebley 1989)], however, continues to decrease because fewer individuals meet the selection criteria and are therefore included in the next generation. The plants retain sufficient ecological adaptability to survive in the wild if human intervention ceases, but the phenotypic variation selected for by humans will gradually disappear in the natural environment.

DOMESTICATED. A plant population similar to (4) but whose ecological adaptability has been reduced to the point that it can only survive in human-created environments, specifically in cultivated landscapes (Harlan 1992). Genetic variability is generally less than in (4) because of increased selection pressure and loss of ecological adaptation. If human intervention ceases, the population dies out in short order, depending upon its life history, stature and the type of vegetation that invades the abandoned area. In clonally propagated crops, a single genotype may be the domesticate, but also is lost soon after it is abandoned." (Clement 1999)

Both Clement (1999) and Wiersum (2008), in addition to other authors (Harris 1989, Harlan 1992) stress the importance of regarding the domestication as a co-evolutionary process involving both the plants and the agroecosystems in which they are manipulated. Wiersum (1997) has designed the following figure (Figure 2-1), specifically in reference to tree crops, illustrating the various agroecosystem settings in which differing degrees of plant management and plant domestication can be identified:

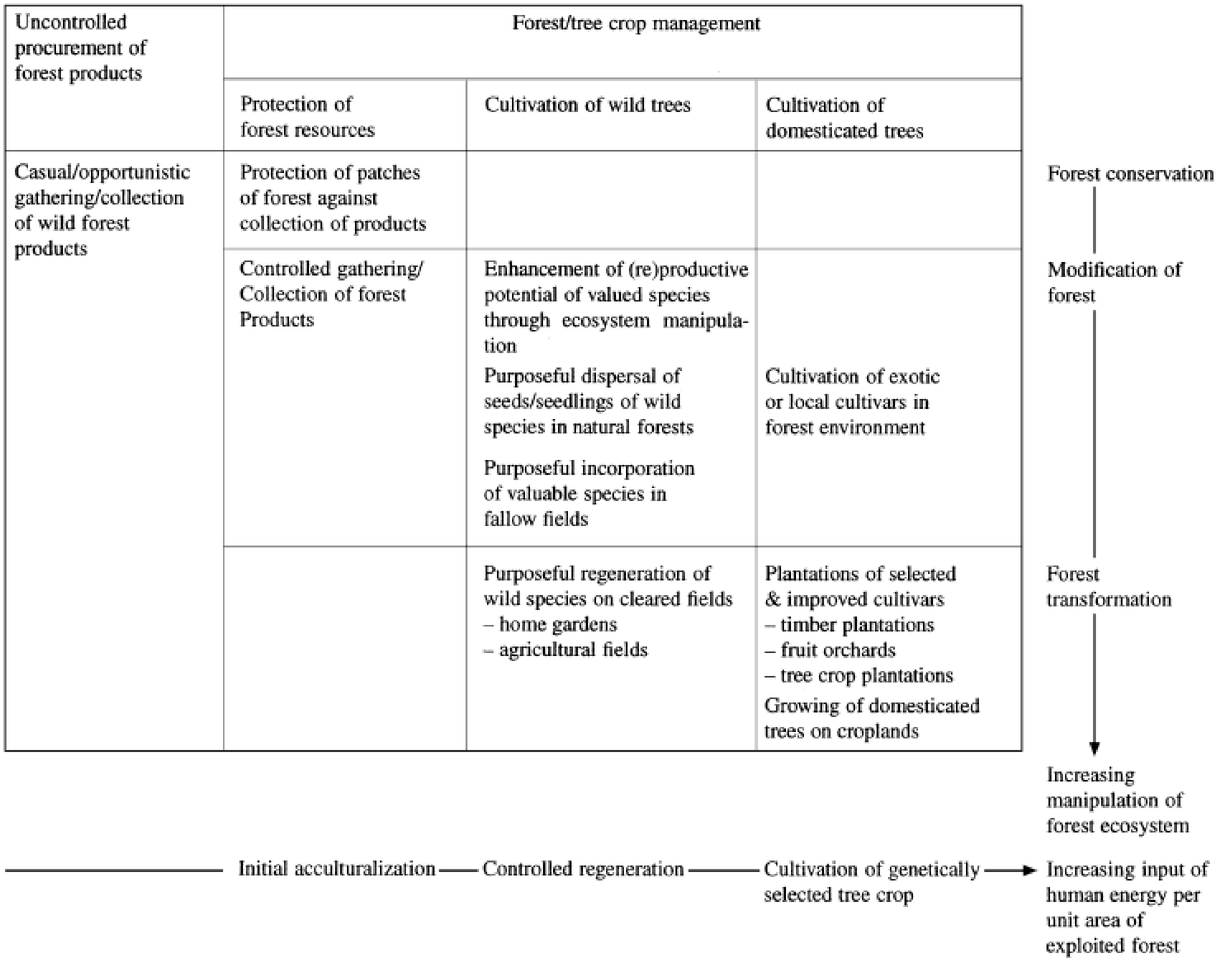

Figure 2-1. Wiersum's stages in forest management

Clement (1999), also addressed the varying intensities of ecosystem management, distinguishing, in order of intensity: 1)Pristine 2)Promoted 3)Managed 4)Cultivated: 4a)Swidden/Fallow, 4b)Monoculture.

Both the models as applied to plants and to ecosystems will prove useful in discussions on the edible plants listed below, particularly *Persea schiedeana*.

Within Mesoamerica, owing to the high diversity of plants in general, and economic plants in particular, estimated to be between 5000-7000 species (Casas et al. 2007) coupled with the high cultural diversity of the area (and relatively intact agricultural/ethnobotanical traditions), domestication has been and continues to be a prevalent theme in plant-human interactions.

Casas et al. (2007) noted that in Mesoamerica, "Domestication is a continuous ongoing evolutionary process, acting on incipient and semi-domesticated plants as well as on fully domesticated plants." They and other authors (Caballero et al. 1998) speculated that around 600-700 species are currently managed in forms that fall in the middle ground between wild and cultivated and allow researchers a unique opportunity to observe incipient domestication in process. These authors articulated the following categories for these plants that they considered to be managed *in situ*, that is the plants are being subjected to management and selection within their natural setting, not in highly domesticated agroecosystems. The first category is similar to that of Wiersum and other authors on the topics, wild gathering, or "systematic gathering" as they phrased it. They estimated that the management of 93% of all economic plant species in Mesoamerica is restricted to this low intensity/low selective pressure category. Secondly, they defined "let standing", the selective sparing of desired species (or phenotypes of a species) while clearing or burning an agroecosystem. Thirdly, they defined "encouraging growing", that is the intentional manipulation of an ecosystem to favor a species and/or the purposeful distribution of seeds or vegetative propagules to increase population density. Fourthly, they defined "protection", as "the deliberate elimination of competitors and predators of useful plants…" (Casas et al. 2007). All of the above mentioned management techniques occur *in situ* and would fall within the incipient cultivation category of Wiersum and between the categories of "promoted" and "managed" of Clement. Casas et al. (2007) reviewed the evidence that these subtler forms of selection and management increase the phenotypic and genetic frequency of desired traits and suggest that *in situ* domestication may be a critical part of the plant domestication puzzle. Other work along these lines (Leakey et al. 2004), corroborated their conclusions, and demonstrated what may be somewhat obvious; that humans through varying forms of management and various selective pressures affect the plants that hold interest for them, increasing the frequency of the desired traits. In the case of out crossing fruit trees, propagated by seed, this is referred to as truncated selection. Its important principles were well explained by Leakey et al. (2004):

> "Typically, trees are out-breeding and genetically very diverse due to the contribution of large numbers of individuals to a shared genepool and the free segregation of alleles during meiosis (Zobel and Talbert 1984). Consequently, the means of different wild sub-populations for any given trait can differ significantly in response to strong selection pressures or if these pressures are weak in the absence of geneflow, the range of variation in these sub-populations overlaps. In plant breeding, cycles of selecting and crossing between only the best individuals in the population (truncated selection), results in new progenies, which outperform their parents in the selected trait (Futuyma 1998). The degree of improvement depends on the narrow sense heritability (Stearns and Hockstra 2000). The domestication of a species must therefore result in changes in the frequency distribution of the values of the selected trait among the members of the population. During the course of several generations of truncated selection, the frequency distribution of the trait can be expected to change through a progression of stages that ultimately lead to the formation of a variety."

It is the truncated selection (quite similar in practice to recurrent selection) already carried out upon many Cinderella species by smallholder farmers during hundreds and thousands of years that the potential of participatory domestication rests upon. Excitingly, the promise of participatory is based upon a marriage of small farmer knowledge (which has historically been marginalized) accessed through ethnobotanical investigations and participatory techniques, and modern horticultural and breeding science.

In the next chapters, the themes, introduced above, of the varying stages of domestication of plants and ecosystems will be applied to the edible species in the Chinantla, Oaxaca, and particularly to the case of *Persea schiedeana*.

One last note in regards to the discussion of domestication need be addressed, for in the case of the Americas, it adds an additional twist on the wild-domesticated continuum of plants and landscapes. While typically thought of as a more or less linear process through time, beginning with human manipulation of a particular plant and ecosystem in the past with selective pressure increasing through time, progressing to the present where we encounter the plant at its current position along the trajectory of domestication and can attempt to retrace its journey, it is now apparent that much of the domestication of plant species and ecosystems was enormously altered upon the collapse of the human populations carrying out this management following the Conquest (Clement 1999, Lentz 2000, Mann 2005). There are numerous examples now of "wild" plants which appear in fact to be naturalized populations of past semi-domesticated species, and "wild" forests that are in fact living anthropogenic artifacts (Gómez-Pompa 1987, Gomez-Pompa et al. 1987, Gomez-Pompa et al. 1990, Clement 1999, Anderson 2003a, b). The road, particularly in the New World, of domestication is thus full of strange U-turns, cul-de-sacs, and start and stops.

CHAPTER 3
EDIBLE PLANTS OF THE CHINANTLA

In order to identify potential "Cinderella species" it was necessary to make an inventory of the edible plants of the study area. The information collected contributes to the incomplete ethnobotany of the area. Though numerous studies have been carried out in the Chinantla (Schultes 1941a, Lipp 1971, Martin and de Avila 1990, Martin 1996, Ticktin and Johns 2002, Caballero et al. 2004) much still remains to be documented in the area. Ethnobotanical work in the Chinantla serves to deepen our understanding of larger macro ethnobotanical patterns of use, as the Chinantla is embedded in a greater area of high biological and cultural diversity, southeastern Mexico, that shares biogeographical (Alcantara et al. 2002) and cultural/agricultural histories (Hernandez Xolocotzi 1953) with the Chinantla. These adjacent areas, the Sierra Norte of Puebla, the flanks of Orizaba, the Chimalapas, and the cloud forests in the highlands of Chiapas (which in turn link with cloud forests and tropical montane forests of Central America) share present ecological conditions with the Chinantla, specifically abrupt mountains facing the warm and wet air masses coming off the Gulf of Mexico/Atlantic (Martin 1996; Bandeira et al. 2005). The Chinantla is biologically and culturally a bridge between these belts of forests to the north and south of it and shares many species (both wild species and those with histories of interaction with humans) and agricultural systems with these areas. Hernandez Xolocotzi (1953) coined this macro area as the eastern escarpment agricultural region.

Freelists

The first method used to elicit information in regards to edible plants was through free lists, a technique widely employed in anthropology and ethnobotany to determine the "domain" that one is researching (Bernard 1994, Castaneda and Stepp 2008). Initially attempts were made to elicit free lists with the question "What are the edible plants that grow here?" It soon became apparent, however, that plant, or "plantas" in Spanish was not a neutral word as in English but referred specifically to edible greens. After being unsuccessful at finding a way to elicit all edible plant types at once, two free list exercises were settled upon, focused upon two of the plant categories of most interest and importance, fruits and quelites (edible greens). The first free-list exercise asked the question, "What fruits grow here?" and the second, "What quelites grow here?" (Cuales frutas se dan aca? Cuales quelites se dan aca?).

In response to the question of "What fruits grow here?" sixty-three fruit species were mentioned by the fifteen respondents. Table 3-1 shows the 25 most frequently mentioned fruits and Appendix A shows the entire free list of elicited fruits.

Sixteen of the top twenty-five mentioned fruits listed are either of local origin or according to botanical studies appear to have been present in the region for a considerable time previous to the Conquest. Notably, avocado appeared with the forth-highest frequency, with 93% of the respondents listing it and chinene (Persea schiedeana) with the 6th highest frequency, with 80% of respondents mentioning it. These two *Persea* were the highest listed native fruit species, demonstrating the importance of them both in the cognitive domain of "fruit" in the Chinantla.

In terms of quelites, the response to the question of "What quelites produce here?" elicited a list of twenty "edible greens" from thirteen respondents, with the top six being mentioned by five or more informants. *Hierba mora*, *Huele de noche*, *Quelite de Venado,* and *Quintonil* are especially important in the cognitive domain of "quelites". Table 3-2 lists the top nine quelites elicited in the free listing.

Table 3-1. Most frequently mentioned fruits*

Common Name Spanish	Common Name English	Taxonomic nomenclature	Response Freq.	%	Smith's S
Naranja	Orange	*Citrus x aurantium (sweet orange group)*	15	100	0.93
Platano	Banana/Plantain	*Musa acuminata &* M. acuminata x M. balbisiana.	14	93	0.71
Mango	Mango	*Mangifera indica*	13	87	0.65
Aguacate	Avocado	*Persea americana*	14	93	0.59
Chinene	Chinene	*Persea schiedeana*	12	80	0.48
Mamey	Mamey Sapote	*Pouteria sapota*	12	80	0.41
Coco	Coconut	*Cocos nucifera*	11	73	0.40
Jinicuile	Ice Cream Bean	*Inga jinicuil*	11	73	0.37
Nance	Nance	*Byrsonima crassifolia*	12	80	0.36
Cacao	Cacao	*Theobroma cacao*	13	87	0.35
Papaya	Papaya	*Carica papaya*	9	60	0.34
Guanabana	Soursop	*Annona muricata*	9	60	0.33
Guayaba	Guava	*Psidium guajava*	10	67	0.31
Anona	Custard Apple	*Annona reticulata*	11	73	0.30
Limon Dulce	Lemon	*Citrus limon*	5	33	0.24
Mandarina	Mandarine	*Citrus reticulata*	4	27	0.20
Limon	Lime	*Citrus aurantifolia*	5	33	0.19
Chico Sapote	Sapodilla	*Manilkara sapota*	8	53	0.19
Yuca	Manioc	*Manihot esculenta*	4	27	0.16
Camote	Sweet Potato	*Ipomoea batatas*	4	27	0.16
Guaye	Leucaena	*Lueceana esculenta*	5	33	0.14
Ilama	Illama	*Annona diversifolia*	5	33	0.13
Ciruela	Hogplum	*Spondias purperea*	4	27	0.12
Carambola	Star Fruit	*Averrhoa carambola*	6	40	0.11
Cacao Blanco	Tiger Cacao	*Theobroma bicolor*	5	33	0.07

*Smiths' S is a measurement that combines the frequency with which an item is listed with its average ranking in the lists (Bernard 1994, Castaneda and Stepp 2008)

Table 3-2. Quelites mentioned during free listing

Common Name Spanish	Common Name English	Taxonomic nomenclature	# of times listed	% of informants to list	Smith's S
Hierba Mora	Nightshade	*Solanum nigrescens & S. americanum*	13	100	0.90
Huele de Noche	Night-blooming Jessamine	*Cestrum nocturnum*	11	85	0.55
Quelite de Venado	Morning glory	*Ipomea sp.*	8	62	0.44
Quintonil	Amaranth, Pigweed	*Amaranthus hybridus*	8	62	0.39
Guia de Calabaza	Squash Vine	*Cucurbita spp.*	6	46	0.19
Guia de Chayote	Chayote Vine	*Sechium edule*	5	38	0.12
Verdolaga	Purslane	*Portulaca oleracea*	3	23	0.11
Nopal	Prickly Pear	*Nopalea cochenillifera*	3	23	0.09
Papalo Quelite	Quilquena	*Porophyllum ruderale*	2	15	0.04

A third free list was generated on a small scale (8 respondants) in regards to the most economically important edible plant species. Table 3-3 shows those species listed.

