LIFE AND TIMES IN A LATE FORMATIVE AND CLASSIC PERIOD SWAMP FOREST IN CHIAPAS, MEXICO

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The members of the Committee appointed to examine the thesis of KARRY L BLAKE find it satisfactory and recommend that it be accepted.

Chair

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LIFE AND TIMES IN A LATE FORMATIVE AND CLASSIC PERIOD

SWAMP FOREST IN CHIAPAS, MEXICO

Abstract

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In the Socunusco region of Chiapas, Mexico archaeological investigations have focused on the use of estuaries by native peoples during the Archaic period and the transition to agriculture. This strong research direction has afforded archaeologists a vast amount of information yet we have a void in our knowledge about the use of these areas during subsequent periods. Recovery and analysis of pollen data from a 468-cm-long sediment core (SOC05-4) collected adjacent to Cerro de las Conchas has provided insight into how people utilized and modified the swamp forest/wetland interaction zone during the Late Formative and Classic Periods as well as a record of the local environment. These data indicate that this stable swamp forest zone was utilized by tropical agriculturalists, which grew maize and likely other domesticates, and practiced shifting agriculture. El Hueyate Swamp was a stable wetland environment during this period with a minor drying episode after the advent of the Classic Period coinciding with a temporary abandonment of the swamp forest by the agricultural inhabitants.

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CHAPTER ONE

INTRODUCTION

Mesoamerica is a center for archaeological research on important issues such as the rise and fall of state-level societies, the development of cultural complexity, the advent of agriculture, and the domestication of maize, to name a few. The Soconusco located along the coastal trade route southeast of the Balsas River Valley, the ancestral home of maize, makes it one of the most important regions in Mexico for the study of the adoption and spread of maize agriculture. A section of coastal Chiapas, Mexico the Soconusco is defined as extending from just southeast of the town of Pijijiapan to just east of the international border between Mexico and Guatemala, a length of roughly 240 km (144 miles) (Voorhies 1989a). The area is also conducive to studying questions about the utilization of marginal areas from the Archaic Period to the time of contact.

Archaeological studies in the Soconusco have centered on the development of markers for cultural complexity (i.e., full-time maize agriculture, social stratification). Voorhies (1978, 2004) and her students have accumulated a large body of data on the transition from the Late Archaic to the Formative period and the adoption of agriculture. Clark and Cheetham (2002) conducted an informative study at Paso de la Amada on the development of chiefdom-level societies and social stratification during the Formative. Lowe et al. (1982) published the site report for Izapa, one of the few studies conducted on a Classic period site in Soconusco, detailing the development of this regional ceremonial and civic center. There is scant evidence of Classic period use of this region by prehistoric peoples due to current difficulties in finding cultural materials from this time period (Voorhies and Kennet 1999). Voorhies and Gasco (1989) compiled an edited volume on the economics of the period from the Postclassic until after contact.

The current study is of a sediment core, Core SOC05-4, extracted from a seasonally wet short tree savanna adjacent to Cerro de las Conchas, the oldest known site in Soconusco (Figure 1). This location was chosen for its proximity to the site and for the potential to provide more information about the Archaic to Formative transition. Core SOC05-4 provides a detailed pollen record of the wetland adjacent to Cerro de las Conchas during the Late Formative through the Classic Periods. Questions addressed by this study include: 1) what was the environment like during the time represented by this core?, 2) were people using the wetland margins in this time frame?, and 3) were they practicing agriculture?, and if so, how intensively?

Background

Previous archaeological investigations at Cerro de las Conchas have focused on the Archaic to Formative transition. Excavations have been undertaken by a number of researchers since the 1980s; John E. Clark conducted test excavations at the site in 1986 with two test pits and a four-meter trench (Clark 1986). In 1990 Richard Lesure again tested the site under the supervision of Clark (Clark et al.1990). Voorhies conducted a third test of the site in 1998 with a trench perpendicular to the slope of the shell mound (Voorhies et al. 2002; Voorhies 2004). This work has confirmed that the core of the mound was formed during the Middle Archaic Period and was utilized as a procurement site for mollusks as the mound was comprised entirely of shell (Voorhies et al. 2002). All of the excavations conducted at this site encountered a rind of sediment containing ceramics from the periods post dating the Archaic identified as Stratum I (Voorhies

2004). Two other strata, dating to the Middle Archaic, were also identified. Stratum II, found during Lesure's excavations, is comprised of mussels and limpets (Clark et al.1990; Voorhies 2004). Stratum III was found in all excavation units and is comprised of bedded marsh clamshells (Voorhies 2004).

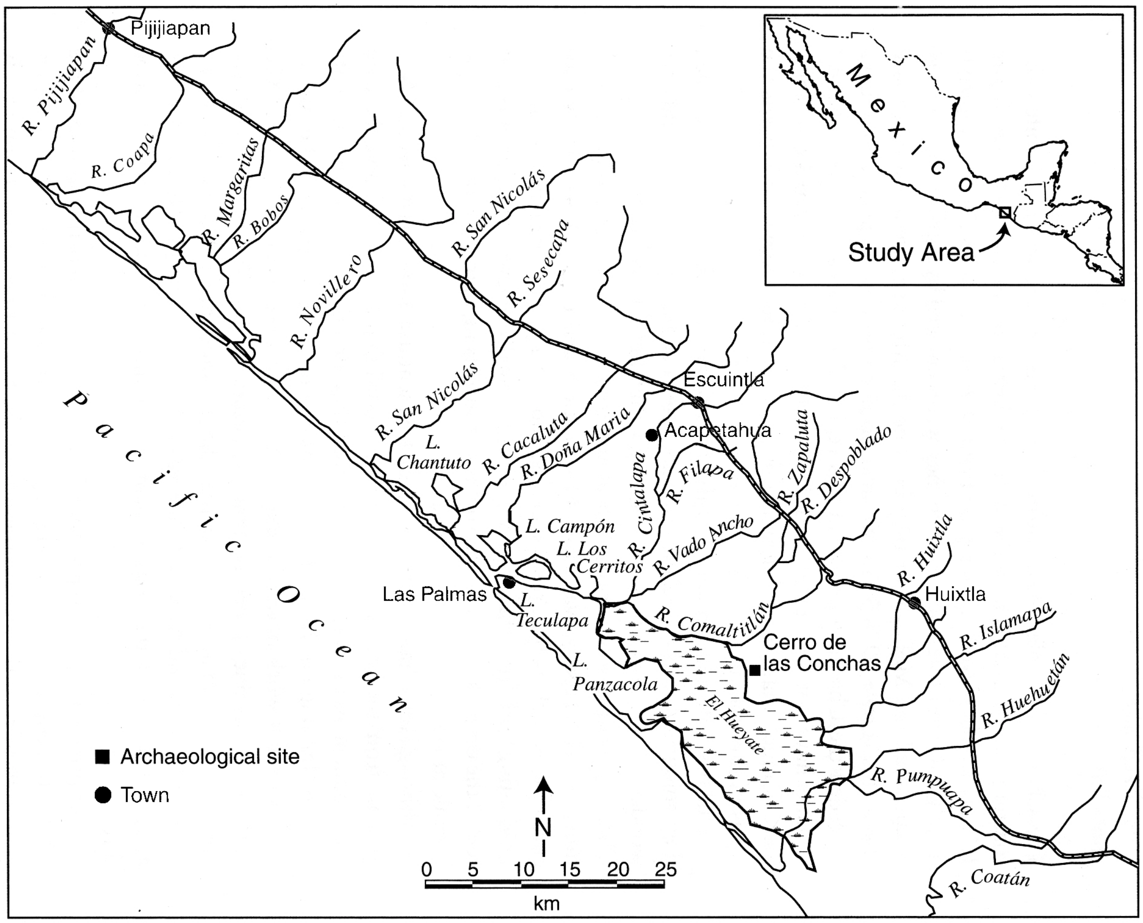

Figure 1. Map of the project area, El Hueyate Swamp Chiapas, Mexico. Modified from Voorhies (2004:2)

Paleoethnobotany has been a major constituent of previous research in the Soconusco (Jones and Voorhies 2004, Voorhies 1976). Initial research on the Late Archaic Period shellmounds found that fossil pollen did not preserve well in these contexts (Voorhies 1976). Subsequently researchers have turned to the study of phytoliths to provide paleobotanical information about this period. Jones conducted phytolith analysis on a set of samples collected from Voorhies' 1998 trench and a second set recovered from the pit excavated by Lesure in 1990, recovering samples from all contexts present at the site (Jones and Voorhies 2004). Results of this study indicate that the environment shifted dramatically through time. Samples from Stratum III indicate a grassland savanna biome to a depth of 3.4 m where a sudden shift occurs to a heavily forested environment. Forest types with some weedy species dominate phytolith assemblages recovered from the upper portion of Stratum III and Stratum II. During the deposition of Stratum I the vegetation around Cerro de las Conchas changed from forested to weedy and by 1.0 m below surface *Zea mays* was cultivated or used at the site, and human-caused clearing was taking place (Jones and Voorhies 2004).

Palynological, phytolith, or macrobotanical research has also been conducted in the Soconusco at Islona Chantuto, Tlacuachero, Vuelta Limón, and CAP-78. The sediments of the Islona Chantuto core (Chantuto 4) were deposited between the Late Archaic and the Late Classic periods (Voorhies 2004). The pollen recovered from Chantuto 4 indicated a stable wetland environment in which people were actively living and practicing horticulture on a small scale during the Late Archaic Period. The sedimentary data indicated that people abandoned the area around Islona Chantuto during the Formative and much of the Classic Periods. Subsequent to 1,000 years ago the area was again regularly inhabited (Jones and Voorhies 2004).

At the Tlacuachero site, the sediments did not contain well-preserved pollen. Here, researchers found that phytolith data was the most reliable to reconstruct past environments, though macrobotanical remains were also recovered and analyzed. Tlacuachero deposits, Late Archaic in age, are delineated by the presence of a prepared clay floor (Voorhies 2004). This creates a marked physical separation in the sediments and denotes a change in site use as seen in the phytoliths record. Evidence suggests that before the construction of the floor, the site area was intensively used often or for extended periods of time preventing grasses from growing. Sediments deposited after the construction of the floor show a relative abundance of open environment taxa suggesting periods of site abandonment (Jones and Voorhies 2004). A pollen core collected near this site in January 2005 confirmed these earlier findings of periodic human habitation in this area (Jones 2007).

Vuelta Limón is an Archaic Period aceramic site where excavations uncovered a sheet midden-like deposit (Voorhies 2004). Pollen samples were collected in two ways at this site. The first set of samples was taken from arbitrary locations in the midden-like layer and the second from a column in an exposed stratigraphic section. While differences were found in samples taken from within and outside concentrations of rocks in the midden, the samples from the stratigraphic sequence indicated an overall picture of increasing human exploitation of the area through time, peaking with dramatic clearing, and maize and squash agriculture. Later deposits show a reduction in agriculture with reforestation and greatly reduced indications of agriculture (Jones and Voorhies 2004, Voorhies 2004).

CAP-78 is a Middle Formative mound site situated downstream from Vuelta Limón. Analysis of phytolith samples from a stratigraphic profile here resulted in similar to those upstream at Vuelta Limón (Jones and Voorhies 2004).

Along the Pacific Coast and throughout Mesoamerica many other pollen studies have been conducted. Major research questions include the advent of agriculture, human-environment interaction, the origin of domesticated maize and the spread of maize agriculture. Analysis of a core collected from the Manchon swamp in Guatemala just southeast of the border with Chiapas, indicated that climatic variability was an important factor in the history of human habitation of that region (Neff et al. 2006). Cores retrieved from the Iguala Valley in the Central Balsas watershed indicate a warmer and wetter environment after the termination of the Pleistocene. Researchers also found major landscape modification and maize agriculture associated with high charcoal concentrations by 6500 B.P. (Piperno et al. 2007). A study by Pohl et al. (2007) considers the spread of maize to southeastern Mexico and finds that maize spread rapidly across Central and South America soon after it is transported out of the Balsas Depression. Leyden (2002), using a number of cores from lakes within the Maya Lowlands, demonstrates how human populations can be the dominant force influencing the distribution of plants in the areas under their influence. She found that in the Mayan region the return of forests occurred after the collapse of the Maya for much of the region while in other marginal areas deforestation occurred for the first time (Leyden 2002). The study of Late Pleistocene/Early Holocene sediments from the Panamanian lake Monte Oscuro found that the transition to agriculture took place in an environment of substantial change altering the distribution and accessibility of resources (Piperno and Jones 2003).

These are few examples produced by the study of the pollen records of Mesoamerica. These studies suggest that human modification of their landscapes have dramatic effects upon the vegetational composition and subsequently the climate by altering the vegetation composition of large areas. The larger the human population the greater their impact will be upon the plants growing in the area. Human modification of landscapes can mute and alter the climatic signature produced by local vegetation. By clearing forests, humans enable the increased transport of pollen grains and increase habitat for and productivity of herbaceous species. This in turn will mimic a drying period if the presence of human agents is not accounted for.

Current Vegetation

Soconusco is bounded in the west by the Pacific Ocean and in the east by the Sierra Madre Occidental. The Pacific Coastal Plain, of which Soconusco is a part, is a formation that extends out of central Mexico along the Pacific coast of Chiapas and into Guatemala (Breedlove 1973). Rivers cut the region and form wetlands and lagoons along the coastline. These wetlands and lagoons are then altered by sediment carried by these rivers and by the formation of barrier beaches to form an estuary zone with sheltered natural canals. Seasonal tropical monsoon rains heavily influence the Soconusco (Kennet et al. 2006). Rains are heaviest from April through October and lightest from November to March, with the mountains receiving the most precipitation and the coast the least. These rains cause the rivers to flood and replenish the soils of the coastal plain. The pattern of precipitation and the manner in which the soils drain have created four environmental zones: the littoral, the tropical short-tree savanna, the forested coastal plain, and the piedmont forest (Clark 1994).