Table 3-3. Economically important species

Common Name	# of times listed	% of informants to list	Smith's S
Coffee	5	63	0.63
Maize	4	50	0.33
Chocolate	4	50	0.46
Banana	4	50	0.27
Orange	2	25	0.18

The top species listed, not surprisingly, is coffee, while the 3rd species, less expectedly, was cacao. Although it did not show up on the limited free lists of income, a relative of cacao appears to be of increasing importance it terms of income generation, *Theobroma bicolor* (see discussion below).

Inventories

Agroecosystems

To gain further understanding of the edible species in the region, and where they are found, fifty inventories were made in the various agroecosytems of the area. Through casual conversation and observation, the following five major agroecosystems were delineated: home garden, coffee grove, cacao grove, pasture/ranch, milpa (swidden corn patch).

The home gardens are multistrata systems surrounding the dwelling area and are frequently composed of almost exclusively edible (or otherwise economic) plants. Plants in the home gardens are sometimes purposely sown or transplanted, while other times they arise spontaneously from discarded seeds and are subsequently tolerated and/or encouraged. The main management that occurs in the home gardens is frequent clearing and weeding of unwanted vegetation. This vegetation along with raked leaves and fallen branches of the desired species are then burned. The ash is generally not spread intentionally but through traffic of animals and humans gets locally distributed and is later utilized as a planting area. Animals, especially chicken and turkeys are frequently free roaming in the home gardens, although there are efforts by NGOs and governmental health agency to encourage people to keep their poultry confined for sanitary purposes.

The coffee groves are located sporadically in first and second growth forest, beginning at the edge of the village and to a distance of a three hour walk away. Coffee bushes are frequently transplanted into older second growth forest that is selectively thinned to maintain shade trees that are desirable for their nutrient inputs (especially two species of Inga), for their edible fruits (such as Persea schiedeana and *Pouteria sapota*), or for the firewood or timber they will provide (such as Cedrela odorata). As the coffee grove matures, further manipulation of the shade strata is carried out through the introduction of more economic species by transplant or seed and by continued selective thinning of both juvenile and older trees. The lower canopy is managed in the same way, through transplanting or seeding desired shade tolerant species, and/or leaving spontaneously arising individuals while cleaning of the under story is carried out. In the coffee groves, we thus see a number of plant management techniques being carried out: cultivation, let standing, protection, and enrichment. Only one cacao grove was encountered, its architecture was similar to that of the coffee grove. Numerous studies have been carried out documenting the shade species utilized in Mesoamerican coffee groves (Moguel and Toledo 1999, Bandeira et al. 2005, Martínez et al. 2007, Soto-Pinto et al. 2007), while other studies have demonstrated that while not necessarily as ideal as natural forests, coffee groves do host considerable amounts of biodiversity and when managed so as to have a high diversity of shade species, can serve both the function of conservation and income generation (Gordon et al. 2007).

The agroecosystems of pasture and rancho were combined as they are frequently inseparable in the field. The rancho is an area within the pasture where more intensive cultivation of economic species is carried out, sometimes in an area from which cattle are excluded by fencing. The rancho then bleeds into the actual pasture as the fence lines of the larger pasture are generally planted with economic species, sometimes serving as living fence posts. Other trees serve as shade for livestock. As in the coffee groves, when an area is cleared for pasture/rancho, a selective thinning takes places so that desirable trees are left standing. Later both transplanting and seeding occur with the pasture and rancho proper.

The milpa is that area where annual crops, principally maize, beans, squash, quelites, tomatoes, and gourds are planted and/or tolerated. The area in which milpa is to be planted is generally cleared completely of tree cover which is then burned, typical of the system of slash and burn (or roza, tumba, qema). However, some trees are left that are deemed valuable enough to spare (as was reported with Persea schiedeana). Such spared trees are protected so that the fire does not burn too near them by creating a firebreak around the trees. As the milpa is planted with maize, its principal crop, other seeds are sown (such as beans, squash, gourds), while others are cast (such as tomatoes and quelites). As the milpa develops selective weeding occurs (with machete and now in some instances with herbicide). The desired species that were sown (and those which arise spontaneously from the seed bank, as many quelites are reported to do) are protected from competition with weeds. Again, in the milpa we see the concurrent execution of various management techniques, from let standing to tolerated, enriched, protected, and cultivated. Two cycles of milpa are planted in the Chinantla, the main planting, the “temporal”, lasting from June – November, and a second, sporadically planted crop, the “tonamil” from

December to May. Typically fields are planted only once and then left fallow for five to ten years (Bevan 1938, van der Wal et al. 2006).

Edible Species Categories

The edible species were divided into the following categories; fruit, quelite, condiment, non-leafy vegetable, grain, tuber, beverage, and utensil. Even though many species fulfill more than one of the roles, each species was listed once in what seemed the dominant use category. Around ninety species in total were encountered. Table 3-4 shows the fruits encountered listed in descending order of abundance, a "0" signifies that the species was not seen during the inventories, but spotted casually at another time in the area. Table 3-5 show the quelites most frequently encountered. Appendix B shows all species encountered, Appendix C the percentage of each agroecosystem containing the species, and Appendix D the number of individuals of each species encountered in each agroecosystem.

Table 3-4. Fruits encountered in inventory in order of abundance

Genus	species	Common name Spanish	Total #
Citrus	*x aurantium (sweet orange group)*	Citrus	219
Musa	*acuminata/balbisiana.*	Platano	196
Attalea	*cohune*	Coyol	87
Cocos	*nucifera*	Coconut	77
Mangifera	*indica*	Mango	73
Persea	*americana*	Aguacate	67
Ardisia	*compressa*	Uvita	49
Inga	*jinicuil*	Jinicuile	49
Byrsonima	*crassifolia*	Nance	38
Psidium	*guajava*	Guayaba	29
Annona	*muricata*	Guanabana	27
Pouteria	*sapota*	SapoteMamey	27
Annona	*diversifolia*	Illama	22
Carica	*papaya*	Papaya	22

Table 3-4. Continued

Ananas	*cosmosus*	Pina	20
Annona	*reticulata*	Annona	19
Persea	*schiedeana*	Chinene	16
Atrocarpus	*heterophyllus*	Castana	10
Tamarindus	*indica*	Tamarindo	9
Litchi	*chinensis*	Litchi	7
Manilkara	*sapota*	Chico sapote	7
Eriobotrya	*japonica*	Nispero	4
Persea	americana (Mexican race)	Aguacatillo	4
Vitus	*sp.*	uva	4
Couepia	*polyandra*	caca de nino	3
Muntingia	*calabura*	Capulin	3
Spondias	*purpurea*	Ciruela	3
Terminalia	*catalpa*	Almendra	2
Parathesis	*psychotrioides*	Uvita (longer leaf)	1
Acrocomia	*aculeata*	Coyol de espina	1
Averrhoa	*carambola*	Carambola	1
Beilschmedia	*anay*	Aguacate dulce	1
Morinda	*citrifolia*	Noni	1
Passiflora	*edulis*	Palao	1
Diospyros	*digyna*	Sapote negro	0
Punica	*granatum*	Granada	0
Syzygium	*jambos*	Poma rosa	0

Table 3-5. Quelites encountered in inventory in order of abundance

Taxonomic name	Spanish common name	Total #
Cestrum nocturnum	Huele de noche	177
Solanum americanum & S. nigrescens.	Hierba mora	63
Phytolacca icosandra	??	7
Amaranthus hybridus	Quintonil, quelite blanco	5
Ipomea sp.	Quelite de venado	5
Erythrina sp.	Coraline, quelite boracho	1
Crotalaria sp.	Chipil	1
Portulaca oleracea	Verdolaga	0

Cinderella Species of the Chinantla

Of interest in this study, are those indigenous species, especially fruits, found in relatively high numbers, specifically in home gardens and in coffee/cacao groves. Those species that are important locally but are little known outside of the region, are Cinderella species, which are worthy of further study and potential candidates for participatory breeding projects.

A few of the indigenous fruits encountered in highest numbers were identified as especially of interest and are discussed below.

Due to community and researcher interest in *Persea schiedeana*, it was singled out for further research and is discussed in detail in the next chapter. Sixteen *Persea schiedeana* trees were encountered during the inventories; 75% of these were in coffee groves, 19% in home gardens, 6% in rancho/pasture, while it was absent in milpas. Thirty six percent of the total coffee groves surveyed were found to have at least one chinene. This demonstrates that *Persea schiedeana* is an important shade tree species in the Chinantla, as it is also in Chiapas (Soto-Pinto et al. 2007) and Puebla (Martínez et al. 2007). As demonstrated in free lists (as the second most frequently mentioned native species after *P. americana*), this species is important in the cognitive domain of fruits.

Two species of Myrsinaceae, *Ardisia compressa* and *Parathesis psychotrioides* which were respectively found in 31% and 8% of the home gardens, are of interest owing to the phytochemicals found in other members of the genus *Ardisia* and the wide medicinal use of species in this genus (Kobayashi and de Mejia 2005). Typically considered a children's food in the Chinantla, these fruits are commercialized locally in neighboring Veracruz. Further study of the taxonomy, production, and the chemistry of these species, along with appropriate marketing could create a marketable export nutraceutical type fruit pulp product, as *acai* has become in Brazil and camu camu in Peru (Penn 2008).

Cacao blanco (*Theobroma bicolor*) was one of indigenous species encountered in highest numbers. It was found in 69% of home gardens (equally as frequently as *T. cacao*) but at a higher frequency than *T. cacao* in coffee groves (43% frequency vs. 7% for *T. cacao*). Given the recent interest in specialty chocolates this species could be promoted more. The beginning stages of such work have been initiated and an artisanal chocolate producer in Toronto, Chocosol, has begun to import *Theobroma bicolor* from a village in the Chinantla located near the villages of this study. Locally and regionally, *Theobroma bicolor* is already important. A mixture of *Theobroma cacao* and *Theobroma bicolor* (called cacao blanco, cacao cimmaron, or cacao de tigre), along with *Zea mays* and the masticated shoot tips of a saponin containing *Smilax* sp. are made into the regionally important drink, *Popo*. As the drink has become less ritualized and consumed more frequently, demand for *Theobroma bicolor* has risen such that in March to July 2008 prices for cacao blanco were 35-60 pesos/kilo ($3.50-$6 USD) while for cacao they were 10-30 pesos/kilo ($1-$3 USD). *Theobroma bicolor* is also sent to the central valley of Oaxaca where it is utilized in other regional drinks, one called tejate (which contains maize, *T. cacao*, *T.bicolor*, the seeds of *Pouteria sapota*, and the flowers of *Quararibea funebris*), the other chocolate atole or chocolate espumita (which contains *T. bicolor*, *T. cacao,* wheat, and cinnamon) (Soleri and Cleveland 2007). Local and regional markets for *Theobroma bicolor* are enticing enough for small holders to have begun planting more trees. Given the recent interest in export markets for fine and special chocolates, it would seem that integrating the story and flavor of *Theobroma bicolor*, could be promising.

Further research into the genetic and morphological diversity of local cacao (*T. cacao*) varieties is of great interest as well. Should any prove to be old, pre-Hispanic *crillo* cultivars, specialty marketing of such beans and/or processed products could prove lucrative. The interest in and price for single origin, criollo cacao beans appears poised to continue growing (Rosenblum 2005).

The importance of quelites suggested in the free list interviews is further corroborated by the high levels of occurrence in the inventories, particularly in the milpa, 100% of which contained them, and in the home gardens, in 92% of which they were found. The most abundant species in the inventories were those mentioned most frequently in the free lists, i.e. *Amaranthus hybridus, Solanum americanum, Solanum nigrescens,* and *Cestrum nocturnum*. These and ca. 20 other species that were reported in the free lists to be utilized for the edible greens were reported by residents to be an extremely important part of the local diet, both as an easily obtainable food to accompany tortillas when other food is scarce, and for the nutritional/medicinal qualities they are believed to possess. Informants frequently attributed the longevity and health of older generations to their high consumption of quelites. Quelites have been studied elsewhere in Mexico and are promising in regards to their role in nutritional security and potentially as an income generator, as they are easily "grown", nutrient rich (Ovando et al. 2003) and well adapted companion crops in milpas, coffee groves, and home gardens (Bye Jr 1981, Pico and Nuez 2000, Vazquez-Garcia et al. 2004, Casas et al. 2007). It is interesting to contemplate where quelites fit on the wild to domesticated continuum. They are essentially weeds, and thus could be called "incidentally co-evolved" in Clement's scheme (Clement 1999). However, all of the management techniques of Casas et al. (2007) are applicable to these species, "let standing", "encourage growing", and "protection". Seemingly, human management and selection for the more palatable genotypes has influenced these species. Interestingly, at times seeds are strewn into milpas, or in the case of *Cestrum nocturnum*, cuttings are inserted into the ground, and yet at other times, plants emerge spontaneously from the seed bank, thus straddling the categories tolerated/protected and cultivated/encouraged. While marketed widely throughout Mexico, the villages in the study do not market their quelites, though nearby markets are worth investigating.

Owing to the information of its place on free lists of fruits from the region and its position in inventories, as well as discussions with local residents, it appears accurate to regard *Persea schiedeana* as a “Cinderella species” and to regard it as warranting further investigation. This, along with community and researcher interest, resulted in the commencement of a participatory domestication project and the documentation of the resources of *Persea schiedeana* in the region. One of the necessary steps for underutilized fruit crops like Persea schiedeana to be brought into wider cultivation is to promote the use of superior selections through grafting (Popenoe 1952, Akinnifesi et al. 2008). Popenoe wrote, “..with regards to numerous species, particularly native ones, man has failed to take advantage of the simplest means at his command for improving them. That is to say, he has not had recourse to vegetative propagation”(Popenoe 1952). In addition to allowing for the propagation of superior varieties, grafting has the additional advantage of greatly reducing the juvenility period, thus reducing the time before the harvesting of fruit can commence.

CHAPTER 4
PERSEA SCHIEDEANA (CHINENE): ETHNOBOTANY, LOCAL MANAGEMENT, AND MORPHOLOGICAL DIVERSITY

Persea schiedeana is a member of Lauraceae, a large, magnoliid family, widely distributed in the tropics and subtropics, with around 50 genera and 2550 species (Mabberly 2008).

The genus *Persea* is typically described as a large, heterogeneous genus of ca. 200 species found mostly in the northern hemisphere (Mabberley 2008) in the Asian tropics and subtropics, the Neotropics and the Canary Islands (1 species) (van der Werff 2002). The taxonomy of the genus is in constant debate and revision. The Neotropical *Persea* were divided by Kopp (1966) into two groups, i.e. sub genus *Persea* (referred to as avocados) and subgenus *Eriodaphne* (referred to as ‘aguacatillos’), which are sexually incompatible. Many still recognize these two groups (Scora et al. 2002). In the work of van der Werff (2002), using morphological traits (but not cladistic analysis) to group all of the Central American species, both wild and cultivated, of *Persea* he recognized the two sub generic groups of Kopp, but added two other groups for various species not conforming to the delineations of sub. *Persea* and sub. *Eriodaphne*, commenting “the seemingly clear division of Neotropical *Persea* into two sub genera can no longer be maintained” (van der Werff 2002). Thus in van der Werff’s work we are left with four sub-genera. In recent phylogenetic work (using cladisitic analysis based on morphological traits of a restricted number of species), it was proposed that Neotropical *Persea* is not a monophyletic group and that while the clades sub. *Eriodaphne* and sub. *Persea* exist they are more distantly related than previously supposed and that they should be recognized as separate genera (Rojas et al. 2007). They proposed that a constricted *Persea* clade appears more closely related to genera *Nectandra* and *Ocotea* than *Eriodaphne* (Rojas et al. 2007). The proposed genus *Persea* sensu stricto includes *Persea schiedeana*, along with the West Indian race of avocado (*Persea* *americana*), Mexican race of avocado (*P. drymifolia*) and the Guatemalan race of avocado (*P. guatamalensis*) and wild relatives(Rojas et al. 2007).

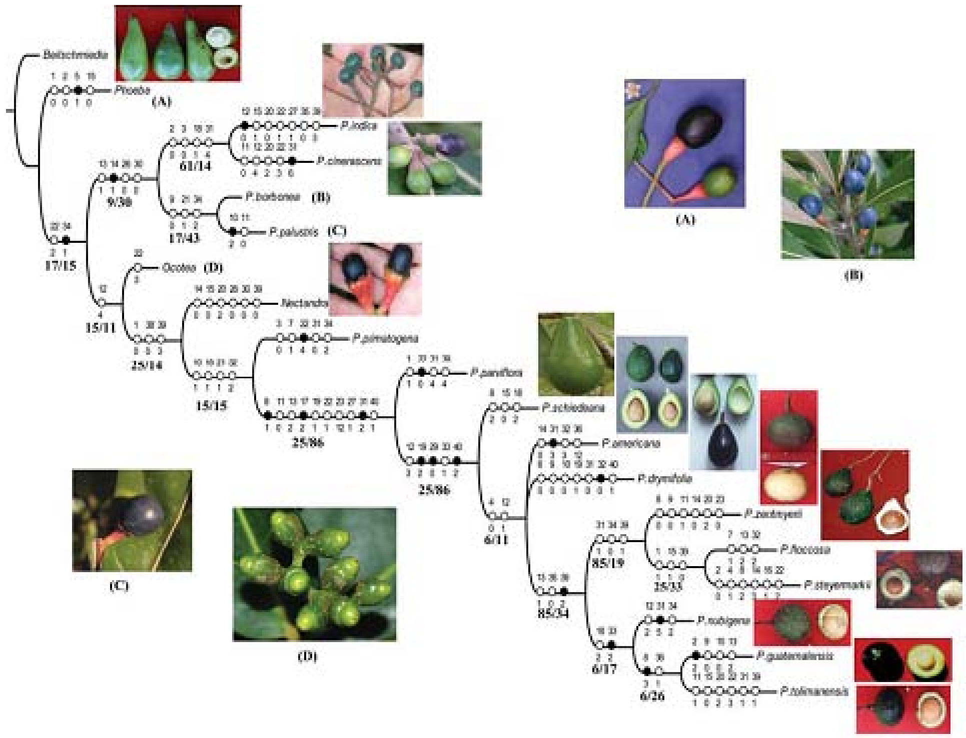

Figure 4-1. Phylogenetic analysis of Neotropical *Persea* from Rojas et al., 2007: "Strict consensus of the five equally parsimonious trees for Persea taxa based on morphological characters. Length = 181,consistency index = 39 and retention index = 60. Synapomorphies are black circles and homoplasies are open circles. Bootstrap/jackknife percentages are given below branches"

Despite nearly one hundred years of avocado exploration and research, beginning with the works of Wilson Popenoe (1920, 1935), followed by Standley (1961), Kopp (1966), Smith (1966, 1969),Williams (1977), Schieber and Zentmeyer (1977), and continued into the present, utilizing modern phylogenetic (Rojas et al. 2007) and molecular techniques (Ashworth and Clegg 2003, Borrone et al. 2007) the exact delineations of *Persea* and its component species and their relationships among one another remain murky and constantly shifting. The family Lauraceae and the genus *Persea* are regarded as difficult to classify, a fact which has been further complicated by the long history of human interaction with a number of species of *Persea*

(Lorea-Hernández 2002, Scora et al. 2002, Galindo-Tovar et al. 2008). Multiple authors have noted that much of the morphological diversity within a broadly defined *Persea americana* is due to human influence (Popenoe, 1935; van der Werff, 2002), this is likely true of related species as well (Brücher 1989).

Long recognized, if not perfectly understood or delineated are the three cultivated groups, varyingly referred to as "varieties", "races", "species", or "subspecies" (depending on the source and classification) of avocado; the Mexican variety, the Guatemalan variety, and the West Indian variety (Popenoe 1920). Indeed, these three types of avocado appear to have been recognized in pre Colombian times, being named differently as *ahuacatl* or *ahuacacuahuitl*, *tlacazolahuacatl*, and *quilahuacatl* (Sahagún and Temprano 2000). The different races and their differing geographies were also were also recognized by early Spanish chroniclers, including Friar Bernabe Cobo (Cobo 1890-95). A number of thorough descriptions of the traits defining these groups and speculations on their respective places of origin are available, including the following compiled using various sources by avocadosource.com (2009):

MEXICAN RACE. Leaves anise-scented; under-surfaces more glaucous (whitened with a bloom). Flowers generally more pubescent (hairy); bloom earliest in the season. Fruit small. Fruit skin thin to membranous, rarely over 0.75 mm. Seed relatively large to very large, and often loose. Fruit pulp commonly rich to strong in flavor, sometimes with anise aroma; often fibrous. About six months from flowering the fruit reaches maturity. The most cold hardy of the avocado races; also more resistant to heat and low humidity. The least tolerant to soil salinity. Rarely does well in coastal environment.

WEST INDIAN RACE. No anise leaf scent. Fruit small to large. Fruit skin leathery, seldom over 1.5 mm. Seed relatively large; sometimes loose in its cavity. Pulp milk to watery in flavor; lower oil content than other two races. About six months from flowering to fruit maturity. The least hardy of the three races to cold and to low humidity, not adapted to anywhere in California. The most tolerant to soil salinity, as either rootstock or top. At point of fruit attachment, the pedicels have a unique nail head configuration.

GUATEMALAN RACE. No anise leaf scent. Young foliage more commonly reddish. Fruits small to large. In adaptation and tolerance to soil and climate, intermediate between the above two races. The fruit skin is usually thick and leathery to woody, sometimes over 6 mm. Seed almost never loose in its cavity. Fruit may require a year from bloom to maturity.

Confusingly, the relationships among these three races and to allied wild species remain unclear. The current consensus seems to be that the three cultivated races (var. *americana* Mill. 'West Indian', var. *guatemalensis* Williams 'Guatemalan', var. *drymifolia* (Schlecht. and Cham.) Blake 'Mexican' (Scora et al. 2002, Scora and Bergh 1990) along with the wild ecotypes, var. *floccosa* Mez, var.*steyermarkii* Allen, var. *tolimanensis,* var. *zentmyerii* and var. *nubigena* (Williams) Kopp. are all varieties of a broadly defined *Persea americana* (Litz et al. 2005, Borrone et al. 2007). However, the latest phylogenetic work proposes that the above-mentioned cultivated races and wild varieties can be recognized on the basis of morphological traits as distinct species and form a clade, which is sister to *Persea schiedeana* (Rojas et al. 2007). The relationships among these "species" (or races or varieties) are not clear and the decision of how to define each of these groups, as species or varieties may ultimately come down to ones' taxonomic philosophy, species concept, and purpose. That the groupings exist in nature is supported by morphological as well as molecular data and is not contested, rather how to name them or rank them is of contention and their exact relationship to one another.

Recent molecular work has not clarified the situation, but shows three clusters, representing the three races of avocado and numerous inter-racial hybrids (Ashworth and Clegg 2003). (See Figure 4-2 below).

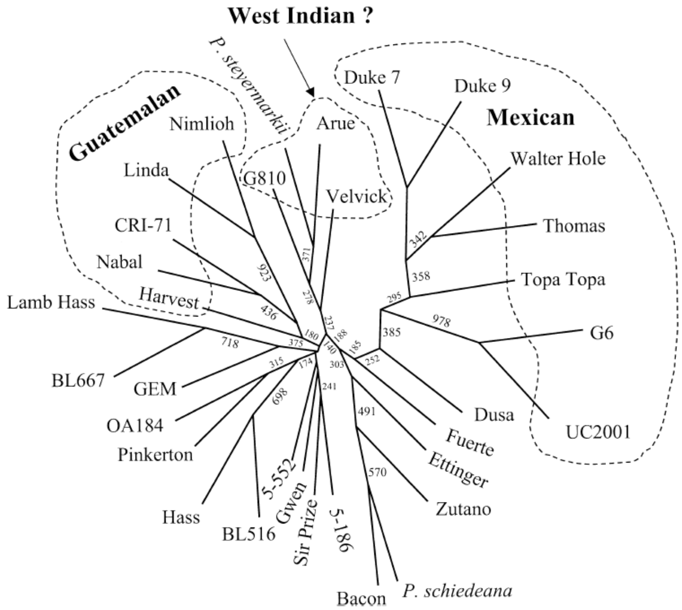

Figure 4-2. Results of molecular analysis by Ashworth and Clegg (2003): "Neighbor-joining consensus tree of 1,000 bootstrap replicates generated from allele frequencies at 25 microsatellite loci for 33 avocado genotypes. Many bootstrap values are low, reflecting the large number of hybrid cultivars in the data set. Dotted lines surround genotype assemblages belonging to the three botanical races of avocado—Guatemalan, Mexican, and West Indian. The West Indian cluster is assigned based on cv. Arue, whose ancestry is presumed to be West Indian. Intermediate clusters unite genotypes of various hybrid origins."

This study is far from perfect, utilizing too few samples and known hybrids. The tree produced is unclear because it is unrooted. However, is does appear to show the molecular basis for the three cultivated groups and to also demonstrate that both among the three cultivated races and *Persea schiedeana* hybridization has occurred in the past and continues to occur, whether owing to natural overlap and/or human manipulation. The history of the domestication of in avocados is, thus, very difficult to elucidate. In fact, it may be artificial to divide a very broadly defined *Persea americana* into varieties, sub species, or separate species. They may be ecotypes and/or biological artifacts of human selection, as seems to perhaps be the case with a number of semi-domesticated Neotropical fruit species (Galindo-Tovar et al. 2008). It is important to keep in mind that the evolution of these species is a dynamic process and any attempt to classify them can only provide a snap shot of the present. Suffice it to say, for the purposes of this paper that *Persea schiedeana* is very closely related to *Persea americana* with which it can and has hybridized, as seen in the rootstock 'Martin Grande' G755a and documented by (Ellstrand et al.1986) and is an important Neotropical fruit in its own right. It is also an important species in the biological and cultural history (and future) of the edible avocados.

In addition to the avocado, which has been and continues to be an important food source in the Neotropics (and now throughout the world), numerous of its relatives are collected from the wild and eaten locally in the Neotropics (Smith et al. 1992, Caballero et al. 2004). The *chinene* (*Persea schiedeana*), also known as *yas* or *coyo*, is one of the most widespread and significant of these, and yet remains an under-recognized and under-studied fruit whose genetic and commercial potentials have yet to be exploited fully. In the Chinantla, some of the wild avocado relatives that are eaten are wild harvested from forested areas, others such as *Beilschmiedia anay* (*anay, escalan*) (Borys et al. 1993) and Persea americana are only found in cultivation. Meanwhile, throughout its range in the Neotropics *chinene* is both wild harvested from forested areas and cultivated/semi-cultivated in home gardens and in shaded coffee and cacao plantings (Popenoe 1920, Popenoe 1935, Stanley and Steyermark 1946-, Williams 1977, Brücher 1989, Smith et al. 1992, Cruz Castillo et al. 2004b, Bandeira et al. 2005, Martínez et al. 2007, Tenorio et al. 2008).

Occurring chiefly along the Gulf facing slopes of the Sierra Madre Oriental from Tamaulipas to Chiapas in Mexico, the range of *Persea schiedeana* continues southwards with confirmed records from Guatemala, Honduras, El Salvador, Costa Rica, Panama, and Colombia (Kopp 1966, Barrientos-Priego and López-López 2000) and reports from the Ecuador-Colombia border. Throughout its range, which is typically from 90m to 2000m (Martinez et al. 2007), *Persea schiedeana* is named, eaten, and semi-cultivated in home gardens and in coffee and cacao plantings by campesinos, as it is in Mexico. Lists of the numerous native names are given in Morton (1987) and more thoroughly in Smith et al. (1992).

A recent revision of the floras of Mesoamerica and Central America, show it listed in Mexico (Standley 1961), Guatemala (Standley and Steyermark 1946-), the Lancetilla Valley of Honduras (Standley 1931), Costa Rica (Standley 1938, Hammel 2003), and Panama (Correa A. et al. 2004). Standley and Steyermark (1946-) write, reflective of many of the entries in floras:

> Called "yas" in Costa Rica, "chuti" in Honduras, and "chinini" in southern Mexico. The tree is common in the mountain forests of various parts of Guatemala, but especially in the mountains of Alta Verapaz. The trees lose their leaves during the dry season. They usually are left when forest is cleared and often are plentiful in pastures. The fruit varies greatly in quality, that of most wild trees being unpleasantly fibrous and having scant flesh. However, the flavor is so good that the fruit is much appreciated, and it is sold commonly in the markets during its relatively brief season. Some trees have large fruits in which the fiber is not conspicuous. Occasionally the trees are planted in *fincas* but most of the fruit is harvested from wild trees.

Despite its widespread use among rural populations, and the localized commerce of it in these areas, where it is highly regarded and sometimes preferred over other avocados, at times fetching prices equal to or greater than avocados in local markets (Smith et al. 1992, Cruz-Castillo et al. 2007b) this species has largely been ignored as a potential fruit for more widespread production and improvement (Cruz Castillo et al. 2004a). Whereas avocados are now found throughout the tropics and subtropics of the world and are a major agricultural commodity, chinene is unknown outside of its native range. Perplexingly, as a fruit crop in its' own right it has been overlooked or dismissed. Jorge Leon, in Botanica de los Cultivos Tropicales, after four pages about avocado, comments only that the mesocarp of *P. schiedeana* is thinner than that of *P. americana*, the seed larger, and the flavor of the pulp less pleasant (León 2000). Julia Morton offers it a bit more consideration, commenting, "..the flesh is oily with a milky juice, few to many coarse fibers, but a very appealing avocado-coconut flavor. The seed is very large."(Morton 1987). Smith et al.(1992) offer it the most attention yet given in English, recognizing its importance in local diets and markets and noting, "This minor crop could become more important if selections were made for large, high-yielding and good-tasting fruits that travel well."