The littoral zone, comprised by the wetlands and estuaries, is a resource-rich area. A mangrove forest and barrier islands stabilize the margins of this zone (Figure 2). This zone reaches its peak productivity during the dry season (Kennett and Voorhies 1996), where regional drying makes it more accessible to people, animals, birds, and aquatic life. Feddema (1993) provides a comprehensive list of the animal resources available in this region. These include sea turtle eggs from nests in the beaches, small animals in the beach scrub, crabs and shellfish at beach margins, and a wide variety of fish, mollusks and crustaceans in still-water habitats (Feddema 1993; Kennett et al. 2006; Voorhies 1976). It is also possible that shrimp were available during the dry season (Clark 1994) but the remains of shrimp have not been found archaeologically. Prehistoric archaeological sites in this zone indicate the region was utilized for the collection of shellfish.

Figure 2. Boats docked at Embarcadaro in the littoral zone. Note the large red mangroves in the background (photograph courtesy of John G. Jones).

Immediately inland of the littoral zone is the short-tree savanna (Figure 3). This area has poorly drained soils and floods during the annual rains. The vegetation is made up of dispersed palms with an under story of grass and herbs (Kennett et al. 2006) (Figure

3). At least two palms in this region have economic potential, *Palma real'*s pith is edible and the coyol palm has an edible fruit (Clark 1994:67). Palm fronds and stands of bamboo of this area were likely attractive to human populations as building material. Sap from the palms of this region may have also been utilized for the manufacture of a fermented palm wine before people began making maize beer (Blake et al. 1992; Pearsall 2006; Smalley and Blake 2003). During the dry season this region was home to many small- and medium-sized mammals including peccary, deer, and armadillo, all of which were used for food historically (Feddema 1993; Kennett et al. 2006).

Figure 3. Modern day savanna of Chiapas. Note cattle grazing and Sabal palms in the background (photograph courtesy of John G. Jones).

Along the inland border of the short-tree savanna is the coastal plain. This zone is typified by many different riparian and forest habitats created by the various rivers dissecting the landscape. There is a mixture of tropical deciduous forests, riparian zones, and evergreen tropical forests (Kennett et al. 2006). The zone is home to a wide variety of mammals, birds, reptiles, and fish (Feddema 1993). This region is composed of well-drained, arable soils that are replenished annually with rains. Another draw to this area for humans was the wide variety of fruit-bearing trees including avacado, sapodilla, cacao, papaya, guanabana, and guayaba (Clark 1994). Scholars believe that the coastal plain was the location of base camps for the logistical gatherers (*sensu* Binford 1980) that inhabited this region during the Archaic and Early Formative periods as well as for the later full-time agricultural groups (Voorhies 1989b). The coastal plain has a long growing season and fertile soils that are beneficial to growing maize, beans, and squash. Today this region is utilized as pasture and farm land.

The piedmont is the final zone present in the Soconusco. This is the region that connects the coastal plain to the Sierra Madre Occidental in the east. Higher rainfall in this area has promoted the growth of a lower montane forest (Miranda 1998). This area was once dense with animal life although subsequent human activities have drastically impacted it (Feddema 1993). The high canopy and dense undergrowth was an attractive to animals. This region has very fertile soils and ample rainfall but has a short growing season and greater seasonal temperature variation than the coastal plain (Kennett et al. 2006). These characteristics limit the ability to successfully grow many tropical food crops, including maize, chile peppers, and squash (Clark 1994).

Core SOC05-4 was extracted from sediments located along the northeastern boundary of El Hueyate Lake and Marsh, adjacent to the archaeological site of Cerro de las Conchas in the transitional area between the estuary and short-tree savanna. El Hueyate Lake and Marsh are large freshwater features immediately southeast of the

Acapetahua Estuary. The Cerro de las Conchas shellmound has a core of brackish water mollusks, indicating that El Hueyate was a more brackish environment when the site was initially formed (Voorhies 2004). The lake/marsh system extends to roughly 30 km^2 in the dry season, 60 km^2 and up to two meters deep during the wet season (Helbig 1976, Voorhies 2004). Today the freshwater environment is home to migratory birds and other wildlife. The predominant plants are sedges (Ciperaceae) mixed with reeds and rushes in the immediate vicinity of El Hueyate (Helbig 1976, Voorhies 2004). Along the inland margin of this body of water is a short-tree savanna and swamp forest comprised primarily of grasses, *Coccoloba* and palms. Other trees noted include *Pithecellobium*, *Caesalpinia*, *Mimosa*, and *Bursera*.

Organization

Following this introduction, I present the culture history of this area in Chapter 2. Chapter 3 outlines the field and laboratory methods used in the collection and analysis of Core SOC05-4. Chapter 4 provides detailed information about each taxa identified during analysis. In Chapter 5 I interpret and discuss these results presented in Chapter 4. Chapter 6 concludes the thesis and proposes future research.

CHAPTER TWO
CULTURE HISTORY

Investigations of Mexico's prehistory throughout the years have provided a generalized chronology for the greater area into which fit specific regional time-lines (Table 1). This thesis focuses on the Soconusco region of coastal Chiapas. Archaeological evidence indicates that people have inhabited the Soconusco region since the middle of the Archaic Period (5500-2000 B.C.). Evidence present in other regions of Mexico indicating habitation since Paleoindian times but has not yet been found in Soconusco (MacNeish and Nelken-Terner 1983; Voorhies 2004). To date, investigations of this region have led to the greater understanding of the Preclassic periods especially, with less emphasis on the Classic and Postclassic occupations. This section presents the chronology of the Soconusco area within the wider context of Mesoamerican prehistory through the Classic period. Details on general Mesoamerican culture history have been taken from Evans (2004) and Coe and Koontz (2002) unless otherwise noted. A summary of the information presented in this chapter is provided in Table 1.

Overview of Mesoamerican Culture History

Archaic (8000-2000 B.C.)

The evidence for the Archaic Period is meager but indicates that this 6000-year period was one of significant change in the lifeways for the inhabitants of Mesoamerica. During this time, the subsistence patterns of the inhabitants shifted from a highly nomadic, large-game-focused hunting and gathering lifestyle to a sedentary or semi-sedentary lifestyle with a restricted foraging territory. Accompanying these changes was reliance upon plant foods such wild grasses, *agave*, or cacti. This is evident in the dramatic increase in plant processing implements found at archaeological sites, including informal grinding surfaces and hand stones (Adams 2005; Evans 2004). In the arid northern extents of Mexico, seeds and nuts became important parts of the diet after the advent of the Holocene (Evans 2004). According to Willey (1966) the roots of Mesoamerican culture are found in the deserts of the North American desert west. The Great Basin practice of small-game hunting and foraging for plant foods is very similar to adaptations in Mesoamerica during the early Holocene. Dry caves in northern Mexico, such as Frightful Cave, remains of grinding implements, baskets, sandals, and plant remains have been found at the earliest levels, 6900 to 5300 B.C. (Evans 2004, Taylor 1966). At Frightful Cave remains of prickly pear (*Opuntia*) fruits and pads were found along with mesquite (*Prosopis*) beans and pods along with numerous other plant specimens in the archaeological deposits (Taylor 1972). These plants were still in

Table 1. Overview of Mesoamerican and Soconusco chronologies

General Mesoamerican Chronology		**Date**	**Soconusco Chronology**	
Major Developments and Trends	**Period**		**Period**	**Major Developments and Trends**
		8000 7000 6000		No evidence of occupation during this time
Domesticated local varieties of plants Became semi- to fully sedentary horticulturalists Cultivated maize, beans, and squash Increased trade between groups	Archaic	5500 5000 4500 4000 3500	Chantuto A	Shell midden primary site Utilized littoral zone for shellfish No obsidian
		3000 2500 2000	Chantuto B	Logistical collectors, shell middens, one inland site Obsidian used
No data from this time				

Table 1. Overview of Mesoamerican and Soconusco chronologies

General Mesoamerican Chronology: Major Developments and Trends	General Mesoamerican Chronology: Period	Date	Soconusco Chronology: Period	Soconusco Chronology: Major Developments and Trends
		1500	Barra	First use of pottery Chiefdom development Hunter-fisher-gatherers Practicing shifting agriculture
Living in compact settlements First ball court appears at Paso de la Amada	Early Formative	1400 1300	Locona	2-tier settlement system Increased social strat. First ball court
Chiefdomlevel organization beginning of social class differentiation		1200	Ocos	Obsidian at central villages Figurines appear
First state-level society, Olmecs		1100	Cherla	Increased Olmec influence Subsistence patterns similar
		1000	Cuadros	3-tier settlement system developed Adopt Olmec ceramic styles
		900	Jocotal	1st large centers monumental constructed
Complex social and political systems Long Count calendar Waning of the Olmec state	Middle Formative	800 700 600	Conchas	Monumental architecture People move to Rio Naranjo Valley Spec. manufacture of goods Prismatic obsidian blades + reliance upon maize Domestic dog meat source
		500 400		
Numerous state level societies City building Social hierarchies Craft specialization Complex agricultural systems	Late Formative	300 200 100 0 A.D. 100 200	Late Formative	Izapa is the regional center Producing and trading cacao Formalized city layout Specialized collectors utilizing the wetlands Increased reliance upon agriculture . Population increase .
State level societies with vast agricultural fields Rise of Teotihuacan Defensive locations for civic and ceremonial centers Human sacrifice Mass production of goods	Classic	300 400 500 600 700 800	Classic	Collapse of centers in Naranjo River Valley Izapa collapse but is still used ritually Adoption of full-time agriculture Broadened prey selection

Table 1. Overview of Mesoamerican and Soconusco chronologies

General Mesoamerican Chronology			Soconusco Chronology	
Major Developments and Trends	**Period**	**Date**	**Period**	**Major Developments and Trends**
Rigid, secularized states Mexico wide economy Reorganization of trade relationships	Postclassic	900 1000 1500	Postclassic	Organized into small polities Conquered by Aztecs Full-time agriculturalists

use by the area inhabitants at the time of contact and were noted ethnographically as food sources (Taylor 1972).

In response to increasingly seasonal conditions, the inhabitants of Archaic Mesoamerica became increasingly scheduled in their movements especially in the highlands of central and southern Mexico (Flannery 1968). The increasing reliance upon plants in the diets of Archaic Period hunter-gatherers required them to be in specific places to harvest the food materials in season. Excavations have revealed that *agave* was an important food source to the people of the Archaic. Quids comprised of *agave* fibers have been found at several Archaic Period sites, including Frightful Cave and Guilá Naquitz Cave, indicating the plant's dietary importance (Marcus and Flannery 1996; Taylor 1966). Other food items collected at Guilá Naquitz include acorn pulp, various fruits, cactus leaves, and the remains of deer and rabbit (Marcus and Flannery 1996). The range of plant remains present in the early sediments of Guilá Naquitz indicates it was a seasonally occupied cave used during the summer through winter (Evans 2004; Marcus and Flannery 1996). People began using domestic gourds as storage devices as evidenced by remains from several dry caves (Clark and Blake 1994; Evans 2004). Toward the end of the Archaic Period domesticated plants begin to be used. Pollen data from Pulltrouser Swamp indicates that maize and manioc were present (Pohl et al. 1996).

With the extinction of the megafauna ubiquitous during the Ice Age, people adjusted their hunting techniques to exploit small- and medium-sized game and became adept at utilizing the seasonally available plant products in their regions. In more coastal areas, people also began to utilize marine resources. As time progressed, the continuous exploitation by people of the plants in their foraging territory caused changes in the plants, such as *Zea mays,* and plant communities in their range. Trade between groups, evidenced by marine shell beads found at inland sites such as Frightful Cave (Taylor 1972), enabled the spread of these new types of plants throughout Mesoamerica. By the end of the Archaic Period, the inhabitants of Mesoamerica had domesticated and become adept at cultivating the maize, beans, and squash that later became the mainstay of their diets (Adams 2005; Coe and Koontz 2002;Voorhies 1996).

Formative Period (1500 B.C.-A.D. 250/300)

The Formative or the Preclassic is comprised of three subphases, Early (1500-900 B.C.), Middle (900-300 B.C.), and Late (300 B.C.-A.D. 300). According to Willey (1962) this period establishes the unity of Mesoamerica as a culture area. The Formative period begins with people living in autonomous villages and by its termination the inhabitants of Mesoamerica are organized into hierarchical societies. The adoptions and refinement of agriculture certainly enables the sweeping changes, in the social order and ceremonial practices across Mesoamerica that typify this period.

During the Early Formative (1500-900 B.C.) Period, scholars find the first consistent evidence of the presence of cultural traits that became the hallmarks of

Mesoamerican cultures (Table 1). Specifically, social complexity was developed and elaborated upon throughout the Early Formative Period (Grove 1981). Social complexity is defined in this context as the presence of hierarchical relationships within groups and between groups that influence social interaction at a societal level. A major aspect of the development of social complexity is the establishment of social, ideological, and institutional practices that are connected to the enfranchisement of elites and the sustaining of their dominion over societies (Mann 1986). This influence of a small group of people over the majority is a dramatic shift away from general egalitarianism present in the Archaic. With an egalitarian society an individual may be considered a leader but everyone has access to this person and leaders do not have the ability to command. In a society with elites, this social group has the ability to command and control the actions of those of lesser status. During this period, people begin living in compact, permanent settlements and the earliest known Mesoamerican ball court was established at Paso de la Amada (Blake 1991, Clark and Cheetham 2002). The establishment, use and maintenance of a ball court is usually considered evidence of investment in creating and supporting the elite status of a few people by the majority.