Most of the attention *Persea schiedeana* has received has been as a source for resistance to root rot (*Phytophthora cinnamomi*) in breeding programs for *P. americana* or for its potential as a root stock for this species with *Phytophtora* resistance and tolerance of heavy, wet soils (Coffey 1987). Root rot is currently the single most significant threat to avocado cultivation globally (Litz et al. 2005). The cultivar Martin Grande or G755a, collected in Coban, Guatemala in 1977, appears to be of hybrid origin between a Guatemalan race avocado and *P. schiedeana* (Ellstrand et al. 1986) and appears to possess "as much resistance to *Phytophthora cinnamomi* as any compatible line known" (Lahav and Lavi 2002). However, initial hopes for this rootstock have not been borne out, as the yields of commercial varieties grafted on to it have proven to be too low for commercial production (Lahav and Lavi 2002). Experiences contrary to this, however, were reported from South Africa (Schroeder 1974). New work with *P. schiedeana* as a rootstock for Hass avocado is currently taking place in Veracruz, Mexico where it is thought that the tolerance of *P. schiedeana* to heavy clay soils will be advantageous (Fernandez per. comm. 2009).

Recently, work on *Persea schiedeana* has been undertaken in Mexico to survey the ecophytogeography of the species and to characterize the diversity of fruit forms found in Veracruz and Tabasco (Cruz Castillo et al. 2004a, Cruz-Castillo et al. 2007a, Cruz-Castillo et al. 2007b, Martinez et al. 2007, Tenorio et al. 2008). Work has also been undertaken to determine the oil contents and components of chinene (Cruz-Castillo et al. 2007a, Martinez et al. 2007). This work contributes to the beginning stages of an effort to improve/further domesticate chinene (Cruz-Castillo et al. 2007b).

Much that was written in the early to middle 20th century in regards to avocado is applicable to the present situation of *Persea schiedeana*, such as high variability, almost exclusive seed propagation, lack of named varieties, incomplete understanding of phenology and biology, and lack of recognition outside of regions in which it is produced for self consumption or at best sale to local markets (Popenoe 1920). The confounding role of past human selection and movement likewise applies to *P. schiedeana* as it does to *P. americana*. Williams (1977) writes:

> The tree has undoubtedly been in cultivation, or semi-cultivation, for a long period of time. The fruits are large and much used for food although inferior to true avocados. The variations in the fruits, in the vegetative structure and in the tree itself are rather great as might be expected in a seedling plant that has been selected for superior fruits over a long period of time…How much of [its] range is natural and how much due to man is impossible to say. The tree is capable of invading a forest situation and does well on open slopes or in old fields. The altitudinal range in which it does well is rather great, from near sea level to nearly 2,000m.

Later, Brucher (1989) comments, “Its present dispersal from Mexico-Guatemala to Costa Rica, Panama and Colombia may have been influenced by migrating Indians in early times.”

Persea schiedeana is regarded as the most easily recognizable species in the genus *Persea* (Williams 1977). It is distinguished by its large, pubescent leaves (to 20cm wide) and ferruginous pubescent twigs. It is also recognized for its large scarious margined bud scales (Williams 1977, van der Werff 2002). In floral characters, van der Werff distinguishes *P. schiedeana* by its “large flowers (tepals 6-8mm long) and long pedicels (10-25mm)” and “densely pubescent pistil” (van der Werff 2002). It is also noted for meatier and round tipped nectaries in the flowers (as opposed to the more pointed nectaries in *P. americana*) and for its perianth and stamens that turn red with age. Like *P. americana,* it has protogyneous flowers, but in contrast to *P. americana*, the flowers do not close during the evening following floral anthesis. Thus though the flowers exhibit protogynous diurnally synchronous dichogomy like avocado, the female and male phases are not separated by floral closure and re-anthesis, but rather “a stand by” during which the flowers remain open but are not actively in either sexual phase (Tenorio et al. 2008). The importance of out-crossing versus selfing is not known exactly for Persea schiedeana. It is assumed to be predominately an out-crosser, but it is hypothesized that as with P. americana, greater selfing may occur at higher elevations and/or latitudes due to cool temperatures that disrupt the dichogomy mechanisms (Tenorio et al. 2008).

Figure 4-3. Flowers of *Persea schiedeana*

The fruit often appears superficially quite similar to the avocado (pyriform) while at other times a long neck distinguishes it from the majority of avocado cultivars (although some West Indian cultivars share this trait). The white to cream pulp color normally easily distinguishes chinene from avocado which is normally green to yellow. Researchers in Veracruz have noted the color of the skin of the fruit to vary from green to black, brown, and purple (Martinez et al.

2007). The flavor has been described to resemble that of coconut (Popenoe 1920), while personal experience by the author, noted a flavor similar to that of a Hass avocado but with a slight hint of raw onion. In Mexico, chinene is typically eaten by halving the fruit, removing the seed, and filling the seed hole with a salsa of dry roasted red chiles, salt and raw garlic. The salsa and chinene pulp are then mashed together to form something resembling guacamole, which is then eaten inside of a tortilla. Owing to its softer texture than avocados, chinene cannot be cut and removed from the shell in pieces as one may do with *P. americana* cultivars.

Figure 4-4. Photos of fruits of *Persea schiedeana*

Figure 4-5. Photos of *Persea schiedeana* as typically eaten

That the chinene is an important contributor to local diets, just as avocado, has been noted. However, the oil and nutritional contents have only recently been determined (Cruz-Castillo et al. 2007a, Martinez et al. 2007). In their study of chinene in Las Tuxtlas, Veracruz, Mexico, researchers found significant morphological diversity in fruits in terms of size and form, as well as in regards to skin color (Martinez et al. 2007). An analysis of the oil content was also carried out, with the studied chinene having 24.7-36% fatty acid, much higher compared to the 4 to 7% common for West Indian race avocados grown in similar climates and nearly equal with Mexican and Mexican x Guatemalan hybrids. The dominant monounsaturated oil type is oleic acid, the same oil found in olive oil, and widely regarded as having healthy attributes. Other fatty acids detected in significant levels were palmitic with 24.4-34.4%, palmitoleic with 7.2-14.4%, and linoleic (omega 3) with 6.3-9.9% (Martinez et al. 2007). Their results demonstrate quantitatively what has previously been known anecdotally, that significant variation exists in chinene in regards to both its fruit morphology and its oil content and that it is indeed a quite nutritious food source. Other works have demonstrated variation in important characters of chinene, including shape, size, seed to pulp ratio, and pulp fiber content (Cruz Castillo et al. 2004a, Cruz-Castillo et al. 2007a).

Part of the purpose of this thesis is to contribute to the growing body of knowledge regarding *Persea schiedeana*, by presenting information about *Persea schiedeana* in the Chinantla area of Oaxaca, which is adjacent to southern Veracruz and Tabasco, the two areas where the most research has been carried out thus far. The research presents data specifically regarding fruit morphology, tree habitat, management techniques, ethnobotanical knowledge, and selection pressures.

Methods

Between February and July 2008, both ethnoecological-management data and morphological data were collected on *Persea schiedeana* in the Chinantla, specifically in the village of San Mateo Yetla and the six villages compromising CORENCHI.

Interviews

To obtain information on the ethnoecology and management of *Persea schiedeana*, an interview was elaborated and administered to a total of 34 people, of varying ages, both male and female, from all seven villages (see Appendix E for full interview). The interview was partly inspired by similar work on another Mesoamerican semi-domesticate, *Sideroxylon palmeri* (González-Soberanis and Casas 2004). The purpose of the interview was to elicit information about how the diversity of *Persea schiedeana* is perceived and managed, as well as local knowledge of its ecology and ecological interactions. In a participatory domestication program, the local knowledge of the species in question is regarded as one of the most important fonts of information in regards to local diversity, ecological preferences, superior individuals, and, obviously, usage (Leakey and Akinnifesi 2008).

The answers to many of the questions were subsequently coded numerically and percentages of each answer calculated. Other answers were used as free list data to analyze in the program ANTHROPAC (Borgatti 1996).

Fruit Morphology and Diversity

In each of the villages of CORENCHI, data was collected on trees and fruits during late May and June 2008, the early and middle part of harvest season of chinene in the Chinantla. Local research assistants were trained in each village prior to data collection to aid in the collection of data and to help in interaction with the communities. The training of research assistants and their paid assistance was a stipulation by the communities to research in their villages and territory, so that resources, both intellectual and monetary are accrued by the communities.

Information on the tree and its location was collected in the field, including GPS coordinates, estimated level of sunlight reaching canopy, estimated humidity of site, estimated yield, type of agroecosystem, whether the tree was planted or spontaneously arose, soil type, etc. Fruits were either collected from the ground (if present) or retrieved from the tree by various means, such as climbing, rock and stick throwing, branch shaking, and/or sling shot shooting, all typical ways that locals harvest the fruits. An attempt to collect five fruits from each tree was made though it did not always prove possible.

Upon return to the village data was recorded on the fruit exterior, i.e. color, skin texture, shape, weight, dimensions, etc. If the fruit was ripe, the fruit was cut open and data was recorded on the interior of the fruits. More typically, however, the fruit was not ripe and 2 to 3 days later, data was recorded on the interior part of the fruit. As part of this process of data collection on the interior of the fruit or immediately afterwards, “Chinene Fairs” were held in each of the villages, during which the fruits were publicly displayed and villagers were encouraged to examine and try the fruits and voice their opinions concerning which were superior. The success of these fairs was mixed, in some villages serving quite well, in others only moderately well. In the best cases, collectively participants decided upon the best fruits of the village. In other cases, the researcher, along with research assistants made the subjective determination as to the best fruits. Appendix F is the information sheet that was used with each tree.

Results

Interviews

Ethnoecology and management

The information gathered during the interview process is substantial and to the knowledge of the researcher provides the first systematic study of the ethnocological knowledge pertaining to *Persea schiedeana* and its management. A good deal of information useful in the participatory breeding project undertaken was generated.

Local importance

During earlier visits to the area, it was anecdotally reported that *Persea schiedeana* is an important indigenous fruit crops in the area. A number of questions were included in the interview that attempted to further explore the role of *Persea schiedeana* in the Chinantla. 79% of respondents reported that they harvest the fruits of *P. schiedeana*. Of these, 32% report that they harvest the fruit by climbing the trees and cutting the fruit, while 29% report more casually looking for the fallen fruits under the trees, and 39% report utilizing both of the strategies to obtain the fruits. Climbing the tree is no easy feat, as it is frequently higher than 20m with the lowest branches well out of climbing reach. Both shimmying and especially the use of ropes to climb trees were reported. The danger of such work was frequently noted and the height of the trees was the most frequently mentioned barrier to further exploitation of the species (and thus one of the primary local desires is for dwarfed trees).

In terms of dietary role, those interviewed reported that they eat on average 3 fruits per day during the harvest season (late May to early August, depending on altitude), which significantly falls during a time that maize supplies are diminishing from the last harvest and just prior to the season of local avocado varieties (July to September), which is in turn followed by *Beilshmiedia anay* (late October-December). Whereas, chinene is apparently an important subsistence item, only 32% of respondents reported to sell chinene, with the majority of those reporting to sell it within the village, at the average price of 3 pesos ($.30 USD) per fruit.

In terms of other uses of the tree 56% reported that fallen branches or felled, old, unproductive trees are utilized as firewood. 29% reported that under similar circumstances timber is harvested from the tree. No reports were given of medicinal uses of any part of the tree, nor of culinary uses other than the fruit. Likewise, no reports were given of the tree being utilized for animal fodder.

Table 4-1. Summary of local importance data

Average fruits eaten per day	Other uses	Sell fruits?
3 fruits +/-2	29% Timber	Yes-32%
	56% Firewood	3 pesos/fruit

Management

In much of the scant literature on *Persea schiedeana*, it is reported to be wild harvested and occasionally cultivated (Popenoe 1920, Standley and Steyermark 1946-, Cruz Castillo et al. 2004a, Cruz-Castillo et al. 2007a, Martinez et al. 2007). In the interviews an attempt was made to determine to what extent the tree is regarded in the area as a wild tree and to what extent it is regarded as a cultivar associated with human activity. Other questions delved into the management techniques applied to the tree, first and foremost whether it is intentionally managed or cultivated and if so what if any selective criteria are imposed.

In regards to where *P. schiedeana* is found, 89% reported it is found in “monte virgin” (virgin forest), although of this 89%, 16% explicitly qualified the occurrence of chinene in the “monte” as being in areas where people worked or lived in the past. 97% percent of respondents reported that chinene is found in coffee groves and 85% in home gardens.

Table 4-2. Percent respondents reporting *P. schiedeana* in ecosystem

Monte	Coffee Grove	Home Garden
89%	97%	86%

In regards to whether chinene is cultivated, 85% of respondents reported having planted it from seed, 66% of these typically plant it directly as seed in the place where they desired to have the plant, while 15% reported starting the tree first in a home/nursery 85% reported to have planted chinene, 100% reported that chinene also frequently comes up on its own without being planted; "*se nace solo*" (it is born alone). While such trees are sometimes near the mother tree, the fruits and seeds are regarded to frequently be distributed by a number of animals. A list of ten animals and the number of times they were mentioned as a consumer of the fruits and/or a seed dispersal agent is in Table 4-3.

Table 4-3. Animal species mentioned in interviews to distribute *P. schiedeana* seeds

# of times mentioned:	Spanish Name	English Name	Latin Name
22	Tepezcuintle	Paca	*Cuniculus paca*
13	Tejon, Coati	White nosed coati	*Nasua narica*
13	Serete	Agouti	*Dasyprocta sp.*
12	Ardilla	Squirel	*Sciurus deppei*
9	Jabalíi, Pecarí de collar	Javalina	*Tayassu tajacu*
3	Tlacuache	Opposum	*Didelphis virginia*
2	Armadilla, Toche	Armadilla	*Dasypus novemcinctus*
1	Mapache	Racoon	*Procyon lotor*
1	Perro	Dog	*Canis lupus familiaris*

Diversity of fruit characters

In terms of the perception of the diversity of fruit forms found locally, all respondents (100%) reported that fruit morphology does vary between trees, in regards to shape, color, and size. 97% reported that fruit quality among this diversity is variable and that some trees produce superior fruit over others. In terms of flavor, 65% reported that it is variable between trees. The most frequent and salient of the responses to the question, "How are the best chinene?" generated the free list found in Table 4-4

Table 4-4. Characters elicited in interviews as defining the best *P. schiedeana* fruits

Best Fruit Character (n=33)	# of times listed	% of informants to list	Smith's S
Large	14	42	0.40
Good Flavor	13	39	0.31
Long	9	27	0.2
Dark Skin Color	7	21	0.16
Low Fiber	10	30	0.15
Small Seed	10	30	0.15
High Pulp Content	8	24	0.14
Green Skin Color	5	15	0.12

Beyond merely observing that a large diversity of fruit types and qualities exist, the vast majority of respondents (91%) reported that selection is made according to these criteria when planting a seed. Table 4-5 shows the most frequent and salient responses as to the criteria utilized to decide which seed to plant.

Table 4-5. Criteria listed as selective basis for deciding what seed of *P. schiedeana* to plant

Selective Criteria (n=31)	# of times listed	% of informants to list	Smith's S
Best	18	58	0.58
Good Flavor	7	23	0.21
High Pulp Content	6	19	0.2
Large	4	13	0.12

Fruit diversity within a tree was acknowledged by 27%, whereas the rest asserted that all fruits from a tree are the same. Those who reported variation cited principally variation in size as the only variable character.

Management

Although *Persea schiedeana* has been noted to be cultivated or semi-cultivated, no examination as to the management of the trees receive has been made. In light of this respondents were asked about management applied to planted or spontaneous occurring seedlings. 80% reported that when a tree is encountered while clearing forest for milpa or pasture that *P. schiedeana* trees are spared. 30% reported that they are not only spared but also protected from burning by clearing firebreaks around them.