By the end of the Archaic the people of Mesoamerica had begun to actively grow specific plants for use as food. During the Formative, farming becomes a viable and effective subsistence strategy throughout much of Mesoamerica, supplying surplus foodstuffs to support an increasing population. Slash-and-burn or shifting agricultural techniques developed during the Archaic were the norm along with the cultivation of maize, beans, squash, chili peppers, some cacao, sweet manioc, and agave (Coe and Koontz 2002; Evans 2004; Willey 1962). The increasing population size seen through the

Early Formative caused an increase in the amount of cultivation occurring and enabled an increased rate of innovation. The increasing reliance on farming changed their material culture. Grinding stones become more common and displayed increasing complexity; while the ceramic industry flourished and flaked stone artifacts become more refined. People began to use looms to weave cloth, and they began to manufacture female figurines of clay (Adams 2005; Coe and Koontz 2002; Evans 2004; Willey 1962).

The improvements in farming changed the Mesoamericans' perception of their world. The people of Mesoamerica reordered their cosmology, centering it not as much on natural features but rather on the field plot as the focus through which they sustained themselves and their gods (Evans 2004; Love 1999). With the increasing importance of maize and agriculture in the lives of Mesoamerican people, the first depictions of maize deification appeared in this period, though full florescence of the maize cult is not evident until the Middle Formative and the dominance of the Olmec culture (Evans 2004).

Exotic obsidian, shell, art, and pottery all indicate that long-distance trade routes and relationships are in use. In Veracruz along the gulf coast of Mexico, the Olmecs, the first state-level society of Mesoamerica, rose to power in the latter part of the Early Formative and became the dominant cultural influence south and east of the Isthmus of Tehuantepec (Coe and Koontz 2002; Diehl 2004; Evans 2004).

The Middle Formative (900-300 B.C.) brought about another florescence of the Olmec culture; though by the end of this period they would lose their power and influence (Diehl 2004, Evans 2004) (Table 1). Other regions throughout Mesoamerican such as the Basin of Mexico, the Valley of Oaxaca, and the Río Naranjo region of Guatemala began to expand and develop complex social and political systems. The Long

Count calendar came into use during this period and became a standard part of Mesoamerican ritual and daily life (Diehl 2004). Through Olmec influence, elites became associated with mystical beings and the control of climate and plant growth. As the cultural dominance of the Olmec began to wane, widespread trade networks began to move ideas across the landscape from areas such as the Valley of Oaxaca and Guerrero. By the termination of this period chiefdoms were widespread and egalitarianism less common (Adams 2005, Coe and Kootz 2002, Evans 2004).

The Middle Formative is a period in which people elaborated their agricultural techniques and honed their craft specializations. Between 900 and 800 B.C. increased moisture in central Mexico encouraged the expansion of field systems, while a subsequent drier period from 800 – 550 B.C. (Messenger 1990) may have required development of a system to take water to the field systems. In the Puebla region, at Cerro Amalucan, a system of drainage and irrigation canals was developed and an expansion of fields systems is seen. This intensification and manipulation of landscape for agriculture is also found in the Basin of Mexico (Evans 2004). In Belize, an archaeological study at the site of Colha has shown extensive land modification and the draining and filling of swamplands to maintain their agricultural fields (Jones 1994). Entire settlements became known for their specific trade goods. The site of Laguna Zope, located at the western extent of the Pacific Coastal Plain, became renowned for their trade in seashells used in lapidary work (Evans 2004).

By the Late Formative (300 B.C.-A.D. 300) political organization in Mesoamerica as a whole can be characterized as chiefdom in level with incipient state formation in the most densely populated areas (Table 1). Subsistence during this period was still focused on agriculture and the production of the Mesoamerican staples mentioned previously. The major changes and trends of this period were in society and demography. State-level societies developed in the Valley of Oaxaca, the Valley of Mexico, Guerrero, and the Maya Lowlands at this time. Vast increases in population help support increases in social complexity and in the construction of cities occurring at this time. Writing and calendrics developed by the Olmecs became tools of the elite (Adams 2005; Coe and Koontz 2002; Evans 2004).

While in the Early Formative Period, elites were encouraged and supported by the general populace, by the Late Formative elites relied upon social, ideological and institutional controls to maintain their position (Love 1999b). Monumental architecture combined with writing and calendrics were utilized to justify elite power and became devices through which they controled the general populace (Adams 2005; Evans 2004). Along with the state level of organization came an increasing amount of power wielded by elites. Elites require goods through which they advertise their status. Craft specialization provides these goods and creates further stratification within societies (Adams 2005; Coe and Koontz 2002; Evans 2004). Prestige goods were widely traded across Mesoamerica along the same routes that helped spread agriculture across the region.

By the Late Formative Period, domesticated crops were thoroughly entrenched and producing a surplus to help support the needs of craft specialists and elites. Agricultural staples of maize, beans, and squash are still of significant importance. People begin employing new techniques during this period to increase the agricultural productivity and usefulness of land, such as constructing the extensive canal systems and the drained fields of Teotihuacan (Adams 2005; Coe and Koontz 2002; Evans 2004). Drained and raised fields were also present in the Maya region of Belize (Jones 1994; Pohl et al. 1996). In Teotihuacan and among the Maya there is no evidence that agriculture was state controlled. It is believed that market economies were present by the end of the Formative (Adams 2005, Coe and Koontz 2002, Evans 2004). By the termination of this period, Olmec influence had disappeared and Teotihuacan became the dominant culture of Mesoamerica.

Classic (A.D. 250/300-900)

Scholars consider the expansion of Teotihuacan in central Mexico as marking the beginning of the Classic Period (Coe 2002). State-level societies with large ceremonial and urban centers appeared across Mexico. Teotihuacan's influence is apparent throughout Mexico and scholars consider it the primary political power during the Classic Period. By this time, the Maya and Zapotecs were using the long count calendar to keep track of years. This suggests they had full hieroglyphic scripts as well, though no books remain from this period (Coe and Koontz 2002). Archaeological remains indicate people throughout Mexico worshipped a single pantheon of gods, many of which were shared by the Maya. The elite of these state-level societies constructed their civic and ceremonial centers in defensible locations (Coe and Koontz 2002; Evans 2004). On the Gulf Coast of Mexico, elites were using human sacrifice during the Classic at levels similar to those practiced by the Aztecs at the time of European contact (Coe and Koontz 2002). Social stratification was strongly reinforced during this period and in some cases became more distinct. Temple complexes became more frequent and elaborate, reinforcing the elite status of religious leaders (Adams 2005; Coe and Koontz 2002; Evans 2004). At

Teotihuacan there is evidence of apartment complex-like living quarters for specific craft specializations and separate elite districts within the city (Evans 2004).

Populations continued to grow during the Classic Period supported by full-time cultivation of maize, beans, pumpkins, tomatoes, and squash with the addition of chili peppers (Adams 2005; Evans 2004). Agave, manioc and other root crops were being cultivated or collected to help meet dietary needs (Adams 2005; Pohl et al. 1996). Manioc is especially underrepresented even in pollen records as the plant can be cultivated and used by humans without having to flower (Jones 1994). Recently, Dahlin et al. (2007) used soil chemistry analysis to identify a Classic Period marketplace in Guatemala. This indicates that a market economy was functioning in at least the Maya region of Mesoamerica. It also suggests that the Mayan state did not control food production in their polity.

Craft specialization continues with evidence for mass production and the use of molds to produce ceramic ritual items (Coe and Koontz 2002; Evans 2004). Art styles and products are widely spread across Mexico at sites of this age possibly indicating increased trade and/or warfare. However, the latter may be less likely considering the lack of defensive locations for non-ceremonial and non-civic settlements.

The end of the Classic period is defined by events in the major city centers of Teotihuacán, Monte Albán, and the lowland Maya cities (Weaver 1972). These were areas of centralized control, power, and government and, as these centers collapsed, turmoil disseminated to the regions they under Mayan dominance. Teotihuacán collapsed around A.D. 650 with the destruction of the elite residences and the ritual spaces (Adams 2005; Coe and Koontz 2002; Evans 2004). In the Maya Lowlands, the Yucatan peninsula, Belize, and Guatemala, construction projects were abandoned in the middle of work, stelae were smashed, and some places were abandoned after the carving of their final date, ranging between A.D. 800 and A.D. 889 (Weaver 1972). Theories abound to explain the collapse of this period. One suggests that the collapse of the agricultural system and the lack of productivity of the fields caused a disenfranchisement of those in power leading to the collapse of the state (Coe and Koontz 2002). At Teotihuacán the intentional destruction of the elite and ceremonial districts suggests an uprising of the lower classes (Adams 2005; Coe and Koontz 2002; Evans 2004). Another theory on the collapse proposes that disaffected nobles caused destabilizing internal pressure (Coe and Koontz 2002). Adams (2005:274) puts it most simply by stating collapse occurred when the civilization had "developed in unbalanced and inefficient directions." Given that these states fell within a short time of each other across Mesoamerica, it is likely that some regional factor influenced their demise. It does not seem probable though that the collapse of such large societies fell for a single reason—it is more likely that various local issues contributed to the break down at the end of the Classic Period.

Soconusco Culture History

Archaic (5500-1500 B.C.)

Unlike many parts of the New World, the Archaic of the Soconusco region is the focus of much research. This region provides an excellent window through which to study the transition from hunting and gathering to an agricultural lifeway because the region was one of the earliest to encounter the spread of maize. The evidence for this period is found primarily in the form of shell mounds along the inland edges of estuaries with very few inland sites identified. The Chantuto Phase equates to the Middle and Late

Archaic periods in the greater Mesoamerican chronology (Table 1). This period is broken into two subphases, Chantuto A (5500-3500 B.C.) and Chantuto B (3500-1500 B.C.), based on changes in artifact assemblages and the distribution of radiocarbon dates (Blake et al. 1995; Voorhies 2004). The artifact assemblage of Chantuto A is comprised primarily of scraping tools made from bivalve shells with no presence of obsidian. Recovered Chantuto B artifacts include hammer stones, grinding stones, and some items made of obsidian (Blake et al. 1995).

Recovery of Chantuto A materials has occurred only in shell mound contexts, primarily at the site of Cerro de las Conchas, but excavations have yet to uncover the basal levels making the date for the beginning of this phase conditional (Voorhies 2004). Similarly, materials dating to the Chantuto B period are from numerous shell mounds and one inland site, Vuelta Limón. This site has material that is transitional from the Chantuto B to the subsequent Early Formative Barra phase. In shellmound contexts, the archaeological boundary between Chantuto B and younger deposits is misleading. After abandonment, later occupants of the region mined the shellmounds for shell thus disturbing and mixing the upper deposits of the mounds (Voorhies 2004). This disturbance has made the termination date of 1500 B.C. for the Chantuto B Phase relatively tentative.

The shell middens are the most visible site type left by the inhabitants of the Soconusco during the Archaic but researchers do not believe this record fully reflects the subsistence patterns of the period. Due to the seasonal flooding of the estuary zone Voorhies (2004, 1996, 1989b, 1976) and Blake et al. (1995), have proposed that a more collector-like (*sensu* Binford 1980) subsistence pattern was in place. It has been proposed that the groups lived on the upper slopes of the coastal plain. Specialized collectors repeatedly utilized the estuaries for its easily acquired food materials while foraging and hunting the coastal plain and the lower slopes of the Sierra Madres. The site of Vuelta Limón is likely an example of such an inland base camp (Voorhies and Kennett 1995; Voorhies et al. 1991).

Several factors limit the visibility of archaeological remains in this period. Most important is the rapid rate of sediment deposition from seasonal flooding that has severely affected inland sites. A survey of riverbanks conducted by Voorhies and Kennett in 1991 highlighted this issue (Voorhies and Kennett 1995). Unfortunately, this period lacks temporally sensitive artifact classes that allow for relative dating and archaeologists must rely upon radiocarbon assays and the lack of ceramics to firmly place sites within the Chantuto Phase. Research currently focuses upon excavation of the shell mounds and collection of sediment cores. These methods allow archaeologists to learn more about the early inhabitants of the region as well as further explore the adoption of agriculture.

Formative (1500-500 B.C.)

In the Soconusco region the Formative is divided into eight different subphases, Barra, Locona, Ocos, Cherla, Cuadros, Jocotal, Conchas A-C, and Conchas D.

The Barra Phase (1500-1400 B.C.) is transitional for the Soconusco, an adjustment from a predominantly hunting, fishing, and gathering lifestyle to one more reliant upon agriculture (Table 1). The Barra phase also has evidence of the first extensive settlement and use of pottery in the region. Researchers have termed the people of this period the Mokaya; it is unclear if they were immigrants or *in situ* descendents of the Chantuto people (Blake et al. 1995; Evans 2004). Archaeologists have identified 15 sites containing Barra phase components in the region. Finely made, high-quality ceramics are the key artifacts used to identify this phase. The vessels were of primarily two types: the *tecomate*, a plate-like vessel, and a deep bowl (Lowe 1975). The *tecomate* are legless and flat-bottomed during this phase. Bowls are found in two main forms: with wide apertures and no shoulders, and with a constricted opening and pronounced shoulders (Blake et al. 1995; Lowe 1975). The latter might be referred to as a jar in the American Southwest. All vessel types were decorated during this period, including storage and cooking pots (Blake et al. 1995; Evans 2004). During the Archaic, people used domestic gourds as storage devices and scholars believe that ceramics developed as an extension of this technology (Clark and Blake 1994). Though figurines are common elsewhere in Mesoamerica during the Early Formative, there are few associated with Barra deposits.

The subsistence practices among the people of the Soconusco during this period are also very different from other parts of Mesoamerica. Stable carbon-isotope analysis conducted on two samples of human bone, from San Carlos and Paso de la Amada, indicate very little consumption of C_4 plants, such as maize (Blake et al. 1992a). Researchers have found that the stable carbon-isotope ratios in human bone reflect the relative importance of the various types of plants and animals consumed (Price 1989). It has been found that consumption of C_4 plants (i.e., maize, tropical grasses, and types of amaranth) result in relatively high stable-carbon values while C_3 plants (i.e., most flowering plants, temperate-zone grasses and many trees and shrubs) have the opposite effect (Chisholm 1989; Vogel and van der Merwe1977). These data suggest that the people of the Soconusco during the Barra Phase were not eating a diet comprised primarily of C_4 plants. This does not mean that maize was not present in the region, but do suggest that it was not a dominant food source.

Macrobotanical and faunal remains associated with Formative period Barra Phase sites display a heavy reliance upon hunting, fishing, and collecting and demonstrate the cultivation of C_3 plants, such as beans, gourds and possibly avocado (Blake et al. 1992a, 1995; Evans 2004). Fish remains are common among the faunal assemblages from this period and include both freshwater and brackish species indicating a continued exploitation of the estuary zone popular during the preceding Chantuto phases (Blake et al. 1995). A connection may exist between this lack of maize reliance and the productivity of the variety of corn they were growing at this time. Remains of cobs recovered from this period are only about one inch in length, which would not provide an adequate food source. This is sufficient for the production of a supplementary food source or for the manufacture of beer (Evans 2004). It has been proposed that the spread of early maize may have occurred so rapidly because the maize stalks were being utilized to produce alcoholic beverages to replace fermented palm sap (Blake et al. 1992b; Piperno 2006; Smalley and Blake 2003). The use of fermented beverages in the ritual sphere would have encouraged people to adopt this plant to help maintain their ritual practices.

In Mesoamerica, the Soconusco was precocious in the development of a chiefdom-level social structure during this period in a few isolated settlements. It was; however, slow to adopt a full reliance upon maize agriculture. In other parts of Mesoamerica, such as Belize, the inhabitants were intensifying their production of agricultural products; the people of the Soconusco were still relying on a rather broad diet. Subsistence remains recovered from archaeological contexts indicate the consumption of maize, avocado and beans, combined with wild estuarine plants and animals (Blake et al. 1995).

A change in settlement pattern and material culture occurs during the succeeding Locona Phase though the people continued to rely on a mixed subsistence base of estuary resources, hunting, and agriculture (Blake et al. 1995). Archaeologists identify the Locona Phase (1400-1250 B.C.) by a marked change in ceramic decoration, new vessel forms, a greater variety in vessel size, and the first appearance of anthropomorphic and zoomorphic figurines (Blake et al. 1995; Evans 2004) (Table 1). The period shows continued growth in population levels and the development of a two-tiered settlement system of central villages and hamlets. To accommodate increased organizational needs of a larger populace, chiefdoms become more prevalent, and there is evidence for increases in social stratification.

Scholars consider the site of Paso de la Amada as the first central village in the Soconusco during its Locona occupation. The site was occupied during the Barra period but expanded significantly and became a cultural center during the Locona (Blake et al. 1995; Clark and Cheetham 2002; Evans 2004). At Paso de la Amada, archaeologists recovered the remains of the first elite residences and the first definitive formal ballcourt (Blake et al. 1995; Clark and Cheetham 2002; Evans 2004). Researchers believe that the presence of the ballcourt indicates people were supporting the transition into a more stratified society by encouraging intervillage competition that added to the prestige of those in power (Clark and Cheetham 2002:295).

The trend toward increasing social and organizational complexity continues in the succeeding Ocos Phase (1250-1100 B.C.). Only in the last twenty years has this phase been determined to be distinctive from Locona (Blake et al. 1995). All of the sites determined to be Locona in age have an overlying Ocos component and the population expansion continued during this phase, establishing many new communities. New settlements continued the patterns of the Locona with a two-tiered system of central villages surrounded by smaller settlements (Blake et al. 1995). Clark and others (1989) have suggested that, during the Ocos, the presence of obsidian primarily in the central villages, with minimal amounts in the hamlets, is evidence of the continued presence of social stratification of society and political control held by elites.

The material remains of the Locona and Ocos phases display continuity with some minimal changes in the ceramics. This period sees the first occurrence of brown and gray wares, and figurines are at their most abundant for any period in Soconusco prehistory (Blake et al. 1995). Subsistence patterns in this period continue to display continuity with previous periods. Stable isotope research conducted upon human remains from this region indicates that people were not relying on C_4 but instead were utilizing a more mixed diet including marine resources, terrestrial animal, domesticated and non-domesticated plants (Blake et al. 1992b).

Compared to the continuity seen between the Locona and Ocos phases, the Cherla Phase (1100-1000 B.C.) is a period of rapid changes. The increasing influence of the Olmec culture has spread to the Pacific Coast by this period, indicated by the appearance of Olmec-influenced figurines, ceramics, and stone carvings seen near Pijijiapan (Blake et al. 1995; Voorhies 1989a). These Olmec-style sculpture, dating to the earliest Olmec tradition, on large, non-portable stone, suggests the physical presence of Olmec people in the Soconusco during this period (Voorhies 1989a). The specific nature of the Olmec – Soconusco relationship is currently under consideration by archaeologists. The presence of the stone carvings near Pijijiapan combined with the early formation of chiefdom-level societies in Soconusco supports the possibility that the Olmecs arose in the Soconusco and migrated to the eastern lowlands, rather than originating in the eastern lowlands and migrating to the Soconusco.

A signature item of the Olmec cultural suite is an abundance of magnetite mirrors thought to be status markers (Evans 2004). At Paso de la Amada magnetite mirrors are found with increasing frequency during this period indicating and increasing amount of trade and continued support of social stratification and complexity (Blake et al. 1995). At this time, Olmec forms replace figurine styles present during previous periods (Blake et al. 1995). Traditional Soconusco pottery forms, such as the *tecomate,* were used less frequently in central villages though outside of these villages the *tecomate* was still a dominant vessel type. Central villages also displayed the Olmec influence by replacing their traditional red-ware ceramics with brown- and gray-wares. This again is not a pattern seen in the peripheries, such as specialized procurement sites (Blake et al. 1995).

Evidence suggests that sites located in the estuaries provided aquatic food resources for those living inland (Blake et al. 1995) indicating a subsistence pattern similar to the logistical collectors (Binford 1980). A Cherla Phase storage pit excavated at the site of Aquiles Serdán contained a variety of faunal material indicating the utilization of fresh/brackish water estuaries, fresh water areas, and various terrestrial mammals, including domesticated dog, in their diet (Flannery and Mudar 1991). However, remains of *Zea mays* have been recovered from this and all other Early Formative phases along with remains of squash, chile peppers, and avocado (Rosenswig 2006b). It is thought that crops were being grown with swidden or slash-and-burn agricultural techniques. Dietary evidence, in the form of stable carbon-isotope data from three samples of skeletal material, suggests a limited reliance on maize agriculture (Blake et al. 1992a, 1995). As of yet, it has not been possible to conduct stable carbon-isotope analysis on a large enough population to enable differentiation by status. Therefore it is not possible to discuss differential access to maize products as influenced by status, wealth, or ritual importance.

Olmec cultural influence became more widespread and expansive during the subsequent Cuadros Phase (1000-900 B.C.). There is some debate among scholars about whether the identified Olmec "influence" is an *in situ* development or an importation of the material culture of a dominant group (Blake et al. 1995). Continuity between the Cuadros and the Ocos Phases are seen in the continued strong presence of Olmec material culture. Nevertheless, Cuadros is distinctive with changes in settlement pattern; they establish a three-tier settlement system, and a more complete adoption of Olmec ceramic styles.

Material culture collected from Cuadros deposits is currently limited and few dates have been acquired (Blake et al. 1995). The people of this period constructed a new cultural center along the Coatan River and developed a three-tier settlement system of hamlet, village, and center. The 44 identified sites with Cuadros materials indicate a settlement system that had generalized sites or base camps as well as villages and centers inland and specialized procurement sites found in the estuaries (Blake et al. 1995). As seen during the Ocos Phase, the traditional *tecomate* form continued to decline at the larger sites while it remained the primary form found at the estuary sites. The ceramic assemblages from this period show a marked change with Olmec-like black-, white-, and gray-wares replacing all of the traditional redwares (Blake et al. 1995). This phase appears to represent a continuation and wider acceptance of the Olmec influence that first appeared in the Ocos period. Stable carbon isotope data for the Cuadros period does not indicate a reliance on maize (Blake et al. 1992a) though maize cupules have been recovered from Cuadros-age deposits (Coe and Flannery 1967). It is likely that people continued to utilize broad-based subsistence strategies while growing and consuming some maize.

As Olmec power and influence expands throughout the rest of Mexico, during the Jocotal Phase (900-850 B.C.) in the Soconusco, their motifs also became more common and are found deeply incised onto gray- and black-wares. The Jocotal Period is very short lived in Mexico but is thought to have lasted longer in the Guatemala portion of the coastal plain. Accurate dating of this period is still difficult and scholars are in need of more samples to verify the dating (Blake et al. 1995).

Evidence provided by Jocotal Phase sites indicates continued population growth. It is estimated that the population doubled in size compared to the previous phases based upon the site frequency and size. Jocotal phase ceramics are present or dominant on the surface of most sites in the Soconusco. A three-tiered settlement system came into use in the previous period; however the first large regional centers with monumental construction are thought to appear during the Jocotal Phase (Blake et al. 1995). Archaeologists identify this phase by changes in ceramic assemblage much like previous periods. Traditional *tecomates* comprise about 15 percent of the assemblages collected from Jocotal sites; versus 25 percent in the Cuadros Phase, 35 percent in the Cherla Phase, 45 percent in the Ocos, 47 percent in the Locona, and 85 percent during the Barra; with bowl and jar forms predominating (Blake et al. 1995). This period's settlement hierarchies and ceremonial mound building and use mark the transition from the Early to Middle Formative in the Soconusco.

Subsistence during this period is still relatively broad based. Stable isotope data still suggests a lack of large-scale consumption of maize (Blake et al. 1992). While archaeological deposits at Salinas La Blanca contained maize cob casts (Coe and Flannery 1967), it is likely that Jocotal Phase occupants of the Soconusco were continuing to rely on a broad base of subsistence resources including fish, mussels, reptiles, deer, and domesticated dog as seen in earlier phases.

During the subsequent Conchas Phase (850-500 B.C.), construction and use of monumental architecture and the centralization of populations became more pronounced. This period is also thought to have the first documented stratified society in the region (Love 2002, Rosenswig 2006a). Archaeologists believe that the people of the Soconusco at this time began to congregate in the Naranjo River valley. This is based on the presence of the large civic/religious center of La Blanca, and because 80 percent of the identified Conchas Phase sites are located in the Naranjo River valley (Blake et al. 1995). The cause of this apparent population relocation is currently unknown.

The presence of La Blanca style ceramics indicates that La Blanca's area of influence stretched from Izapa in the west to Río Ocosito in the east (Love 1999b). Izapa was influential to the north and west along the coastal plain of Chiapas (Lowe et al. 1982) and flourished primarily after the fall of La Blanca. According to Love (1999b) two other cultural centers were present during this period in Guatemala: Abaj Takalik, 45 miles east of La Blanca, and Ujuxte 45 miles to the southeast of Abaj Takalik. The latter site was founded near the end of this period around 600 B.C. as La Blanca began to decline (Love 1999a, 1999b). This period is generally separated into two phases, Conchas 1 and 2, but has been subdivided into as many as four subphases using more finely demarcated material difference such as Love's description of La Blanca phases or Lowe et al.'s Izapa phases (Blake et al. 1995; Lowe et al. 1982; Love 1993). Scholars distinguish the subphases based upon changes in ceramic decoration and vessel form as well as the addition of new types.

An overall trend in the Conchas ceramic assemblage is the shift to putting a new repertoire of Olmec motifs on white-slipped ceramics rather than the grey- and black-wares as seen during the Jocotal phase (Blake et al. 1995). Subsistence during this phase began to rely heavily upon domesticated dog and maize, which in turn decreased the demand for a greater diversity of food materials to be collected and increased the demand for items requiring specialized manufacture (Blake et al. 1992a). Materially, the Conchas phase shows increased sophistication in the needs of the people and the specialization of manufacture. Specialty ceramics of kaolinite clays are manufactured during this phase, while prismatic obsidian blades were imported to supplement household needs (Blake et al. 1995). During previous phases prismatic blades were limited to elite residences and ceremonial precincts. The increased production of specialty ceramics suggests greater participation among the non-elite social classes in ceremonial and ritual activities and possibly an increased use of these specialty ceramics as status symbols.