The most important and widely executed management technique is protecting trees (both young and old from competition for light from other trees and, in the case of older trees, lianas). 94% of respondents reported this as a management practice employed with chinene, whereas 22% reported pruning or rather tipping of saplings being a management technique employed to try to promote branching and dwarfed stature, and only 18% reported any irrigation of young trees.

Phenology/ecology

In terms of the phenology and ecology of *P. schiedeana*, the average juvenility period reported was 9 years (+/-3.6). 74% reported that flowering and fruiting occurs at the same time for all trees, while the remainder indicated that some minor variation was to be found, principally owing to the conditions of the site. Likewise, 54% reported that the quantity of fruits that trees produce varies and 65% that the juvenility period can vary, both according to environmental conditions. Casually, it was frequently stated that the trees prefer moist sites of soils rich in organic matter. 97% of respondents reported that chinene is strongly biennial in its cropping pattern, though there were a few anecdotal reports of trees (especially in home gardens) that yield equally each year. 97% responded negatively to the question as to whether they felt that avocado and chinene can cross and/or they have observed any trees of intergrading characteristics.

Up to the present, propagation of chinene has been carried out by seed, a process that does not allow for a high retention of desired traits. However, limited encounters of grafting *P. schiedeana* have been reported in Mexico and experimentation is currently successfully under way in Huatusco, Veracruz (Castillo Cruz pers. com. 2008). In the Chinantla, 95% of respondents felt that it was possible to graft chinene though they are not familiar with how to do so. In the study mentioned above, it was found that in Las Tuxtlas, Veracruz, the most widespread propagation technique is by seed (95%) with only 5% of trees being grafted (Martinez et al. 2007).

Ecological and Morphological Field Observations

Phenology of Persea schiedeana: Through the nearly two years of research on *Persea schiedeana*, the following phenological cycle has been observed (with the dates varying considerably depending upon altitude, trees in hotter climates reach each phase earlier):

January-March: Terminal bud break and flowering, followed by flush of new foliage.

February-March: Drop of old leaves, maturation of new leaves.

May-August: Fruiting

August-December- 2nd flush of foliage and sporadic re-flowering (reports of rare fruiting in February from this flowering).

Best time for grafting: December-early January

Root-stock can be generated from seed in June-July to grafting size in January.

A significant amount of data on the trees and fruits of *Persea schiedeana* was generated, in addition to interesting information suggesting that selection upon *Persea schiedeana* has been carried out successfully in the Chinantla. One hundred and twenty four individual trees were encountered among the six villages of CORENCHI.

The basic data on the altitude, age, height, and diameter at breast height of the trees is presented in Table 4-6.

Table 4-6. Summary of tree data

	Age (n=117)	Altitude (n=118)	DBH (n=124)	Height (n=34)
Overall Mean	32.5 (+/-22)	733m (+/-235)	50cm (+/-27)	21m (+/-9)
Maximum	100 years	1193m	153cm	45m
Minimum	8 years	255m	15cm	5m

The trees were found unequally among seven different agroecosystems. Figure 4-6 shows the percentage of trees found in each of the agroecosystems. It demonstrates that the agroecosystems with the most trees is the cafetal, which contained nearly half of all trees encountered. The remaining agroecosystems each contained considerably fewer trees, including the forest. This suggests that human-management, through planting, selective clearing and protection has increased the densities of *Persea schiedeana* in coffee groves, as they are regarded as desirable because they provide both food and shade.

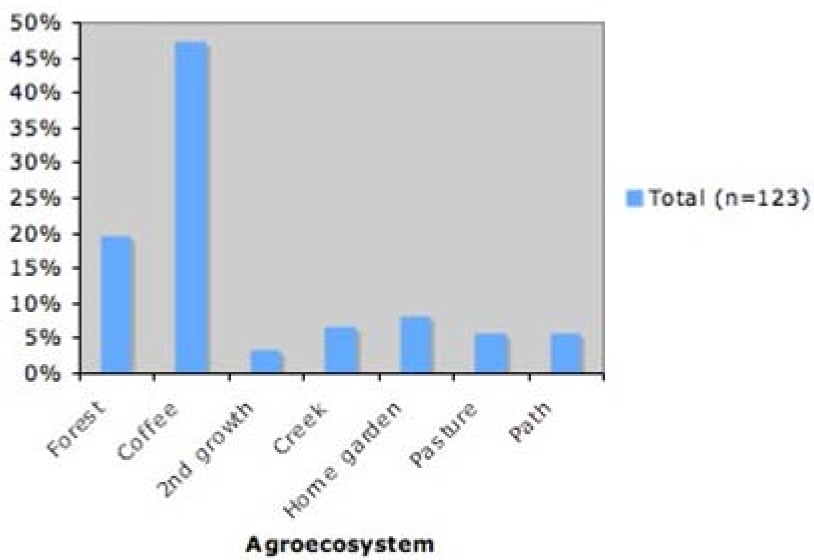

Figure 4-6. Percentage of all *P. schiedeana* trees found in each agroecosystem

Data on the ecological characteristics of the sites where the trees were found is presented in Table 4-7. The data corroborates the information from community members that *Persea* *schiedeana* prefers sites with medium to high moisture, rich soils, and sunlight on the tree canopy.

Table 4-7. Ecological characteristics of sites where *P. schiedeana* were encountered

Characteristics of sites						
Soil Type (n=120)	*Abonoso*	*Negro*	*Medio*	*Amarilla*	*Arenosa*	*Segunda*
	Organic	Black	Medium	Yellow	Sand	Second
	29%	53%	1%	6%	7%	5%
Humidity of Site (n=123)	Driest	Dry	Medium	Humid	Hyper-humid	
	0%	7%	39%	46%	7%	
Light of site (n=116)	Shade	Sun				
	21%	79%				

Both quantitative and qualitative data on the fruits of the trees was recorded. Table 4-8 presents the quantitative data of all fruits encountered. Table 4-9 presents qualitative data on the same fruits. For comparison, Table 4-10 shows morphological data collected on *Persea schiedeana* elsewhere in Mexico.

Table 4-8. Quantitative fruit characters of the Chinantla

Quantitative Fruit Characters		
Fruit Length (n=487)	Length Average 14.24cm (+/-3.6)	Min/Max Length 8cm-28cm
Fruit Width (n=485)	Width Average 6.24cm (+/-1)	Min/Max Width 9.5cm-3cm
Fruit Weight (n=484)	Weight Average 297g (+/-112)	Min/Max Weight 90g-1000g
Pulp/Skin Weight (n=195)	Weight Average 211g (+/-75)	Min/Max Weight 80g-440g
Seed Length (n=194)	Length Average 9cm (+/-2)	Min/Max Length 3.4cm-16.6cm
Seed Width (n=197)	Width Average 4cm (+/-1.3)	Min/Max Width 2cm-12.5cm
Seed Weight (n=209)	Weight Average 91g (+/-43)	Min/Max Weight 30g-240g
Pulp:Seed Ratio (n=192)	Ratio Average 2.6 (+/-1.4)	Min/Max Ratio .6-10

Table 4-9. Qualitative fruit characters

Qualitative Fruit Characters					
Fruit Form (n=90)	Long neck	Pyriform	Ball	Med. Neck	Cucumber
	20.0%	44.4%	12.2%	21.1%	2.2%
Flavor (n=83)	Best flavor(1)	Good flavor(2)	Ok(3)	Poor flavor(4)	Worst flavor(5)
Mean 1.99 +/-1.1	44.6%	24.1%	19.3%	12.0%	0.0%
Fiber (n=86)	None(1)	Low(2)	Medium(3)	High(4)	Extremely(5)
Mean 2.33 +/-.9	15.1%	51.2%	20.9%	11.6%	1.2%
Quality (n=83)	Best(1)	Good(2)	Average(3)	Poor(4)	Bad(5)
Mean 2.02 +/-.9	36.1%	36.1%	18.1%	8.4%	1.2%
Fruit Pulp Texture (n=83)	Watery	Creamy	Floury		
	20.5%	77.1%	2.4%		
Skin Color (n=97)	Light Green	Dark Green	Purple	Red	
	74.2%	18.6%	6.2%	1.0%	

Table 4-10. Data on quantitative characters of fruits from various municipalities in Veracruz, Mexico (Cruz-Castillo et al. 2007a)

Municipios	Color del fruto	Numero de frutos	Peso del fruto (g)	Diám. Proximal (mm)	Diám. Medio (mm)	Diám. Distal (mm)	Long. del fruto (cm)	Peso de semilla (g)	Peso de pulpa (g)	Peso de cáscara (g)	Diám. Semilla (mm)	Long. Semilla (mm)
Ixhuatlán	Café	26	198.7±13.5	27.5±0.9	45.7±2.1	56.1±1.4	13.4±0.4	62.2±5.2	90.1±6.9	41.5±2.5	39.1±1.4	86.6±2.6
Ixhuatlán	Verde	21	172.3±7.5	24.6±0.7	43.4±0.9	55.8±0.9	12.1±0.3	52.7±2.8	79.5±4.0	37.7±1.9	37.0±0.8	81.3±2.5
Ixhuatlán	Negro	22	207.3±12.0	24.8±0.9	43.5±0.9	57.9±1.5	13.9±0.5	72.4±8.3	89.8±5.6	46.5±2.9	40.7±1.5	89.9±3.5
Ixhuatlán	Morado	9	162.1±8.2	23.2±1.3	43.6±1.5	55.3±1.3	12.1±0.7	58.0±6.3	62.8±7.2	40.6±2.4	39.7±2.3	81.5±3.0
Tepatlaxco	Café	9	204.2±10.8	22.0±1.0	40.0±0.9	57.7±1.4	16.2±0.7	73.3±3.2	90.5±8.0	41.8±2.4	42.0±1.0	121.6±5.6
Tepatlaxco	Verde	6	181.4±8.9	21.4±0.6	42.2±1.2	58.6±0.9	12.1±0.4	61.0±7.5	88.4±5.0	38.8±2.3	38.7±1.4	75.2±4.4
Calcahualco	Negro	10	254.7±33.4	27.6±0.6	47.6±1.6	60.8±3.3	15.4±0.8	89.1±20.2	106.4±10.4	54.8±5.0	43.6±3.9	104.6±8.0
Tomatlán	Negro	7	224.1±8.7	29.1±0.3	42.9±1.0	57.7±1.6	14.8±0.4	70.6±8.6	103.2±4.2	49.0±1.8	39.4±2.0	119.2±6.2
Excola	Café	7	158.2±18.2	26.9±1.3	39.8±0.8	53.7±2.3	11.0±0.4	62.1±9.2	63.4±7.0	31.3±2.2	37.9±2.1	87.1±3.5
Córdoba	Café	6	160.1±23.6	25.9±1.4	38.3±1.5	51.6±2.7	11.3±0.9	66.3±13.2	64.5±7.1	28.0±4.2	40.4±3.2	85.9±8.9
Comapa	Verde	5	163.9±28.0	22.6±1.8	39.12.0	56.8±3.4	12.7±1.9	79.7±19.7	56.7±12.3	26.0±4.0	42.9±2.3	64.8±4.1
Fortin	Café	8	176.8±12.2	26.2±1.0	40.2±1.7	55.7±1.9	12.0±0.3	57.9±5.8	77.7±8.2	38.7±6.1	41.2±1.6	90.9±3.7

The principal hypotheses of this thesis is that the fruits of *Persea schiedeana* from planted trees should be statistically different than those of spontaneously arising trees in the characteristics that are subject to selection, which were elicited during interviews. A mechanism to explain this would be the effects of truncated selection, where through selection for desired characters, the population of selected individuals begins to differentiate from the larger "wild" population (Leakey et al. 2004). Of the 124 trees encountered, 63 trees were reported as planted and 51 as spontaneous (the origins of 9 trees was not recorded).

Figure 4-5 shows the agroecosystems in which the planted and spontaneous trees were encountered. Significantly, the vast majority of the planted (selected) trees are in managed agroforestry systems, home gardens (20%) and coffee groves (nearly 70%). Even so, within both of these agroecosytems, especially coffee groves, spontaneous trees are found (nearly 50% of all spontaneous trees were in coffee groves). This shows that both cultivation and sparing/protection strategies are occurring in both home gardens and, especially, in coffee groves.

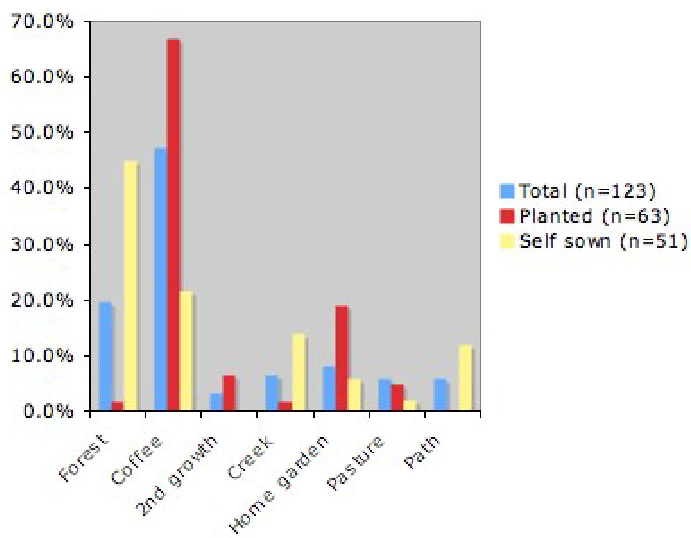

Figure 4-7. Percentages of planted and self-sown trees found in each agroecosystem

Table 4-11 shows the qualitative and quantitative characters of the planted versus spontaneous trees, along with the significance of difference obtained in independent T-tests using SPSS version 9 software. Of interest, a number of differences are notable between the planted and spontaneous populations in the Chinantla. Firstly, flavor and quality scores are significantly superior for the planted trees. Fruit length, width, and weight are all significantly greater in the planted trees. All of these characters are characters that are selected for according to the interviews conducted (see above). Interestingly, another character selected for, high pulp is only achieved with over all greater fruit size, the planted trees do not have a superior pulp: seed ratio. The planted trees also have a higher diversity of skin colors.