One of the most significant subsistence changes seen during this period is an apparent increased reliance on maize and the adoption of the domesticated dog as a protein source. Unlike previous phases, maize has become an agricultural staple during this period, used to support the increased population and craft specialization as seen in other parts of Mexico (Blake et al. 1992a). This is particularly evident in the stable isotope data from the Río Naranjo region, which clearly show a dependence on maize (Blake et al. 1992a). Stable isotope dates from the remainder of the Soconusco show geographical differences in the consumption of maize. Samples from the central portion of the Soconusco, around Izapa, displays patterns similar to the Early Formative phases (i.e., broad-based subsistence with limited reliance on maize) while the samples from the northern portion of Soconusco indicate a greater reliance of maize similar to Río Naranjo (Blake et al. 1992a). Expanded reliance upon maize is indicated and supported outside of the Río Naranjo region by a distinctive increase in the numbers of ground stone recovered from archaeological sites, such as Cuauhtémoc (Rosenswig 2006b). According to Voorhies (1989a), excavation data suggests that coast dwellers continued to farm and fish during this period.

The data for the period coinciding with the Late Formative (i.e., 500 B.C. – A.D. ~250) after the termination of the Conchas Phase is relatively scarce. About 49 sites were identified in the Soconusco by Voorhies (1989b) as containing material dating to this period, though very few have been excavated. Much of the information comes from the cultural and political center of Izapa. Lowe et al. (1982) have connected the rise of Izapa's influence to the presumed production and control of cacao. Izapa was the regional center for the Soconusco from 450 B.C. to about A.D. 450 (Lowe et al. 1982; Voorhies

1989). This segment of prehistory in the Soconusco has been more thoroughly documented in Guatemala than in Chiapas, Mexico but in comparison with the information collected from Izapa many of the same trends appear to be occurring in Chiapas. Both regions have large centers with Olmec sculpture and monumental constructions that combine smaller mounds laid out in a formalized manner (Love 1999b).

According to Voorhies' (1989b) settlement pattern study, sites dating to this period displayed a wide range of habitat types. Possible specialized activity sites, such as shellfish procurement sites, were found in the form of middens in the wetlands. In the foothills and along the inland portion of the coastal plain, sites of this period were also identified. These portions of the region have the highest agricultural potential with good rains and well drained soils (Voorhies 1989b). Voorhies suggests that the increased identification of sites in the inland regions reflects increased use of agriculture. This period terminated in political turmoil with the collapse of Ujuxte in the Naranjo River Valley at about A.D. 100 and a dramatic decrease in settlement of the immediate area (Bove 1981, 1993; Love 1999a, 2002, 2007).

Classic (A.D. ~250 - 900)

The Classic period in the Soconusco is not well studied and the literature has not been widely published. According to Voorhies and Gasco (2004), there are two primary reasons for the lack of information about the Soconusco during this and later periods. The first is that archaeologists have been primarily drawn to sites with elaborate monumental architecture, which is not particularly common to the Soconusco in the Classic. The second reason is the lack of interest by the Mesoamerican archaeological community in time periods with written records (Voorhies and Gasco 2004). This period began with the turmoil caused by the loss of the political centers in the Rio Naranjo area and redistribution of the populations that once inhabited that region.

Survey data show a number of sites dating to the Classic period present in Soconusco (Voorhies 1989b). This suggests that after the fall of Ujuxte, populations that once congregated in the Rio Naranjo valley began to redistribute across the landscape. This is supported by archaeological surveys that found a distinct lack of evidence for a large Early Classic population in the Rio Naranjo valley (Bove 1981, 1993). Voorhies (1989b) found the Early Classic had the highest density of sites in the Soconusco. As at other times in Mesoamerica, trade was important during this period and this was reflected in some site locations. Sites were found located strategically near the natural canals in the wetlands, presumably to take advantage of this trade route (Voorhies and Gasco 2004).

The archaeological site of Izapa provides much of the information on the Classic period in this region. Izapa reflects the political turmoil at the outset of this period with the lack of monuments erected during this time (Love 2007). After Izapa's collapse people continued to use the site as a ceremonial center through the remainder of the Classic until about A.D. 1200, though it was not regionally influential (Lowe et al. 1982).

Lowe et al. (1982) define five subphases within the Classic period at Izapa. These are based upon ceramics, sculpture, and the distribution of architectural features, but these subphases have not been established throughout the entire Soconusco region. Izapa's influence after the collapse of the Olmec state created a local tradition that is unique even though it is located close to the traditional border with Mayan peoples

(Voorhies 1989a). Izapa's dominance is apparent in other parts of Soconusco in the form of ceramics and sculpture (Lowe et al. 1982).

Scholars believe that the people of the Soconusco during the Classic were full-time agriculturalists but to date researchers know little about daily subsistence in this period. Data from Izapa and other cultural centers in Soconusco seem to suggest an increasing reliance on agricultural products and the domesticated dog for their subsistence (Blake et al. 1995; Hudson et al. 1989; Lowe et al. 1982; Love 1993). A study was conducted on the faunal remains from six sites in Soconusco ranging in age from the Late Archaic to the Late Postclassic. The spatial distribution of the sites ranged from littoral to inland within easy access to the littoral zone and rivers. This study found that during the Middle Classic there was a short and sharp decrease in the importance of mammals and in the Late Classic a similar decline was seen in the utilization of fish while mammal use returned to previous levels (Hudson et al. 1989). Overall, the faunal component of the Soconusco diet stayed relatively stable through the Classic with a broadening of the categories of fauna exploited as the population increased (Hudson et al. 1989). The breadth of diet often coincides with an increase in population because of the depletion of higher ranked prey. The diminished utilization of aquatic resources may be reflecting the societal shift toward craft specialization with fewer people involved in subsistence activities.

Postclassic (A.D. 900 - 1519)

Postclassic societies in Mesoamerica in general have a tendency toward building their sites in defensible locations. The sense of militarism on the landscape is seen in the public art of this time where warriors are depicted with great frequency (Coe and Koontz

2002). The beginning of the Postclassic is characterized by the collapse of most Classic cultures. In the Late Postclassic period, the reorganization of the people into more rigid and secularized state societies with empire aspirations had occurred with the emergence of an economic system integrating Mesoamerica as a whole (Adams 2005; Voorhies and Gasco 2004).

Overall the Postclassic is distinctive with the rise of an elite merchant class and a separation of the civil and economic aspects of life from the spiritual or supernatural. In the Soconusco people were organized into small independent polities (Voorhies and Gasco 2004). During this period the region was conquered by two groups. The first were the K'iche', who conquered three to four towns in southeastern Soconusco. Not long after, eight towns and some smaller communities were taken over by the Aztecs (Voorhies and Gasco 2004). There is a great deal of evidence for long distance trade and the reorganization of trade relationships.

Ceramics and metal objects found in archaeological deposits suggest contacts and influences with people in western Mexico and afar (Voorhies and Gasco 2004). Obsidian is acquired from central Mexico rather than the Guatemalan sources utilized during the Classic (Clark et al. 1989). Evidence for Soconusco's participation in the wider Mesoamerican ideological trends and art styles is limited primarily to ceramics as written works have yet to be recovered, and figurines, stone sculpture, and censors are very rare (Voorhies and Gasco 2004). It is believed that the Soconusco was an important region in the trade of cacao, as it comprised a significant portion of the tribute that was paid to the Aztecs. During this time the consumption of chocolate in both the secular and ritual spheres increased dramatically. Supporting the region's importance in the cacao trade is not only the amount of tribute they paid but also the positioning of settlements along the littoral zone to take advantage of the waterway for transport via canoe (Voorhies 1989; Voorhies and Gasco 2004). This period terminated with the arrival and conquest of the Aztecs by the Spaniards.

Core SOC05-4

Core SOC05-4 sediments reflect activities in the area around Cerro de las Conchas during the Late Formative through the Classic Period. This period in the Soconusco is one of resettlement and changing political atmosphere. The Classic period is also a time of population increase with some sites located in the seasonally inundated short-tree savanna (Voorhies 1989b). The continued importance of agriculture brought people into the coastal plain to settle and build villages where the soil was good for crops. This trend continued into the end of the Conchas Phase and throughout the Classic period. People rely more heavily on agricultural products and domesticated dog with declining interest in fish and other aquatic resources (Hudson et al. 1989). This core provides much needed data on the use of the wetlands during a time in which evidence suggests people have left this zone for full time agriculture inland.

Human presence alters landscapes, and the distribution of vegetation from these activities should also be apparent in the data collected from Core SOC05-4 if people are using this area at the termination of the Conchas Phase and during the Classic. The sediments collected for study are reflective of the environmental conditions at the northeastern margin of El Hueyate Swamp and provide information on how people were living along the edge of the littoral zone.

CHAPTER THREE

METHODOLOGY

Extraction of Core SOC05-4 occurred in a seasonally wet, short-tree savanna adjacent to the archaeological site of Cerro de las Conchas, the oldest known site on the coast of Chiapas. The coring area has poorly drained soils and floods during the annual rains. The vegetation is made up of dispersed palms and *Coccoloba* trees with an under story of grass and herbs (Kennett et al. 2006). Hector Neff (California State University, Long Beach), John G. Jones (Washington State University), and the author with the assistance of two local field assistants collected Core SOC05-5 in January 2005.

Field Methods

In January 2005 fieldwork was undertaken as a continuation of the studies Barbara Voorhies and her students have been conducting in the Soconusco for the last two decades. Douglas Kennett and Voorhies directed the 2005 season. This work was part of a larger project studying the adoption of maize agriculture and the seasonality of coastal habitations used by the prehistoric inhabitants of Chiapas. This particular portion of the project focused upon collecting several sediment cores associated with known archaeological sites dating to the Late Archaic and Formative periods. The analysis of these cores can detect the introduction of maize and illustrate the vegetational changes seen with the intensification of maize agriculture.

Sediment samples for this project were collected using a Briggs and Stratton 8hp vibracore under the direction of Hector Neff (CSULB) and John G. Jones (WSU). This is a bottom-filling coring device, which allows the removal of contiguous samples of sediment from the surface downward with clear and undisturbed stratigraphy and minimal compaction (Figure 4). The vibracore, a modified engine used for concrete casting, uses vibrations to enable the aluminum tube to penetrate the ground. A vacuum created with water poured into the top of aluminum tube and a seal over the opening facilitated retrieval of the sediment from the ground (Figures 4 and 5).

Figure 4. Hector Neff (CSULB), center, and two local field assistants pulling a full aluminum tube from the ground (photograph courtesy of John G. Jones).

The vibration assists the tube's penetration of the sediments and keeps the coring process from distorting the stratigraphy. The resultant sample has an average 1mm rind of disturbed sediment where the material comes in contact with the vibrating tube. Core SOC05-4 is 468 cm in length of which, the lower 238 cm are the focus of this study. The upper 230 centimeters of material from the core was composed of heavily oxidized sands and was unlikely to contain fossil pollen. Analysis of samples from 220 and 225 centimeters below surface (cmbs), in fact confirmed this expectation. After extraction, the aluminum tubes are labeled with core number, segment number, top, bottom, arrows pointing up and the location of the ground surface (Figure 5).

Figure 5. A section of aluminum tubing fully inserted into the ground, capped, and labeled (photograph courtesy of John G. Jones).

After extraction from the ground, cores were stored in the aluminum collection tubes until sampling, with both ends sealed with caps and duct tape to prevent contamination. Sampling was conducted at the field laboratory set up in the courtyard of Hotel Toledo, in Esquintla. Trees, weeds, and other plants in flower within the vicinity of the sampling area were noted and, when possible, samples were collected to identify potential contaminants in the pollen samples. Each tube was cut down the length on two sides with a circular saw then the sediment inside was cut in half with a knife (Figure 6). At the top of each core segment, except the first, was a small amount of mixed material that had slumped after the removal of the previous core segment. This material was identified and discarded. Much of the material comprising SOC05-4 was collected from below the water table. Core segments were lined up based on number and depth then digital photographs were taken and the sediments were described (Table 2).

Figure 6. A section of Core SOC05-4 cut open and displaying the stratigraphy (photograph courtesy of John G. Jones).

Table 2. Field descriptions, sampling depths, processing status, pollen status, and dates summarized

Depth (cmbs)	Field Sediment Description	Sampled Yes/No	Processed Yes/No	Pollen Present Yes/No	Pollen Condition	^{14}C Date
0-11	Compression	No	No	-	-	-
11-13	Black organic, A horizon soil	Yes	No	-	-	-
15-17		Yes	No	-	-	-
20-22		Yes	No	-	-	-
22-24	Possible ash lens	Yes	No	-	-	-
25-27	Dark gray, silty, lighter with depth	Yes	No	-	-	-
30-32		Yes	No	-	-	-
35-37	Oxidized silty clay, gray brown at top, reddish brown at bottom	Yes	No	-	-	-
40-42		Yes	No	-	-	-
45-47		Yes	No	-	-	-
50-52		Yes	No	-	-	-
55-57		Yes	No	-	-	-
59-61		Yes	No	-	-	-
65-67	Oxidized, mottled reddish, brown/gray silty clay, similar to above sediments but not as clearly definable	Yes	No	-	-	-
70-72		Yes	No	-	-	-
75-77		Yes	No	-	-	-
80-82		Yes	No	-	-	-
85-87		Yes	No	-	-	-
90-92		Yes	No	-	-	-
95-97		Yes	No	-	-	-
100-102		Yes	No	-	-	-
105-107		Yes	No	-	-	-
109-111		Yes	No	-	-	-
113-115	Similar to above, oxidized red/brown	Yes	No	-	-	-
120-122	Oxidized silt with some fine sands, reddish with gray mottling	Yes	No	-	-	-
125-127		Yes	No	-	-	-
130-132		Yes	No	-	-	-
135-137		Yes	No	-	-	-
140-142		Yes	No	-	-	-
145-147		Yes	No	-	-	-
150-152		Yes	No	-	-	-
155-157	Oxidized reddish brown, blocky sandy silt, less sand than above	Yes	No	-	-	-
160-162		Yes	No	-	-	-
164-166		Yes	No	-	-	-
170-172	Oxidized, reddish brown silty sand	Yes	No	-	-	-
175-177		Yes	No	-	-	-

Table 2. Field descriptions, sampling depths, processing status, pollen status, and dates summarized

Depth (cmbs)	Field Sediment Description	Sampled Yes/No	Processed Yes/No	Pollen Present Yes/No	Pollen Condition	^{14}C Date
178-180	Oxidized reddish brown, siltier, less sand	Yes	No	-	-	-
182-184	Oxidized gray/brown silt with less sand	Yes	No	-	-	-
186-188	Oxidized gray sandy silt	Yes	No	-	-	-
190-192	with red mottling	Yes	No	-	-	-
195-197	Red coarse sand with gray mottles and FeO_2 concretion	Yes	No	-	-	-
200-202	Oxidized gray silt with	Yes	No	-	-	-
205-207	red mottling, possible	Yes	No	-	-	-
210-212	slop	Yes	No	-	-	-
215-217		Yes	No	-	-	-
220-222	Oxidized coarse red sand	Yes	Yes	No	-	-
225-227		Yes	Yes	No	-	-
230-232	Oxidized medium coarse	Yes	Yes	Yes	Heavily Eroded	-
235-237	sand laminated red and gray, w/ some silt	Yes	Yes	Yes	Poor	-
239-241		Yes	Yes	Yes	Poor	-
245-247	Very coarse, reduced	Yes	Yes	No	-	-
250-252	gray sand with very little silt	Yes	Yes	Yes	Poor	-
255-257		Yes	Yes	Yes	Good	-
260-262		Yes	Yes	Yes	Fair	-
265-267	Gleyed, medium gray silt with some fine sand	Yes	Yes	Yes	Fair	-
270-272		Yes	Yes	Yes	Good	-
275-277		Yes	Yes	Yes	Good	-
279-281	Gleyed, medium gray silt	Yes	Yes	Yes	Good	-
282-284	Gleyed, medium gray	Yes	Yes	Yes	Good	-
286-288	clay, thin "peat" band at 286 cmbs	Yes	Yes	Yes	Good	-
288-290	Gleyed, black, brown	Yes	Yes	Yes	Good	-
291-293	peat, laminated with thing clay bands	Yes	Yes	Yes	Slightly eroded	-
293-295	Gleyed, dark brown/gray	Yes	Yes	Yes	Good	-
295-297	peat with clay	Yes	Yes	Yes	Good	-
297-299	laminations and clay	Yes	Yes	Yes	Good	-
299-301	inclusions	Yes	Yes	Yes	Good	-

Table 2. Field descriptions, sampling depths, processing status, pollen status, and dates summarized

Depth (cmbs)	Field Sediment Description	Sampled Yes/No	Processed Yes/No	Pollen Present Yes/No	Pollen Condition	^{14}C Date
301-302		Yes	Yes	Yes	Good	1252±39 BP
303-305	Dark brown/black clay	Yes	Yes	Yes	Fair	-
306-308		Yes	Yes	Yes	Good	-
310-312	Dark gray clay	Yes	Yes	Yes	Good	-
315-317		Yes	Yes	Yes	Poor/Eroded	-
320-322		Yes	Yes	Yes	Fair	-
325-327		Yes	Yes	Yes	Poor/Eroded	-
330-332		Yes	No	-	-	-
335-337		Yes	Yes	Yes	Poor/Eroded	-
340-342		Yes	No	-	-	-
345-347		Yes	No	-	-	-
349-351		Yes	Yes	Yes	Poor/Eroded	-
355-357	Dark gray clay	Yes	No	-	-	-
360-362		Yes	No	-	-	-
365-367	Dark gray, gleyed fine sand and silt	Yes	No	-	-	-
370-372		Yes	Yes	Yes	Poor/Eroded	-
375-377		Yes	No	-	-	-
380-382	Dark gray silty clay band	Yes	No	-	-	-
385-387	Dark gray, gleyed fine sand and silt	Yes	No	-	-	-
390-392		Yes	No	-	-	-
395-397	Gray medium sand	Yes	Yes	Yes	Good	-
400-402	Dark gray, gleyed fine sand and silt	Yes	Yes	Yes	Slightly eroded	-
405-407		Yes	Yes	Yes	Slightly eroded	-
410-412		Yes	Yes	Yes	Good	-
415-417		Yes	Yes	Yes	Good	-
420-422		Yes	Yes	Yes	Eroded	-
424-426		Yes	Yes	Yes	Good	-
427-429	Medium coarse gray sand	Yes	Yes	Yes	Poor	-
430-432	Medium gray, sandy silt	Yes	Yes	Yes	Good	-
435-437	Medium coarse gray sand	Yes	Yes	Yes	Good	-
440-442	Coarse gray sand	Yes	Yes	Yes	Poor	-
445-447		Yes	Yes	Yes	Very poor	-
450-452		Yes	Yes	-	Broke	-
455-457		Yes	Yes	Yes	Very poor	-

Table 2. Field descriptions, sampling depths, processing status, pollen status, and dates summarized

Depth (cmbs)	Field Sediment Description	Sampled Yes/No	Processed Yes/No	Pollen Present Yes/No	Pollen Condition	^{14}C Date
461	Peat lens	Yes	Yes	Yes	Good	1870±41 BP
462-464	Fine gray sands with some silt	Yes	Yes	Yes	Fair	-
466-468		Yes	Yes	Yes	Good	2316±61 BP

Core SOC05-4 was sampled for pollen, phytoliths, and soil chemistry, as were the other cores collected during the course of fieldwork. Radiocarbon samples were collected from the base of each core and from other layers that appeared to be composed of organic-rich material. Sampling occurred along the entire length of the core in the natural strata and generally at a two-centimeter interval. When the sampling interval crossed a stratigraphic boundary, the sample was taken one centimeter within the deeper layer. Collection began at the first intact sediment layer identified when the sediments were described. Samples were removed from the center of the core by cutting off the rind of material in contact with the aluminum tube as well as the surface created when the core was cut in half to avoid mixing and contamination. The equipment used to remove individual samples was cleaned between each sample to prevent cross-contamination between samples. Each sample was placed in individual, sterile curation bags and whirl-paks labeled with the core number, sample type, and depth.

Specifically, the collection of Core SOC05-4, under the direction of John G. Jones (WSU), began at 11 cmbs to avoid the disturbed and compacted A horizon. Samples were two centimeters thick and spaced four centimeters apart (i.e., 11-13 cmbs and 15-17 cmbs, see Table 2). If the sampling interval straddled a stratigraphic boundary the sample was extracted from the deeper layer. Radiocarbon samples were collected during the initial collection process at 461 cmbs, a peat lens, and another at 468 cmbs, the base of the core. A total of 112 pollen samples were collected from SOC05-4 and were returned to Washington State University (WSU) pollen laboratory for analysis under the supervision of John G. Jones (WSU).

Laboratory Methods

Analysis of Core SOC05-4 was conducted at WSU in the pollen laboratory. A total of 48 samples were processed and analyzed for this study under the supervision and guidance of John G. Jones (WSU). Initial sub-sample selection attempted to provide an overall impression of the state of pollen preservation throughout the core. As such, the first batch of 12 samples processed from this core was selected based upon position in the core and likelihood of the presence of preserved pollen. This initial assessment was used to guide further sample selection.

Pollen extraction followed Jones' standard procedures, which are similar to those presented in Faegri and Iverson (1989). The samples were first quantified (2-10 cc), placed in sterile beakers, and a known quantity of exotic tracer spores was added to each. To prevent contamination, tools used to sample the sediment were cleaned thoroughly with soap and water between uses. European *Lycopodium* spp. spores were chosen as the exotic because these are unlikely to be found in the actual fossil pollen assemblages from this region. Tracer spores are added during processing for two reasons. First, by adding a known quantity (two tablets at 12,542 ± 416 spores each) of exotic spores to a known quantity of sediment, fossil pollen concentration values can be calculated. Second, in the event that no fossil pollen is observed in the sediment sample, the presence of *Lycopodium* tracer spores verifies that processor error was not a factor in the pollen loss.

Following the addition of the tracer spores, the samples were washed with concentrated Hydrochloric Acid (HCl). The samples were allowed to soak with occasional stirring until they were disaggregated and any reaction to the HCl had subsided. This step removed carbonates and dissolved the bonding agent in the tracer spore tablets. The samples were then rinsed in distilled water and consolidated by centrifuging and decanting until all of the HCl was removed. The samples were then sieved through 150-micron mesh screens, and swirled to remove the heavier inorganic particles such as sand. After screening, each sample was consolidated through centrifuging and decanting, mixing thoroughly with a vortex mixer between spins. After each sample was consolidated, they were mixed and spun down in the centrifuge multiple times until the supernatant became clear and the clays were removed. Between each spin in the centrifuge, the sample was decanted and mixed.

The next step was to remove any unwanted silicates that remained in the sediments after screening. This was done by adding 48 percent Hydrofluoric Acid to the residues. After soaking for 12-17 hours, the samples were rinsed three times to remove all of the HF solution. Potassium hydroxide (KOH), at a concentration of 1 percent, was then added and the samples spun down twice to remove any humates still present. The samples were then dehydrated in Glacial Acetic Acid, and were subjected to an acetolysis treatment (Erdtman 1960) consisting of 9 parts Acetic Anhydride to 1 part concentrated Sulfuric Acid. During this process, the samples were placed in a heating block for a period not exceeding 8 minutes. This step removed most of the unwanted organic materials, including cellulose, hemi-cellulose, lipids and proteins, and converted these materials to water-soluble humates. The samples were then rinsed in distilled water until a neutral pH was achieved.

Following this treatment, the samples were next subjected to a heavy density separation using Zinc Chloride (Sp.G. 2.00). Here, the lighter organic fraction was isolated from the heavier minerals. After this treatment, the lighter pollen and organic remains were collected. The residues were then dehydrated in 95 percent alcohol, and transferred to a glycerine medium for curation in glass vials.

Permanent slides were prepared using glycerine as a mounting medium, and identifications were made on a Nikon compound stereomicroscope at 400x magnification. Identifications were confirmed by using published keys and the Palynology Laboratory's extensive pollen reference collection under the supervision and with the assistance of John G. Jones (WSU). Minimum 200-grain counts, standard among most palynologists (Barkeley 1934), were made for each sample when pollen was preserved in the sediments. Counts were terminated at 75 *Lycopodium* spp. when no pollen was encountered during this time. Barkeley (1934) did an intensive statistical analysis of the results from various grain counts and found that there is little statistical difference between a 200-grain count and a 500-grain count while there was a significant difference between a 200-grain count and a 150 or smaller grain count. Thus, 200-grain counts are thought to be fairly reflective of past vegetation and paleoenvironmental conditions.

For every sample with a 200-grain count, charcoal was counted for 20 *Lycopodium* spp. Counting charcoal up to a certain number of *Lycopodium* enabled the calculation of charcoal concentration values. Charcoal concentration can, in conjunction with pollen data, provide a proxy for the presence of people in a region because they increase the amount of atmospheric charcoal with their campfires and slash-and-burn agricultural practices.

Concentration values were calculated for all samples. Hall (1981) and Bryant and Hall (1993) note that concentration values below 2,500 grains/ml of sediment may not be well reflective of past conditions, and usually record a differentially preserved assemblage (i.e., only those plants with sturdy pollen grains are represented). Pollen with less surface decoration or thinner exines degrades faster than pollen grains with abundant surface decorations or thicker exines. In samples with low concentration values reflecting differential preservation, the more fragile pollen types have been destroyed while the hardier pollen types remain present creating a skewed picture of the vegetation. As a result, counts with low concentration values should be viewed with caution.

Summary

The sediments of Core SOC05-4 provide a detailed record of the environment of the immediate coring vicinity as well as a transcript of human activity in this location. Through the deposition of pollen and particulate matter, evidence remains of activities conducted in the area by human inhabitants. The close interval of the processed samples provides a nearly complete picture of the past environment of the area within the time frame represented by this core (Table 2). The picture is not complete because of poor and differential preservation in some portions of the core. For these sections of the core, it is possible to speculate that conditions, such as frequent wetting and drying cycles, were not conducive to the preservation of pollen.

Radiocarbon dates place the sediments within a chronological framework though it is not possible to assign a specific date to each sedimentary layer. Without submitting samples from each sedimentary layer for dating it is not possible to determine how long it took each section to be deposited. Superposition of the deposits allows those sediments from the base of the core to record activities that occurred before those recorded in sediments from the middle of the core. The history recorded in this core is a continuum of activity from the Late Formative through the Classic and is discussed as such.

CHAPTER FOUR

RESULTS

Core SOC05-4 consists of sediments composed of organic rich clays, oxidized sands, silts and un-oxidized sands, consistent with seasonally wet savanna ecology, present in the collecting locality today. Preserved fossil pollen was present in about half of the sediments collected in Core SOC05-4. Past wetting and drying cycles are likely responsible for damage and destruction of deposited pollen grains. The sediments above 230 centimeters below surface (cmbs) were heavily oxidized sands and were devoid of fossil pollen. Analysis conducted upon samples collected from 220, 225, and 230 cmbs found each sample lacking pollen, confirming that pollen was not present in the upper section (Tables 2 and 3). Pollen in sediment samples from 239 to 250 cmbs, 335 to 395 cmbs, and 427 to 455 cmbs was very poorly preserved and concentration values were low, thus finer interval samples were not examined from these sections (Tables 2 and 3). Pollen concentration values from these sections ranged from 1943 to 6355 fossil grains/cc of sediment, values considered to be fairly low indicating poor pollen preservation and/or rapid sedimentation (Moore et al. 1991). Concentration values are important in palynological studies, as they assist in determining state of preservation and provide information useful for environmental reconstruction. Concentrations throughout the remainder of the core, however, were generally very high (e.g., >10,000 fossil grains/cc), supporting the well-preserved state of the fossil pollen. Thus, processing and analysis was performed on every sample below 220 cmbs.