Table 4.-11. Comparison of planted and self sown fruits

Planted vs. Self Sown	Planted	Self-sown	Significance
Skin Color (n=44,44)	LG:61.4%,DG:25.0%,P:11.4%,R:2.3%	LG:84.1%,DG:15.9%,P:0.0%,R:0.0%	
Pulp Texture (n=37,40)	W:20.5%, Cr:77.1%, Fl:2.4%	W:24.3%, Cr:73.0%,Fl:2.7%	
Flavor (n=36,41)	1.56 +/-.135	2.44+/-.175	0.000
Fiber (n=38,42)	2.61 +/-.139	2.07+/-.138	0.008
Quality (n=37,41)	1.68 +/-.140	2.39+/-.160	0.001
Fruit Form (n=58,24)	1:20.7%,2:43.1%,3:12.1%,4:22.4%,5:1.7%	1:20.8%,2:50.0%,3:16.7%,4:12.5%,5:0.0%	
Fruit Length (n=225,224)	14.4 cm +/-.2	13.7cm+/-.2	0.022
Fruit Width (n=224,223)	6.4cm +/-.07	6.1cm+/-.07	0.028
Fruit Weight (n=226,220)	313g+/-8	280g+/-7	0.002
Pulp/Skin Weight (n=123,54)	223g+/-7	187g+/-9	0.003
Seed Weight (n=123,62)	101g+/-4	79g+/-4	0.001
Pulp:Seed Ratio (n=121,53)	2.62g+/-.13	2.61g+/-.2	0.969
Best vs. Rest	Best:15.6%, Rest:84.4%	Best:8.0%, Rest:92.6%	

Skin Color: LG=light green, DG=dark green, P=purple/black,R=red; Pulp Texture: W=watery,Cr=creamy,Fl=Floury Fruit Form: 1=Long neck, 2=Pyriform, 3=Ball, 4=Medium neck, 5=Cucumber

Table 4-12. Fruits from “best” trees selected during “Chinene Fairs” compared to all others

Best vs. Rest	Best	Rest	Significance
Skin Color (n=26,73)	LG:60.0%,DG:20.0% P:16.0%, R:4.0%	LG:79.2%, DG:18.1%,P:2.8%	
Pulp Texture (n=26,57)	W:4.2%, Creamy 95.8%	W:27.1%, C:69.5%, F:3.4%	
Flavor (n=26,57)	1.19+/-.079	2.35 +/-.143	0.000
Fiber (n=26,60)	2.65 +/-.2	2.18 +/-.108	.027
Quality (n=25,58)	1.32+/-.095	2.33 +/-.133	0.000
Fruit Form (n=25,65)	1:28.0%,2:40.0%,4:28.0%, 5:4.0%	1:16.9%,2:46.2%,3:16.9%,4:18.5%,5:1.5%	
Fruit Length (n=122,365)	16.1cm +/-.34	13.6cm +/-.17	0.000
Fruit Width (n=122,363)	6.5cm +/-.09	6.2cm +/-.06	.005
Fruit Weight (n=119,365)	339g +/-10.8	284g +/-5.6	0.000
Pulp/Skin Weight (n=85,110)	229g+/-9	198g+/-6	.003
Seed Weight (n=96,113)	100g+/-5	83+/-3	.004
Pulp:Seed Ratio(n=85,107)	2.63g+/-/.176	2.64g+/-.119	.944
Site* graphed elsewhere	F:14.8%, C:63.0%, SG: 0%, Cr:0%, HG:18.5%, P:3.7%, T:0%	F:20.8%, C:42.7%, SG:4.2%, Cr:8.3%, HG:10.4%, T:7.3%	
Planted vs. Self Sown	70.8% Planted, 29.2% Self Sown	51.1% Planted, 48.9% Self Sown	

Site: F=Forest, C=Coffee grove, SG=Second Growth, Cr=Creek, HG=Home garden, P=Pasture, T=Trail/Path

During the Chinene Fair held in each village, the best trees were chosen in each village (except in Nopalera, where a fair was not held). Between the five villages 27 trees were identified as providing superior fruits, leaving 97 average trees. The differences between the fruits of the "best" trees and those of the "average" trees are even greater than the differences between the planted and the spontaneous trees, demonstrating the high variability that exists even among "planted/selected" trees due to outcrossing and meiosis, as well as among self sown trees. Table 4.12 (above) presents the data on "best" versus "average" fruits. Again, higher diversity of skin colors was found in the bests versus the average trees. Both flavor and quality were superior in the best trees, as was texture with 95.8% of the best trees having "creamy" texture, compared to 77% of the planted having "creamy" texture. Creamy texture suggests a higher fat content, which has been shown elsewhere to be a variable trait (Martinez et al. 2007). Again, as with planted trees, the best trees showed greater weight, length, and width than the average trees, but the same pulp: seed ratio. Significantly, of the twenty-seven best trees, 70.8% of them were planted trees, suggesting that the selection of superior quality seed stock according to the traits listed above is to a large extent successful.

Discussion

The data above provided useful background information with which to commence a participatory breeding program on *Persea schiedeana*. It shows that as elsewhere with other fruits (Leakey et al. 2004), small holder selection on the plants has resulted in some differentiation between those planted and those "wild" plants. The selective criteria elicited During the interviews can aid in creating an ideotype of chinene (Leakey and Page 2006).

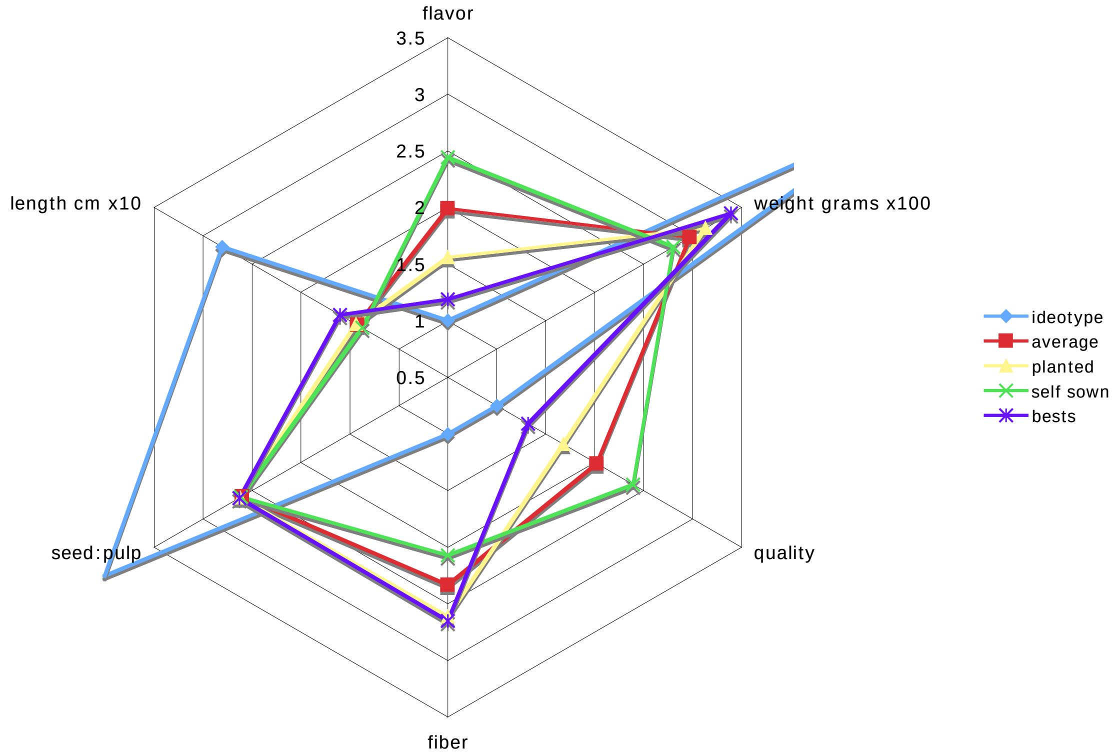

Figure 4-8. Ideotype of Chinene

The image generated above shows in light blue ideotype (or ideal) of chinene based on interviews and compares the average of all chinene encountered in the study (red), the planted trees (yellow), the self sown trees (green), and those which were selected as bests during ‘chinene fairs’ (purple) to the ideotype. Those fruits selected during the ‘chinene fairs’ as the best are closest in general to the ideotype for the most important traits shown in the image, those being flavor and quality (1 being best), weight and length (increasing away from center), seed: pulp ratio (better further from center).

To truly improve upon the genetic base that exists in the Chinantla vegetative propagation of the best trees is necessary. While most of the best trees were planted not all were, showing that usable germplasm exists among “wild” trees as well.

This research also illustrates that *Persea schiedeana* is managed according to a wide spectrum of intensities and in numerous different systems. The position of *Persea schiedeana* on the wild to cultivated spectrum seems cloudy in the Chinantla, whereas the other Lauraceae consumed; West Indian avocado *P. americana var. americana* and Mexican avocado *P. americana var. drymifolia*, and *Beilshmiedia anay* are unanimously regarded as cultivars found only in association with human activity. Observations of the researcher affirmed this is the case with the other edible Lauraceae in the zone. *Persea schiedeana*, however, is found in both "wild" and "domesticate" settings, in nearly all of the positions in Wiersum's model (1997). When applying the plant categories of Clement (1999), the categories wild and incipiently domesticated apply to *Persea schiedeana* in the Chinantla. The best trees certainly do appear to be incipiently domesticated as the research results here show. Whether any truly "wild" trees exist in the Chinantla or whether they are all the result of past human introduction and have since naturalized is a question that has plagued the researcher and here no answer is provided. When applying the management types of Casas et al. (2007), a number of them are applicable to practices surrounding chinene in the study area, from "systematic gathering", "let standing", "encouraging growing", and "protection".

The evidence of the vast range of management techniques applied to *Persea schiedeana* and thus varying degrees of domesticated status shown by *Persea schiedeana* in this study, demonstrate the important fact that frequently in traditional agroecosystems a single species simultaneously occupies many positions along the wild to domesticated continuum. In terms of conservation of genetic diversity in situ this is positive. However, in terms of producing reliable, marketable crops and enabling highly effective selective pressure to be applied to an outcrossing species, this could be regarded as a drawback.

Intervention with vegetative propagation provides the opportunity to harness the best individuals, increasing their numbers, and in the short term creating large numbers of the best fruited individuals. In the long-term, it aids in creating a higher number of individuals with desired alleles, thus making selection for desired traits, theoretically more efficient. The additional benefits of grafting, such as reduced juvenility period and decreased stature, are simultaneously enjoyed.

That said, under present management systems and selection systems *Persea schiedeana* occupies a broad part along the domestication continuum and management intensity spectrum, and is as shown in this study to be quite variable in its fruit morphology characters in the study area.

CHAPTER 5
CONCLUSION

This work has demonstrated the rich array of edible plants species in the Chinantla, the unequal distribution of these species amongst the various agroecosystems of the region, and the various levels of management intensity applied to the species and the agroecosystems.

A number of Cinderella species have been identified that merit further work, specifically on the prospects for participatory domestication projects applied to these species and on market potentials for products from these species.

Persea schiedeana has been examined in detail. The base data here contributes to the small but growing documentation of the diversity in fruit morphology of the species. The ethnoecological and management information gathered in interviews is some of the very first information to be collected along these lines. Most of this information is highly applicable in the participatory domestication program that has been commenced.

During Chinene Fairs, the best fruit from each village were identified. These fruits are statistically superior to the rest of the trees encountered in the traits elicited in interviews as selective criteria (bigger fruit, longer fruit, better flavor, better quality and higher pulp weight). These best trees, however, are not different from the average trees in pulp: seed ration, suggesting that selecting for bigger fruit results in frequently selecting for a larger seed as well. Though less so, when planted versus spontaneously arising trees were compared, again, the planted trees were superior in the traits mentioned above. This suggests that the selective pressure applied to *Persea schiedeana* in the Chinantla has been effective, through truncated selection mechanisms. The best fruits produced through this selection and the knowledge accumulated during the generations of Chinantecos' interaction with this species are the highly valuable materials now being harnessed in the early stages of a participatory domestication program. Nurseries of rootstock were established in each village in June/July 2008. By January 2009 those that had received proper care (protection from poultry) were ideal size for grafting. A grafting workshop was arranged in San Antonio Analco from January 9^{th} to Jan 11^{th}. Juan Jose Fernandez, a field technician at Chapingo University's research facility in Huatusco, Veracruz gave extensive instruction on the selection and preparation of scion wood, and the three grafting techniques most appropriate for *Persea schiedeana*, modified cleft graft/tip graft (púa terminal), side graft (púa lateral), side veneer graft (enchapada lateral). Thirty two members of CORECNHI attended the workshop and received materials enabling them to graft. During the course, extensive hands on practice took place and all participants grafted at least one *Persea schiedeana*. Digital video was taken of the keys parts of the workshop and has been distributed each of the communities for re-enforcement of the principles learned in the workshop and as an aid for those who attended the workshop to teach others in their communities.

Thus, the next stage of the participatory domestication project rests in the hands of those who attended the workshop and will be grafting the scion from the "best" trees upon the planted rootstock. How well the grafts take remains to be seen.

APPENDIX A
COMPLETE FREE LIST OF "FRUITS"

Table A-1. Fruits listed in freelists exercise.

Common Name	Response Freq	%	Smith's S
Naranja	15	100	0.927
Platano	14	93	0.712
Mango	13	87	0.648
Aguacate	14	93	0.59
Chinene	12	80	0.478
Mamey	12	80	0.407
Coco	11	73	0.398
Jinicuile	11	73	0.372
Nance	12	80	0.355
Cacao	13	87	0.35
Papaya	9	60	0.337
Guanabana	9	60	0.329
Guayaba	10	67	0.307
Anona	11	73	0.296
Limon Dulce	5	33	0.236
Mandarina	4	27	0.199
Limon	5	33	0.19
Chico Sapote	8	53	0.187
Yuca	4	27	0.164
Camote	4	27	0.163
Pina	4	27	0.159
Tamarindo	4	27	0.155
Pomelo	4	27	0.148
Guaye	5	33	0.139
Toronja	3	20	0.133
Ilama	5	33	0.131
Ciruela	4	27	0.116
Carambola	6	40	0.108
Chayote	2	13	0.096
Castana	4	27	0.088
Limon Agrio	2	13	0.081
Cafe	2	13	0.073
Calabaza	2	13	0.069
Cacao Blanco	5	33	0.067
Uva	1	7	0.067
Palao	4	27	0.065
Naranja China	1	7	0.063

Table A-1. Continued

Common Name	Response Freq	%	Smith's S
Lima	1	7	0.061
Caca de Nino	2	13	0.06
Maracuja	3	20	0.059
Sapote Negro	3	20	0.058
Cana	2	13	0.058
Coyol	2	13	0.058
Uva de Monte	2	13	0.055
Melon	1	7	0.051
Maize	1	7	0.048
Anona Colorado	1	7	0.041
Tomatitos	1	7	0.033
Aguacate Grande	1	7	0.032
Chapulin	1	7	0.03
Aguacate Dulce	1	7	0.029
Jobo	3	20	0.027
Aguacatillo	1	7	0.024
Sandia	2	13	0.021
Tepijilote	1	7	0.02
Jicama	1	7	0.016
Litchi	1	7	0.011
Uva de Cerro	1	7	0.01
Uvita Agrio	1	7	0.009
Capulin	2	13	0.007
Uvita Dulce	1	7	0.006
Tepijiote	1	7	0.005
Cedro	1	7	0.002

APPENDIX B
SPECIES INVENTORY OF SAN MATEO YETLA, OAXACA

Table B-1. Species inventory

Genus	Species	Common name Spanish	Incipient Domesticates	Total # encountered
Fruits				
Acromia	*aculeata.*	*Coyol de espina*	*	*1*
Ananas	*cosmosus*	*Pina*		*20*
Annona	*diversifolia*	*Illama*	*	*22*
Annona	*muricata*	*Guanabana*		*27*
Annona	*reticulata*	*Annona*	*	*19*
Ardisia	*compressa*	*Uvita*	*	*49*
Atrocarpus	*heterophyllus*	*Castana*		*10*
Attelea	*cohune*	*Coyol*		*87*
Averrhoa	*carambola*	*Carambola*		*1*
Beilschmedia	*anay*	*Aguacate dulce*	*	*1*
Byrsonima	*crassifolia*	*Nanche*	*	*38*
Carica	*papaya*	*Papaya*		*22*
Citrus	*spp.*	*Citrus*		*219*
Cocos	*nucifera*	*Coconut*		*77*
Couepia	*polyandra*	*caca de nino*	*	*3*
Diospyros	*digyna*	*Sapote negro*	*	*0*
Eriobotrya	*japonica*	*Nispero*		*4*
Inga	*jinicuil*	*Jinicuil*	*	*49*
Litchi	*chinensis*	*Litchi*		*7*
Mangifera	*indica*	*Mango*		*73*