Table 3. Summary of sedimentary zones, number of samples collected and processed, pollen preservation, and date.

Depth cmbs	Field Sediment Descriptions	# of Samples Collected	# of Samples Processed	Pollen Preservation	^{14}C Date
0-11	Compression	0	0	-	-
11-22	Black organic, A horizon soil	3	0	-	-
22-24	Possible ash lens	1	0	-	-
24-34	Dark gray, silty, lighter with depth	2	0	-	-
34-61	Oxidized silty clay, gray brown at top, reddish brown at bottom	7	0	-	-
61-111	Oxidized, mottled reddish, brown/gray silty clay, similar to above sediments but not as clearly definable	10	0	-	-
111-116	Similar to above, oxidized red/brown	1	0	-	-
116-154	Oxidized silt with some fine sands, reddish with gray mottling	7	0	-	-
154-166	Oxidized reddish brown, blocky sandy silt, less sand than above	3	0	-	-
166-177	Oxidized, reddish brown silty sand	2	0	-	-
177-181	Oxidized reddish brown, siltier, less sand	1	0	-	-
181-185	Oxidized reddish brown, siltier, less sand	1	0	-	-
185-193	Oxidized gray sandy silt with red mottling	2	0	-	-
193-197	Red coarse sand with gray mottles and FeO_2 concretion	1	0	-	-
197-213	Oxidized gray silt with red mottling, possible slop	3	0	-	-
213-230	Oxidized coarse red sand	3	2	None	-
230-241	Oxidized medium coarse sand laminated red and gray, w/ some silt	3	3	Very poor	-
241-254	Very coarse, reduced gray sand with very little silt	2	2	Very poor	-
254-278	Gleyed, medium gray silt with some fine sand	5	5	Good	-
278-281	Gleyed, medium gray silt	1	1	Good	-
281-288	Gleyed, medium gray clay, thin "peat" band at 286 cmbs	2	2	Good	-

Table 3. Summary of sedimentary zones, number of samples collected and processed, pollen preservation, and date.

Depth cmbs	Field Sediment Descriptions	# of Samples Collected	# of Samples Processed	Pollen Preservation	^{14}C Date
288-293	Gleyed, black, brown peat, laminated with thing clay bands	2	2	Good	-
293-302	Gleyed, dark brown/gray peat with clay laminations and clay inclusions	5	5	Good	1252±39 BP
302-308	Dark brown/black clay	2	2	Good	-
308-351	Dark gray clay	9	6	Poor	-
351-363	Dark gray clay	2	0	-	-
363-379	Dark gray, gleyed fine sand and silt	3	1	Very poor	-
379-383	Dark gray silty clay band	1	0	-	-
383-392	Dark gray, gleyed fine sand and silt	2	0	-	-
392-397	Gray medium sand	1	0	-	-
387-426	Dark gray, gleyed fine sand and silt	6	6	Good	-
426-430	Medium coarse gray sand	1	1	Poor	-
430-434	Medium gray, sandy silt	1	1	Good	-
434-437	Medium coarse gray sand	1	1	Good	-
437-460	Coarse gray sand	4	4	Very poor	1870±41 BP
461	Peat lens	1	1	Good	-
461-468	Fine gray sands with some silt	2	2	Good	2316±61 BP

The analysis of Core SOC05-4 resulted in the identification of 31 different pollen types. Pollen produced by plants frequently has characteristics that are specific to its particular family, while some plants may generate pollen distinctive enough to be identifiable to genus or, rarely, species. Morphological features on the surface of the pollen grains, including apertures, ornamentation such as spines or bumps, and occasionally size help to distinguish various pollen types. These attributes also have some bearing on the pollination vector for the plant. Plants that produce pollen that has numerous and/or large surface ornamentations tend to have zoophilous pollination vectors while those plants producing smooth grains or are minimally ornamented are usually wind pollinated (Faegri and Iverson 1989). Wind pollinated plant species produce vast quantities of pollen and are deposited in the form of pollen rain. Those plants that are pollinated by animals and insects (zoophilous) tend to produce less pollen. It is possible for pollen grains from these flowers to be picked up by wind and deposited as pollen rain; the grains can also enter the sedimentary record during transport by the zoophilous pollinator. As the majority of the plants encountered in this study are zoophilously pollinated, differing pollen concentration as a result of pollen production does not seem to be a factor. Identification of the grains found in the samples occurred through comparison to reference collections, published illustrations, and with the assistance of Dr. John G. Jones.

The subsequent section discusses the identified pollen types, their attributes and characteristics of the host plants. The plant families and genera represented in these samples have been placed into three general categories: 1) mangroves and aquatics, 2) herbs and cultigens, and 3) arboreal species. A discussion of the plants in each group occurs in alphabetical order. The distribution of taxa for each sample with a minimum 200-grain count is presented in Table 4.

Mangroves and Aquatics

Mangroves and aquatic plant types comprised 54.5 percent of the grains identified in the samples from Core SOC05-4, by far the largest constituent group of the collection (Table 4).

Table 4. Counts and percentages of each taxa by sample.

	Taxa	Provenience							
		255-257 cmbs		260-262 cmbs		265-267 cmbs		270-272 cmbs	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	0	0.0	1	0.5
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	123	60.9	66	32.4	81	40.3	89	44.1
	Nymphaea	1	0.5	1	0.5	0	0.0	0	0.0
	Rhizophora	2	1.0	0	0.0	0	0.0	4	2.0
	Typha	11	5.4	22	10.8	14	7.0	14	6.9
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	0	0.0	2	1.0	0	0.0
	HS Asteraceae	2	1.0	3	1.5	0	0.0	1	0.5
	LS Asteraceae	7	3.5	5	2.5	0	0.0	2	1.0
	Cheno-Am	14	6.9	22	10.8	12	6.0	7	3.5
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	20	9.9	34	16.7	32	15.9	26	12.9
	Polygalaceae	0	0.0	0	0.0	1	0.5	0	0.0
	Polygonum	0	0.0	2	1.0	0	0.0	0	0.0
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	0	0.0	0	0.0
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	0	0.0	1	0.5	4	2.0	3	1.5
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	1	0.5	1	0.5	2	1.0	5	2.5
	Coccoloba	5	2.5	14	6.9	15	7.5	13	6.4
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	0	0.0	0	0.0
	Juglans	0	0.0	1	0.5	1	0.5	0	0.0
	Moraceae	0	0.0	3	1.5	0	0.0	5	2.5
	Pinus	2	1.0	12	5.9	10	5.0	5	2.5
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	6	2.9	6	3.0	12	5.9
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	1	0.5	1	0.5	0	0.0	5	2.5
	Zanthoxylum	0	0.0	0	0.0	0	0.0	1	0.5
Other	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Indeterminate	13	6.4	10	4.9	21	10.4	9	4.5
	Lycopodium found	313		256		514		211	
	Total	202	100.0	204	100.0	201	100.0	202	100.0
	Concentration grains/ml	8094.20		6662.94		3269.70		8004.69	
	Charcoal Concentration	200672.0		2006720.0		1003360.0		752520.0	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	Provenience							
		275-277 cmbs		**279-281 cmbs**		**282-284 cmbs**		**286-288 cmbs**	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	0	0.0	37	18.1
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	100	49.3	110	51.9	96	46.8	88	43.1
	Nymphaea	0	0.0	1	0.5	0	0.0	0	0.0
	Rhizophora	3	1.5	6	2.8	4	2.0	1	0.5
	Typha	17	8.4	11	5.2	19	9.3	7	3.4
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	2	1.0	0	0.0	0	0.0	0	0.0
	HS Asteraceae	1	0.5	3	1.4	0	0.0	0	0.0
	LS Asteraceae	4	2.0	7	3.3	1	0.5	1	0.5
	Cheno-Am	11	5.4	11	5.2	4	2.0	12	5.9
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	21	10.3	26	12.3	28	13.7	37	18.1
	Polygalaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Polygonum	1	0.5	0	0.0	0	0.0	0	0.0
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	0	0.0	0	0.0
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	1	0.5	0	0.0	2	1.0	1	0.5
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	3	1.5	1	0.5	0	0.0	1	0.5
	Coccoloba	10	4.9	6	2.8	20	9.8	5	2.5
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	0	0.0	0	0.0
	Juglans	2	1.0	0	0.0	1	0.5	0	0.0
	Moraceae	5	2.5	0	0.0	5	2.4	0	0.0
	Pinus	7	3.4	6	2.8	7	3.4	5	2.5
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	4	2.0	9	4.2	8	3.9	0	0.0
	Spondias	0	0.0	1	0.5	0	0.0	0	0.0
	Tiliaceae	0	0.0	1	0.5	0	0.0	0	0.0
	Zanthoxylum	0	0.0	1	0.5	0	0.0	0	0.0
Other	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Indeterminate	11	5.4	12	5.7	10	4.9	9	4.4
	Lycopodium found	115		245		44		98	
	Total	203	100.0	212	100.0	205	100.0	204	100.0
	Concentration grains/ml	22139.36		10852.67		58434.32		26107.84	
	Charcoal Concentration	1743338.0		903024.0		2947370.0		1003360.0	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	**Provenience**							
		288-290 cmbs		**291-293 cmbs**		**293-295 cmbs**		**295-297 cmbs**	
Mangroves and Aquatics	Alismataceae	31	15.1	11	5.3	0	0.0	3	1.4
	Combrataceae	0	0.0	0	0.0	1	0.5	0	0.0
	Cyperaceae	68	33.2	88	42.5	84	41.4	93	43.9
	Nymphaea	0	0.0	2	1.0	0	0.0	0	0.0
	Rhizophora	1	0.5	5	2.4	1	0.5	0	0.0
	Typha	12	5.9	18	8.7	11	5.4	11	5.2
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	4	2.0	4	1.9	0	0.0	0	0.0
	HS Asteraceae	4	2.0	10	4.8	0	0.0	3	1.4
	LS Asteraceae	2	1.0	6	2.9	2	1.0	2	0.9
	Cheno-Am	11	5.4	0	0.0	1	0.5	3	1.4
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	27	13.2	35	16.9	84	41.4	47	22.2
	Polygalaceae	12	5.9	0	0.0	0	0.0	0	0.0
	Polygonum	0	0.0	2	1.0	0	0.0	7	3.3
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	0	0.0	0	0.0
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	1	0.5	1	0.5	2	1.0	5	2.4
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	0	0.0	0	0.0	0	0.0	0	0.0
	Coccoloba	9	4.4	13	6.3	5	2.5	10	4.7
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	0	0.0	0	0.0
	Juglans	0	0.0	0	0.0	1	0.5	0	0.0
	Moraceae	2	1.0	0	0.0	0	0.0	1	0.5
	Pinus	11	5.4	7	3.4	1	0.5	5	2.4
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	1	0.5	0	0.0	0	0.0	5	2.4
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	0	0.0	0	0.0	0	0.0	1	0.5
	Indeterminate	9	4.4	5	2.4	10	4.9	16	7.5
	Lycopodium found	24		6		11		19	
	Total	205	100.0	207	100.0	203	100.0	212	100.0
	Concentration grains/ml	107129.58		432699.00		231456.91		139942.32	
	Charcoal Concentration	400716.9		613930.9		2821950.0		3386340.0	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	Provenience							
		297-299 cmbs		299-301 cmbs		301-302 cmbs		303-305 cmbs	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	123	60.6	96	47.5	115	56.7	99	49.3
	Nymphaea	0	0.0	0	0.0	0	0.0	0	0.0
	Rhizophora	1	0.5	3	1.5	2	1.0	0	0.0
	Typha	3	1.5	15	7.4	15	7.4	15	7.5
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	0	0.0	0	0.0	0	0.0
	HS Asteraceae	3	1.5	1	0.5	0	0.0	0	0.0
	LS Asteraceae	3	1.5	2	1.0	3	1.5	19	9.5
	Cheno-Am	3	1.5	2	1.0	1	0.5	3	1.5
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	42	20.7	50	24.8	49	24.1	36	17.9
	Polygalaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Polygonum	0	0.0	0	0.0	0	0.0	0	0.0
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	0	0.0	1	0.5
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	1	0.5	2	1.0	0	0.0	1	0.5
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	0	0.0	1	0.5	0	0.0	0	0.0
	Coccoloba	1	0.5	7	3.5	6	3.0	2	1.0
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	0	0.0	0	0.0
	Juglans	0	0.0	0	0.0	0	0.0	0	0.0
	Moraceae	0	0.0	1	0.5	2	1.0	0	0.0
	Pinus	10	4.9	4	2.0	7	3.4	11	5.5
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	2	1.0	0	0.0	0	0.0
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	2	1.0	0	0.0	1	0.5	0	0.0
	Indeterminate	11	5.4	16	7.9	2	1.0	14	7.0
	Lycopodium found	20		52		46		213	
	Total	203	100.0	202	100.0	203	100.0	201	100.0
	Concentration grains/ml	127301.30		48720.85		55348.39		11835.41	
	Charcoal Concentration	7587910.0		5909163.3		6960810.0		1538276.3	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	**Provenience**							
		306-308 cmbs		**310-312 cmbs**		**315-317 cmbs**		**320-322 cmbs**	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	96	48.0	81	39.9	135	66.5	78	38.2
	Nymphaea	0	0.0	0	0.0	0	0.0	0	0.0
	Rhizophora	3	1.5	0	0.0	0	0.0	0	0.0
	Typha	9	4.5	7	3.4	3	1.5	13	6.4
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	0	0.0	0	0.0	1	0.5
	HS Asteraceae	0	0.0	2	1.0	0	0.0	3	1.5
	LS Asteraceae	40	20.0	62	30.5	27	13.3	70	34.3
	Cheno-Am	4	2.0	5	2.5	2	1.0	11	5.4
	Croton	1	0.5	0	0.0	0	0.0	0	0.0
	Poaceae	29	14.5	28	13.8	17	8.4	16	7.8
	Polygalaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Polygonum	0	0.0	0	0.0	0	0.0	0	0.0
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	0	0.0	0	0.0
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	1	0.5	0	0.0	1	0.5	0	0.0
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	1	0.5	0	0.0	0	0.0	0	0.0
	Coccoloba	8	4.0	5	2.5	7	3.4	4	2.0
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	0	0.0	0	0.0
	Juglans	0	0.0	0	0.0	0	0.0	0	0.0
	Moraceae	0	0.0	0	0.0	0	0.0	0	0.0
	Pinus	3	1.5	3	1.5	1	0.5	0	0.0
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	0	0.0	0	0.0	0	0.0	0	0.0
	Indeterminate	5	2.5	10	4.9	10	4.9	8	3.9
	Lycopodium found	69		78		55		210	
	Total	200	100.0	203	100.0	203	100.0	204	100.0
	Concentration grains/ml	36353.62		32641.36		46291.38		12183.66	
	Charcoal Concentration	3888020.0		418275.7		366853.5		480358.6	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	**Provenience**							
		325-327 cmbs		**335-337 cmbs**		**349-351 cmbs**		**370-372 cmbs**	
Mangroves and Aquatics	Alismataceae	0	0.0	1	0.5	0	0.0	0	0.0
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	98	48.3	144	71.3	141	68.4	51	25.5
	Nymphaea	0	0.0	0	0.0	0	0.0	0	0.0
	Rhizophora	0	0.0	1	0.5	4	1.9	0	0.0
	Typha	15	7.4	6	3.0	17	8.3	0	0.0
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	0	0.0	0	0.0	0	0.0
	HS Asteraceae	0	0.0	0	0.0	0	0.0	9	4.5
	LS Asteraceae	59	29.1	6	3.0	1	0.5	4	2.0
	Cheno-Am	6	3.0	11	5.4	4	1.9	23	11.5
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	8	3.9	14	6.9	14	6.8	32	16.0
	Polygalaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Polygonum	0	0.0	4	2.0	0	0.0	22	11.0
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	0	0.0	0	0.0
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	0	0.0	0	0.0	1	0.5	2	1.0
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	0	0.0	0	0.0	0	0.0	0	0.0
	Coccoloba	5	2.5	7	3.5	13	6.3	16	8.0
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	2	1.0	3	1.5
	Juglans	0	0.0	0	0.0	0	0.0	0	0.0
	Moraceae	0	0.0	1	0.5	0	0.0	0	0.0
	Pinus	1	0.5	1	0.5	0	0.0	0	0.0
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	1	0.5	0	0.0	0	0.0	3	1.5
	Indeterminate	10	4.9	6	3.0	9	4.4	35	17.5
	Lycopodium found	217		318		473		1291	
	Total	203	100.0	202	100.0	206	100.0	200	100.0
	Concentration grains/ml	11732.84		5311.29		5462.27		1942.99	
	Charcoal Concentration	1787235.0		2884660.0		1442330.0		1567750.0	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	Provenience							
		395-397 cmbs		**400-402 cmbs**		**405-407 cmbs**		**410-412 cmbs**	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	42	20.1	104	49.8	103	46.6	94	47.0
	Nymphaea	1	0.5	1	0.5	0	0.0	1	0.5
	Rhizophora	0	0.0	0	0.0	2	0.9	1	0.5
	Typha	0	0.0	7	3.3	13	5.9	14	7.0
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	5	2.4	0	0.0	11	5.5
	HS Asteraceae	6	2.9	13	6.2	6	2.7	7	3.5
	LS Asteraceae	8	3.8	4	1.9	9	4.1	1	0.5
	Cheno-Am	57	27.3	36	17.2	31	14.0	26	13.0
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	41	19.6	15	7.2	25	11.3	21	10.5
	Polygalaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Polygonum	3	1.4	1	0.5	2	0.9	1	0.5
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	0	0.0	0	0.0	3	1.4	0	0.0
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	3	1.4	0	0.0	1	0.5	1	0.5
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	0	0.0	0	0.0	0	0.0	0	0.0
	Coccoloba	7	3.3	7	3.3	13	5.9	8	4.0
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	1	0.5	0	0.0	0	0.0	0	0.0
	Juglans	0	0.0	0	0.0	0	0.0	0	0.0
	Moraceae	0	0.0	0	0.0	0	0.0	0	0.0
	Pinus	1	0.5	1	0.5	3	1.4	2	1.0
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	0	0.0	1	0.5	0	0.0	0	0.0
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	7	3.3	0	0.0	0	0.0	1	0.5
	Indeterminate	32	15.3	14	6.7	10	4.5	11	5.5
	Lycopodium found	275		97		68		39	
	Total	209	100.0	209	100.0	221	100.0	200	100.0
	Concentration grains/ml	6354.61		18015.66		27174.33		42878.63	
	Charcoal Concentration	1724525.0		5468312.0		1205913.3		2232476.0	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	**Provenience**							
		415-417 cmbs		**420-422 cmbs**		**424-426 cmbs**		**430-432 cmbs**	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	109	54.0	117	55.2	100	49.0	94	44.8
	Nymphaea	0	0.0	0	0.0	0	0.0	1	0.5
	Rhizophora	4	2.0	0	0.0	1	0.5	0	0.0
	Typha	18	8.9	15	7.1	16	7.8	8	3.8
Herbs and Cultigens	*Acalypha*	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	2	0.9	0	0.0	0	0.0
	HS Asteraceae	3	1.5	3	1.4	2	1.0	3	1.4
	LS Asteraceae	1	0.5	5	2.4	7	3.4	6	2.9
	Cheno-Am	20	9.9	16	7.5	17	8.3	15	7.1
	Croton	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	19	9.4	35	16.5	30	14.7	54	25.7
	Polygalaceae	0	0.0	0	0.0	2	1.0	0	0.0
	Polygonum	4	2.0	2	0.9	2	1.0	3	1.4
	Solanaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	2	1.0	0	0.0	1	0.5	0	0.0
Arboreal	*Alchornea*	0	0.0	1	0.5	0	0.0	1	0.5
	Alnus	2	1.0	1	0.5	0	0.0	2	1.0
	Bursera	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	0	0.0	0	0.0	0	0.0	0	0.0
	Coccoloba	8	4.0	10	4.7	6	2.9	7	3.3
	Gymnopodium	0	0.0	0	0.0	0	0.0	0	0.0
	Heliocarpus	0	0.0	0	0.0	0	0.0	0	0.0
	Juglans	0	0.0	0	0.0	0	0.0	0	0.0
	Moraceae	0	0.0	0	0.0	0	0.0	0	0.0
	Pinus	5	2.5	1	0.5	4	2.0	7	3.3
	Quercus	0	0.0	0	0.0	0	0.0	0	0.0
	Salix	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	0	0.0	0	0.0	0	0.0
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	0	0.0	0	0.0	1	0.5	0	0.0
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	0	0.0	0	0.0	1	0.5	0	0.0
	Indeterminate	7	3.5	4	1.9	14	6.9	9	4.3
	Lycopodium found	50		102		109		49	
	Total	202	100.0	212	100.0	204	100.0	210	100.0
	Concentration grains/ml	50669.68		17378.46		15648.73		21500.57	
	Charcoal Concentration	4954090.0		1693170.0		877940.0		5393060.0	