Table B-1. Continued

Genus	Species	Common name Spanish	Incipient Domesticates	Total # encountered
Morinda	*citrifolia*	*Noni*		*1*
Muntingia	*calabura*	*Capulin*	*	*3*
Musa	*acuminata/balbisiana*	*Platano morado*		*196*
Passiflora	*edulis*	*Palao*		*1*
Parathesis	*psychotrioides*	*Uvita longer leaf*	*	*1*
Persea	*americana*	*Aguacate*	*	*67*
Persea	*americana*	*Aguacatillo*	*	*4*
Persea	*schiedeana*	*Chinene*	*	*16*
Pouteria	*sapota*	*Sapote Mamey*	*	*27*
Psidium	*guajava*	*Guayaba*	*	*29*
Punica	*granatum*	*Granada*		*0*
Spondias	*purpurea*	*Ciruela*	*	*3*
Syzygium	*jambos*	*Poma rosa*		*0*
Tamaridus	*indica*	*Tamarindo*		*9*
Terminalia	*catalpa*	*Almendra*		*2*
Vitus	*sp.*	*Uva*	*	*4*
Quelite				
Amaranthus	*hybridus*	*Quintonil, quelite blanco*		*5*
Cestrum	*nocturnum*	*Huele de noche*		*177*
Erythrina	*sp.*	*Coraline*		*1*
Ipomea	*sp.*	*Quelite venado, quebra plato*		*5*
Phytolacca	*icosandra*			*7*
Portulaca	*oleracea*	*Verdolaga*		*0*
Solanum	*americanum/nigrescens.*	*Hierba mora*		*63*
Crotalaria	*sp.*	*chipil*		*1*

Table B-1. Continued

Genus	Species	Common name Spanish	Incipient Domesticates	Total # encountered
Condiments				
Bixa	*orellana*	*Achiote*		*1*
Cinnamomum	*verum*	*Canella*		*1*
Coriandrum	*sativum*	*Cilantro*		*3*
Cymbopogon	*flexuosus*	*Lemon grass*		*3*
Dysphania	*ambrosioides*	*Epazote*		*23*
Eryngium	*foetidum*	*Cilantro del monte/de torro*		*19*
Lueceana	*esculenta*	*Guaye*		*5*
Mentha	*viridis*	*Hierba buena*		*7*
Ocimum	*basilicum*	*Albaca*		*6*
Ocimum	*sp.*	*Oregano*		*8*
Piper	*auritum*	*Hoja santa, ocuyo silvestre*		*28*
Plectranthus	*amboinicus*	*Oregano orejon*		*4*
Porophyllum	*ruderale*	*Papalo*		*1*
Renealmia	*alpinia*	*Huasmole, Huele mole*		*47*
Saccharum	*officinarum*	*Cana*		*7*
Vanilla	*planifolia*	*Vainilla*		*1*
Vegetable				
Allium	*sp.*	*Cebollin*		*26*
Capsicum	*annuum*	*Chile*		*27*
Chameadora	*tepijilote*	*Tepijilote*		*28*
Cucurbita	*moschata*	*Calabaza*		*20*
Hylocereus	*undatus.*	*Nopal tres lobos*		*1*
Solanum	*lycopersicon*	*Tomate*		*31*
Opuntia	*ficus-india*	*Nopal*		*29*
Physalis	*philadelphica*	*Jitomate*		*9*
Sechium	*edule*	*Chayote*		*13*

Table B-1. Continued

Genus	Species	Common name Spanish	Incipient Domesticates	Total # encountered
Spathiphyllum	*sp.*	*Cuna de Moises, Chile de Gato*		*70*
Grain				0
Phaseolus	*coccineus*			*0*
Phaseolus	*vulgaris*	*frijole*		*3*
Vigna	*ungulata*	*tripa de pollo*		*2*
Zea	*mays*	*maize*		*0*
Tuber				
Colocasia	*esculenta*	*malanga*		*35*
Dioscorea	*esculenta*	*yame*		*1*
Ipomea	*batatas*	*Camote*		*0*
Manihot	*esculenta*	*Yuca*		*155*
Pachyrhizus	*erosus*	*jicama*		*0*
Xanthosoma	*sagittifolium.*	*malanga*		*15*
Beverage				
Coffea	*arabica*	*Café*		*18*
Coffea	*robusta*	*Café*		*4*
Smilax	*sp.*	*Popo, cocomecatl*		*19*
Theobroma	*bicolor*	*Cacao blanco, cimmaron*		*179*
Theobroma	*cacao*	*Cacao*		*17*
Utensil				
Calathea	*lutea*	*Hoja de posole*		*32*
Crescentia	*cujete*	*Jicara*		*4*
Lagenaria	*siceraria*	*Chikal*		*18*

APPENDIX C
PERCENT PRESENSE OF EACH SPECIES IN EACH AGROECOSYSTEM

Table C-1. Species presence in agroecosystems

Genus	Species	Common name Spanish	% Homegarden	% Coffee Grove	% Pasture/Rancho	% Milpa
			n=13	n=14	n=14	n=8
Fruits			**100%**	**100%**	**100%**	**75%**
Acromia	*aculeata.*	*Coyol de espina*	0%	0%	*7%*	*0%*
Ananas	*cosmosus*	*Pina*	*0%*	*0%*	*7%*	*0%*
Annona	*diversifolia*	*Illama*	*23%*	*29%*	*29%*	*0%*
Annona	*muricata*	*Guanabana*	*62%*	*7%*	*21%*	*25%*
Annona	*reticulata*	*Annona*	*31%*	*7%*	*29%*	*0%*
Ardisia	*compressa*	*Uvita*	*31%*	*0%*	*0%*	*0%*
Atrocarpus	*heterophyllus*	*Castana*	*31%*	*14%*	*0%*	*0%*
Attalea	*cohune*	*Coyol*	*23%*	*43%*	*29%*	*1%*
Averrhoa	*carambola*	*Carambola*	*8%*	*0%*	*0%*	*0%*
Beilschmedia	*anay*	*Aguacate dulce*	*8%*	*0%*	*0%*	*0%*
Byrsonima	*crassifolia*	*Nanche*	*62%*	*21%*	*50%*	*0%*
Carica	*papaya*	*Papaya*	*46%*	*0%*	*21%*	*0%*
Citrus	*spp.*	*Citrus*	*92%*	*71%*	*100%*	*38%*
Cocos	*nucifera*	*Coconut*	*77%*	*29%*	*29%*	*0%*
Couepia	*polyandra*	*Caca de nino*	*15%*	*0%*	*0%*	*0%*
Diospyros	*digyna*	*Sapote negro*	*0%*	*0%*	*0%*	*0%*
Eriobotrya	*japonica*	*Nispero*	*0%*	*7%*	*7%*	*0%*
Inga	*jinicuil*	*Jinicuil*	*85%*	*64%*	*36%*	*13%*
Litchi	*chinensis*	*Litchi*	*23%*	*0%*	*7%*	*0%*
Mangifera	*indica*	*Mango*	*85%*	*71%*	*21%*	*25%*
Manilkara	*sapota*	*Chico sapote*	*31%*	*0%*	*7%*	*0%*
Morinda	*citrifolia*	*Noni*	*8%*	*0%*	*0%*	*0%*
Muntingia	*calabura*	*Capulin*	*23%*	*0%*	*0%*	*0%*
Musa	acuminata/balbisiana.	*Platano*	*77%*	*79%*	*29%*	*38%*

Table C-1. Continued

Genus	Species	Common name Spanish	% Homegarden	% Coffee Grove	% Pasture/Rancho	% Milpa
Parathesis	*psychotrioides*	*Uvita longer leaf*	*8%*	*0%*	*0%*	*0%*
Persea	*americana*	*Aguacate*	*69%*	*79%*	*36%*	*25%*
Persea	*americana*	*Aguacatillo*	*15%*	*0%*	*0%*	*13%*
Persea	*schiedeana*	*Chinene*	*15%*	*36%*	*7%*	*0%*
Pouteria	*sapota*	*Sapote Mamey*	*15%*	*50%*	*14%*	*0%*
Psidium	*guajava*	*Guayaba*	*54%*	*7%*	*43%*	*0%*
Punica	*granatum*	*Granada*	*0%*	*0%*	*0%*	*0%*
Spondias	*purpurea*	*Ciruela*	*8%*	*0%*	*14%*	*0%*
Syzygium	*jambos*	*Poma rosa*	*0%*	*0%*	*0%*	*0%*
Tamaridus	*indica*	*Tamarindo*	*31%*	*14%*	*7%*	*0%*
Terminalia	*catalpa*	*Almendra*	*15%*	*0%*	*0%*	*0%*
Vitus	*sp.*	*uva*	*23%*	*0%*	*0%*	*0%*
Quelite			***92%***	***50%***	**42%**	**100%**
Amaranthus	*hybridus*	*Quintonil, quelite blanco*	8%	0%	*0%*	*38%*
Cestrum	*nocturnum*	*Huele de noche*	*77%*	*43%*	*36%*	*75%*
Erythrina	*sp.*	*Coraline*	*8%*	*0%*	*0%*	*0%*
Ipomea	*sp.*	*Quelite venado, quelite blanco*	*0%*	*0%*	*0%*	*13%*
Phytolacca	*icosandra*		*0%*	*7%*	*0%*	*25%*
Portulaca	*oleracea*	*Verdolaga*	*0%*	*0%*	*0%*	*0%*
Solanum	*americana/ nigrescens*	*Hierba mora*	*15%*	*0%*	*14%*	*88%*
Crotalaria	*sp.*	*chipil*	*8%*	*0%*	*0%*	*0%*
Condiments			***100%***	***36%***	**50%**	**50%**
Bixa	*orellana*	*Achiote*	8%	0%	*0%*	*0%*
Cinnamomum	*verum*	*Canella*	*8%*	*0%*	*0%*	*0%*
Coriandrum	*sativum*	*Cilantro*	*15%*	*0%*	*0%*	*0%*

Table C-1. Continued

Genus	Species	Common name Spanish	% Homegarden	% Coffee Grove	% Pasture/Rancho	% Milpa
Cymbopogon	*flexuosus*	*Lemon grass*	*15%*	*0%*	*0%*	*13%*
Dysphania	*ambrosioides*	*Epazote*	*38%*	*0%*	*0%*	*0%*
Eryngium	*foetidum*	*Cilantro del monte/de torro*	*31%*	*0%*	*0%*	*0%*
Lueceana	*esculenta*	*Guaye*	*31%*	*7%*	*0%*	*0%*
Mentha	*viridis*	*Hierba buena*	*23%*	*0%*	*0%*	*0%*
Ocimum	*basilicum*	*Albaca*	*23%*	*0%*	*0%*	*0%*
Ocimum	*sp.*	*Oregano*	*31%*	*0%*	*0%*	*0%*
Piper	*auritum*	*Hoja santa, ocuyo silvestre*	*69%*	*14%*	*21%*	*25%*
Plectranthus	*amboinicus*	*Oregano orejon*	*31%*	*0%*	*0%*	*0%*
Porophyllum	*ruderale*	*Papalo*	*0%*	*0%*	*7%*	*0%*
Renealmia	*alpinia*	*Huasmole, Huele mole*	*69%*	*14%*	*21%*	*13%*
Saccharum	*officinarum*	*Cana*	*23%*	*0%*	*0%*	*25%*
Vanilla	*planifolia*	*Vainilla*	*8%*	*0%*	*0%*	*0%*
Vegetable			***92%***	***50%***	**29%**	**88%**
Allium	*sp.*	*Cebollin*	38%	0%	*0%*	*13%*
Capsicum	*annuum*	*Chile*	*62%*	*0%*	*21%*	*13%*
Chameadora	*tepijilote*	*Tepijilote*	*8%*	*7%*	*0%*	*0%*
Cucurbita	*moschata*	*Calabaza*	*23%*	*7%*	*0%*	*38%*
Hylocereus	*undatus.*	*Nopal tres lobos*	*0%*	*0%*	*7%*	*0%*
Solanum	*lycopersicon*	*Tomate*	*38%*	*0%*	*0%*	*38%*
Opuntia	*cochenillifera*	*Nopal*	*54%*	*0%*	*14%*	*25%*
Physalis	*philadelphica*	*Jitomate*	*0%*	*0%*	*0%*	*38%*
Sechium	*edule*	*Chayote*	*62%*	*0%*	*7%*	*13%*
Spathiphyllum	*sp.*	*Cuna de Moises, Chile Gato*	*38%*	*50%*	*0%*	*0%*
Grain			***15%***	***0%***	**0%**	**100%**

Table C-1. Continued

Genus	Species	Common name Spanish	% Homegarden	% Coffee Grove	% Pasture/Rancho	% Milpa
Phaseolus	*coccineus*		0%	0%	0%	0%
Phaseolus	*vulgaris*	*frijole*	0%	0%	0%	0%
Vigna	*ungulata*	*tripa de pollo*	15%	0%	0%	13%
Zea	*mays*	*maize*	0%	0%	0%	100%
Tuber			**23%**	**0%**	**29%**	**13%**
Colocasia	*esculenta*	*malanga*	8%	0%	0%	0%
Dioscorea	*esculenta*	*yame*	8%	0%	0%	0%
Ipomea	*batatas*	*Camote*	0%	0%	0%	0%
Manihot	*esculenta*	*Yuca*	23%	0%	29%	13%
Pachyrhizus	*erosus*	*jicama*	0%	0%	0%	0%
Xanthosoma	*sagittifolium*	*malanga*	8%	0%	0%	0%
Beverage			**69%**	**100%**	**21%**	**25%**
Coffea	*arabica*	*Café*	31%	100%	7%	25%
Coffea	*robusta*	*Café*	0%	7%	0%	0%
Smilax	*sp.*	*Popo, cocomelcate*	31%	21%	0%	0%
Theobroma	*bicolor*	*Cacao blanco, cimmaron*	69%	43%	14%	13%
Theobroma	*cacao*	*Cacao*	69%	7%	14%	38%
Utensil			**62%**	**7%**	**14%**	**25%**
Calathea	*lutea*	*Hoja de posole*	38%	7%	0%	25%
Crescentia	*cujete*	*Jicara*	23%	0%	7%	0%
Lagenaria	*siceraria*	*Chikal*	0%	0%	7%	13%

APPENDIX D
NUMBER OF INDIVIDUALS OF EACH SPECIES ENCOUNTERED BY AGROECOSYSTEM

Table D-1. Species inventory numbers

Genus	Species	Common name Spanish	# in Homegarden	# in Coffee	# in Pasture/Rancho	# in Milpa	Total #
Fruits							
Acromia	*aculeata.*	*Coyol de espina*	*0*	*0*	*1*	*0*	*1*
Ananas	*cosmosus*	*Pina*	*0*	*0*	*20*	*0*	*20*
Annona	*diversifolia*	*Illama*	*4*	*7*	*11*	*0*	*22*
Annona	*muricata*	*Guanabana*	*14*	*1*	*10*	*2*	*27*
Annona	*reticulata*	*Annona*	*5*	*1*	*13*	*0*	*19*
Ardisia	*compressa*	*Uvita*	*49*	*0*	*0*	*0*	*49*
Parathesis	*psychotrioides*	*Uvita longer leaf*	*1*	*0*	*0*	*0*	*1*
Atrocarpus	*heterophyllus*	*Castana*	*8*	*2*	*0*	*0*	*10*
Attalea	*cohune*	*Coyol*	*15*	*23*	*47*	*2*	*87*
Averrhoa	*carambola*	*Carambola*	*1*	*0*	*0*	*0*	*1*
Beilschmedia	*anay*	*Aguacate dulce*	*1*	*0*	*0*	*0*	*1*
Byrsonima	*crassifolia*	*Nanche*	*22*	*8*	*8*	*0*	*38*
Carica	*papaya*	*Papaya*	*11*	*0*	*11*	*0*	*22*
Citrus	*spp.*	*Citrus*	*67*	*59*	*89*	*4*	*219*
Cocos	*nucifera*	*Coconut*	*36*	*34*	*7*	*0*	*77*
Couepia	*polyandra*	*caca de nino*	*3*	*0*	*0*	*0*	*3*
Diospyros	*digyna*	*Sapote negro*	*0*	*0*	*0*	*0*	*0*
Eriobotrya	*japonica*	*Nispero*	*0*	*1*	*3*	*0*	*4*
Inga	*jinicuil*	*Jinicuil*	*22*	*19*	*7*	*1*	*49*
Litchi	*chinensis*	*Litchi*	*5*	*0*	*2*	*0*	*7*
Mangifera	*indica*	*Mango*	*34*	*30*	*7*	*2*	*73*
Morinda	*citrifolia*	*Noni*	*1*	*0*	*0*	*0*	*1*
Muntingia	*calabura*	*Capulin*	*3*	*0*	*0*	*0*	*3*
Musa	acuminata/balbisiana	*Platano*	*76*	*46*	*59*	*15*	*196*

Table D-1. Continued

Genus	Species	Common name Spanish	# in Homegarden	# in Coffee	# in Pasture/Rancho	# in Milpa	Total #
Passiflora	*edulis*	*Palao*	*0*	*0*	*1*	*0*	*1*
Persea	*americana*	*Aguacate*	*15*	*37*	*13*	*2*	*67*
Persea	*americana*	*Aguacatillo*	*2*	*0*	*0*	*2*	*4*
Persea	*schiedeana*	*Chinene Sapote*	*3*	*12*	*1*	*0*	*16*
Pouteria	*sapota*	*Mamey*	*3*	*17*	*7*	*0*	*27*
Psidium	*guajava*	*Guayaba*	*17*	*1*	*11*	*0*	*29*
Punica	*granatum*	*Granada*	*0*	*0*	*0*	*0*	*0*
Spondias	*purpurea*	*Ciruela*	*1*	*0*	*2*	*0*	*3*
Syzygium	*jambos*	*Poma rosa*	*0*	*0*	*0*	*0*	*0*
Tamaridus	*indica*	*Tamarindo*	*6*	*2*	*1*	*0*	*9*
Terminalia	*catalpa*	*Almendra*	*2*	*0*	*0*	*0*	*2*
Vitus	*sp.*	*uva*	*4*	*0*	*0*	*0*	*4*
Quelite							
Amaranthus	*hybridus*	*Quintonil, quelite blanco*	*1*	*0*	*0*	*4*	*5*
Cestrum	*nocturnum*	*Huele de noche*	*31*	*23*	*65*	*58*	*177*
Erythrina	*sp.*	*Coraline*	*1*	*0*	*0*	*0*	*1*
Ipomoea	*sp.*	*Quelite venado, quelite blanco*	*0*	*0*	*0*	*5*	*5*
Phytolacca	*icosandra*		*0*	*1*	*0*	*6*	*7*
Portulaca	*oleracea*	*Verdolaga*	*0*	*0*	*0*	*0*	*0*
Solanum	*americanum/ nigrescens.*	*Hierba mora*	*11*	*0*	*3*	*49*	*63*
Crotalaria	*sp.*	*chipil*	*1*	*0*	*0*	*0*	*1*
Condiments							0

Table D-1. Continued

Genus	Species	Common name Spanish	# in Homegarden	# in Coffee	# in Pasture/Rancho	# in Milpa	Total #
Coriandrum	*sativum*	*Cilantro*	*3*	*0*	*0*	*0*	*3*
Cymbopogon	*flexuosus*	*Lemon grass*	*2*	*0*	*0*	*1*	*3*
Dysphania	*ambrosioides*	*Epazote*	*23*	*0*	*0*	*0*	*23*
Eryngium	*foetidum*	*Cilantro del monte/de torro*	*19*	*0*	*0*	*0*	*19*
Lueceana	*esculenta*	*Guaye*	*4*	*1*	*0*	*0*	*5*
Mentha	*viridis*	*Hierba buena*	*7*	*0*	*0*	*0*	*7*
Ocimum	*basilicum*	*Albaca*	*6*	*0*	*0*	*0*	*6*
Ocimum	*sp.*	*Oregano*	*8*	*0*	*0*	*0*	*8*
Piper	*auritum*	*Hoja santa, ocuyo silvestre*	*16*	*3*	*6*	*3*	*28*
Plectranthus	*amboinicus*	*Oregano orejon*	*4*	*0*	*0*	*0*	*4*
Porophyllum	*ruderale*	*Papalo*	*0*	*0*	*1*	*0*	*1*
Renealmia	*alpinia*	*Huasmole, Huele mole*	*27*	*8*	*8*	*4*	*47*
Saccharum	*officinarum*	*Cana*	*4*	*0*	*0*	*3*	*7*
Vanilla	*planifolia*	*Vainilla*	*1*	*0*	*0*	*0*	*1*
							0
Vegetable							0
Allium	*sp.*	*Cebollin*	*21*	*0*	*0*	*5*	*26*
Capsicum	*annuum*	*Chile*	*18*	*0*	*6*	*3*	*27*
Chamaedora	*tepijilote*	*Tepijilote*	*25*	*3*	*0*	*0*	*28*
Cucurbita	*moschata*	*Calabaza*	*5*	*5*	*0*	*10*	*20*
Hylocereus	*undatus (?)*	*Nopal tres lobos*	*0*	*0*	*1*	*0*	*1*

Table D-1. Continued

Genus	Species	Common name Spanish	# in Homegarden	# in Coffee	# in Pasture/Rancho	# in Milpa	Total #
Solanum	*lycopersicum*	*Tomate*	*11*	*0*	*0*	*20*	*31*
Opuntia	*cochenillifera*	*Nopal*	*17*	*0*	*10*	*2*	*29*
Physalis	*philadelphica*	*Jitomate*	*0*	*0*	*0*	*9*	*9*
Sechium	*edule*	*Chayote*	*11*	*0*	*1*	*1*	*13*
Spathiphyllum	*sp.*	*Cuna de Moises, Chile de Gato*	*47*	*23*	*0*	*0*	*70*
Grain							
Phaseolus	*coccineus*		*0*	*0*	*0*	*0*	*0*
Phaseolus	*vulgaris*	*frijole*	*2*	*0*	*0*	*1*	*3*
Vigna	*ungulata*	*tripa de pollo*	*0*	*0*	*0*	*2*	*2*
Zea	*mays*	*maize*					*0*
Tuber							
Colocasia	*esculenta*	*malanga*	*35*	*0*	*0*	*0*	*35*
Dioscorea	*esculenta*	*yame*	*1*	*0*	*0*	*0*	*1*
Ipomea	*batatas*	*Camote*	*0*	*0*	*0*	*0*	*0*
Manihot	*esculenta*	*Yuca*	*10*	*0*	*144*	*1*	*155*
Pachyrhizus	*erosus*	*jicama*	*0*	*0*	*0*	*0*	*0*
Xanthosoma	*sagittifolium*	*malanga*	*15*	*0*	*0*	*0*	*15*
Beverage							
Coffea	*arabica*	*Café*	*13*	*0*	*1*	*4*	*18*
Coffea	*robusta*	*Café*	*0*	*4*	*0*	*0*	*4*
Smilax	*sp.*	*Popo, cocomelcate*	*11*	*8*	*0*	*0*	*19*
Theobroma	*bicolor*	*Cacao blanco,cacao cimmaron*	*84*	*88*	*6*	*1*	*179*
Theobroma	*cacao*	*Cacao*	*10*	*1*	*2*	*4*	*17*

Table D-1. Continued

Genus	Species	Common name Spanish	# in Homegarden	# in Coffee	# in Pasture/Rancho	# in Milpa	Total #
Utensil							
Calathea	*lutea*	*Hoja de posole*	*24*	*1*	*0*	*7*	*32*
Crescentia	*cujete*	*Jicara*	*3*	*0*	*1*	*0*	*4*
Lagenaria	*siceraria*	*Chikal*	*0*	*0*	*13*	*5*	*18*

APPENDIX E
ETHNOECOLOGY/MANAGEMENT INTERVIEW

Proyecto Chinene

Jay Bost

1. Se da chinene por aca? Does chinene grow here?
2. Tiene otros nombres? En dialecto? Does it have other names?
3. Donde hay arboles? Where are trees found?

a.monte: forest

b.cafetal: coffe groves

c.solar: homegardens

d.acahual: second growth

4. Son todos los arboles de chinene igual? Are all of the trees the same?

a.hojas: leaves

b.tiempo de brotear hojas nuevas: time to put on new leaves

c.tiempo de aflorerar: flowering time

d.tiempo de dar fruta: fruiting time

e.olor de hojas: odor of leaves

f.la cantidad de fruta que se dan? Quantity to produce

g.la edad cuando se empesan a dar? The age at which they start to bear

5. A que edad se empesan de dar los chinene? At what age do trees start to bear?
6. Son todos las frutas de chinene igual? Are the fruits all the same?

a.color: color

b.tamano: size

c.forma: form

d.cuantidad de pulpa: quantity of fruit

e.textura de pulpa: pulp texture

f.tamano de semilla: size of seed

g.sabor: flavor

h.cuantidad de fibra: quantity of fiber

7. Unos arboles dan mejores frutas de los ademas? Do some trees give better fruit than others?
8. Las frutas que se da un arbol son todos iguales? Are all the fruits from one tree the same?
9. Como son los mejores chinenes? How are the best chinene?
10. Donde se dan los mejores? Where are the best ones found?
11. Donde esta el mejor arbol que conoces? Where is the best tree you know of?
12. Usted cosechas chinene? Do you harvest chinenes?
13. De donde? From where? Donde tienes arboles? Where do you trees? Cuantes arboles tienes? How many trees do you have? Cuantos anos tienen? How old are they?
14. Como los cosechas? How do you harvest them?
15. Has sembrado unos chinenes? Have you planted trees? Como se sembra? How do you plant them? De semilla ou plantita? By direct seeding or transplanting?
16. Unos chinene se dan solos? Do some trees come up on their own?

17. Los animales se mueven las frutas? Do animals move the fruits around? Cuales animales? Which animals?
18. Como se decide cual chinene a sembrar ou dejar crecer? How do you decide which seed to plant or which trees to let grow?
19. Se prefere de sembrar ou dejar plantitas de ciertos arboles? Do you prefer to plant certain seeds or leave particular trees?
20. Como se maneja un arbol de chinene? How do you manage a chinene tree?

a.se poda: prune

b.se arrega: irrigate

c.se cuida de malezas y sombra: protect from weeds and shade

d.fumigas: apply pesticide

e.se recoje las frutas del arbole ou las dejas cajer: do you pick fruits or let them fall

f.se puede hacer injerto de chinene: do you think it is possible to graft chinene

g.la luna se hace influencia?: does the moon have any influence on tree growth?

21. Cuando se roza por milpa ou para hacer portrero se corta ou deja chinene? When clearing for milp do you cut or leave chinene trees?
22. Que cantidad se da un arbol grande? What quantity of fruit does a large tree give?
23. Un arbol se da igual cada ano? Does a single tree bear the same amount of fruit each year?
24. Durante la cosecha cuantas frutas se comen en la casa por semana? Por dia? During harvest time how many fruits do you eat weekly? Daily?
25. Como se come? How do you eat it?
26. Se usa otra parte del arbol? Do you use other part of the tree?

a. por condimento: condiment

b. por madera: construction wood

c. lena? fire wood

d. medicina: medicine

e. por animales: animal feed

f. ornamento: ornamental

27. Cuando esta la cosecha aca? When is the harvest here?
28. Crees que chinene se puede hibridizar con aguacate? Do you think avocado and chinene can hybridize? Conoces unos arboles cuales se ven intermediarios? Have you seen trees that look intermediary?
29. Hay mas, menos, ou igual numero de arboles de chinene ahora comparado a antes? Porque? Are there more, fewer, or the same number of trees now as before?
30. Usted vendes chinene? Donde? A cuanto los vendes? Se cambia el precio durante la cosecha? Do you sell chinene? Where? How much? Does the price vary during the season?

APPENDIX F
TREE/FRUIT DATA SHEETS

PROYECTO CHINENE: Fecha:
Comunidad:

Numero:
Nombre:
GPS:
Sitio (Monte, cafetal, acahual, arroyo, solar, etc..):
Dueno:
Edad:
DBH: (circumferencia a 1.3 metros/ 3.14)
Vigor (1 debil-5 muy fuerte):
Sembrado / Nacio solo:
Tipo de suelo:
Sombra / Sol
Humedad de sitio (1 seco-5 muy humedo):
Cantidad de fruta que da arbol (1 poco-5 mucho) (estimacion en costales):
Ano baja ou alta

<u>Fruta:</u>
Temporada de cosecha:
Forma de fruta:
Largo: 1. 2. 3. 4. 5.
Ancho: 1. 2. 3. 4. 5.
Pesa: 1. 2. 3. 4. 5.
Cascara: Lisa Medio Rugosa
Color de cascara: Verde clara verde oscura café morada rojo
Amarillo Negro

Pesa de semilla: 1. 2. 3. 4. 5.
Ancho de semilla: 1. 2. 3. 4. 5.
Largo de semilla: 1. 2. 3. 4. 5.

Pesa de carne: 1. 2. 3. 4. 5.
Color de carne cerca cascara: Crema Amarillo Café Verde Morada Negro
Color de carne cerca semilla: Crema Amarillo Café Verde Morada Negro
Textura de carne: Aguada Cremosa Masa Arenosa
Sabor (1 mejor- 5 mal):
Cantidad de fibra (1 nada-5 mucho):

General (1 mejor- 5 mal):

Comentarios:

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BIOGRAPHICAL SKETCH

Jay Benjamin Bost was born in Tulsa, Oklahoma in 1976. In his youth, he learned to enjoy gardening from his mother and camping and hiking from his father. His grandparents infected him with considerable wanderlust. In high school he began studies of ecology and was first introduced to the tropics in Belize. He has been hooked ever since.

His began his undergraduate work at Brown University and after exhausting its botanical and agricultural resources, transferred to Prescott College, where he enrolled in their Agroecology Program. He became increasingly interested in conservation and exploration of plant genetic resources and was introduced to Mexico for the first time on his way to Belize to complete his undergraduate final project on "Riparian Restoration through Agroforestry."

After completing his undergraduate work, he spent numerous years working on organic vegetable, medicinal, and seed farms in the United States, France, and Mexico, while traveling, exploring, and working in Mexico during the winters. During these travels he became enthralled by the cloud forests of eastern Mexico and the great variety of little known edible plants managed in this areas.

As a student at the University of Florida, he has been active with the Ethnoecology Society and helped reinvigorate the Ethnoecology Garden, which has flourished into an oasis of botanical, ethnobotanical, and social resources on campus.

He received his M.S. from the University of Florida in the spring of 2009.

All things point to more time in the Neotropics, among fruits.