Table 4. Counts and percentages of each taxa by sample.

	Taxa	Provenience									
		435-437 cmbs		440-442 cmbs		461 cmbs		462-464 cmbs		466-468 cmbs	
Mangroves and Aquatics	Alismataceae	0	0.0	0	0.0	45	21.8	1	0.5	0	0.0
	Combrataceae	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Cyperaceae	123	45.9	89	44.1	75	36.4	83	41.3	71	35.0
	Nymphaea	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Rhizophora	0	0.0	5	2.5	0	0.0	4	2.0	4	2.0
	Typha	16	6.0	12	5.9	37	18.0	8	4.0	8	3.9
Herbs and Cultigens	*Acalypha*	2	0.7	0	0.0	0	0.0	0	0.0	0	0.0
	Alternanthera-type	0	0.0	3	1.5	0	0.0	6	3.0	1	0.5
	HS Asteraceae	4	1.5	3	1.5	1	0.5	9	4.5	15	7.4
	LS Asteraceae	2	0.7	7	3.5	0	0.0	9	4.5	2	1.0
	Cheno-Am	14	5.2	11	5.4	7	3.4	23	11.4	8	3.9
	Croton	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Poaceae	44	16.4	50	24.8	25	12.1	22	10.9	44	21.7
	Polygalaceae	0	0.0	0	0.0	2	1.0	0	0.0	0	0.0
	Polygonum	5	1.9	0	0.0	0	0.0	2	1.0	0	0.0
	Solanaceae	3	1.1	0	0.0	0	0.0	0	0.0	0	0.0
	Zea mays	3	1.1	0	0.0	2	1.0	0	0.0	1	0.5
Arboreal	*Alchornea*	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Alnus	1	0.4	0	0.0	0	0.0	5	2.5	2	1.0
	Bursera	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
	Chaetoptelea	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Coccoloba	14	5.2	10	5.0	1	0.5	18	9.0	25	12.3
	Gymnopodium	0	0.0	1	0.5	0	0.0	0	0.0	0	0.0
	Heliocarpus	4	1.5	0	0.0	0	0.0	0	0.0	5	2.5
	Juglans	2	0.7	0	0.0	0	0.0	1	0.5	0	0.0
	Moraceae	8	3.0	0	0.0	0	0.0	0	0.0	0	0.0
	Pinus	3	1.1	0	0.0	5	2.4	4	2.0	4	2.0
	Quercus	3	1.1	0	0.0	0	0.0	0	0.0	1	0.5
	Salix	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
	Sapotaceae	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Spondias	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Tiliaceae	1	0.4	0	0.0	0	0.0	0	0.0	1	0.5
	Zanthoxylum	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Other	Unknown	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
	Indeterminate	13	4.9	11	5.4	6	2.9	6	3.0	11	5.4
	Lycopodium found	172		876		170		196		200	
	Total	268	100.0	202	100.0	206	100.0	201	100.0	203	100.0
	Concentration grains/ml	13028.12		578.42		6079.18		5144.78		12730.13	
	Charcoal Concentration	3637180.0		1066070.0		2056888.0		3436508.0		2194850.0	

Figure 7 Pollen Diagram

Alismataceae

Plants of the Alismataceae Family are usually aquatics or wetland herbs. Pollen grains from plants of this family are frequently nearly identical, thus specific genera usually cannot be distinguished (Kapp et al. 2000). Alismataceae has two genera present in tropical America, *Echinodorus* and *Sagittaria*. *Echinodorus* is common in the Western Hemisphere and the most common genus with 26 different species identified, while there are only 14 species of *Sagittaria* currently known in this region (Haynes 2004). Members of this plant family prefer open areas of full sunlight at low elevations in saturated soils or those that were wet when growth began. These plants are typically present along rivers, lakes, and streams with a few species occurring on forest floors (Haynes 2004). Pollination vectors are not well studied but researchers believe they are likely insect-pollinated, with water and animals also playing a part in dissemination of seeds. Some of the tropical varieties of Alismataceae produce edible tubers while others are of little economic value (Haynes 2004). It is not possible to determine if the grains present in these samples do, or do not, reflect an economic variety as the pollen grains are not genera specific. Alismataceae pollen was present in eight samples in frequencies ranging from 22 percent to 0.5 percent in eight samples (Table 4 and Figure 7).

Combretaceae

Combretaceae is another wet habitat plant encountered in this core. The Combretaceae plant family, in the Western Hemisphere, primarily grows in tropical South America with only 21 species extending into Central America. Plants in the Combretaceae Family include trees, shrubs, sub-shrubs or lianas (a climbing woody vine), and can be an important component of forests (especially lianas), savannas (sub-shrubs) and mangrove swamps (Stace 2004). This family has several floral adaptations that influence the type of pollination vector. While some genera are wind pollinated, insects are the primary pollinator with some species pollinated by birds and monkeys (Stace 2004). The pollen produced by this family of plants is all very similar (heterocolporate and psilate) and can rarely be distinguished at a finer scale. Major genera in the project area include *Bucida, Terminalia,* and *Conocarpus*, all classified as white mangrove types. Economic uses for white mangroves are currently unclear. Combretaceae was a very rare taxon in this sediment core; a single grain was encountered in only two samples.

Cyperaceae

Cyperaceae, commonly referred to as the Sedge Family, was the most commonly encountered pollen type throughout the entirety of Core SOC05-4, representing 46 percent of all encountered pollen grains (Figure 7). Sedges are grass-like herbs that grow in a wide variety of environments and are very prolific in most environments. There are about 5,300 species of sedge found in the world with about 1,000 species found in the tropical Americas (Thomas 2004). Sedges can be dominant or ecologically important components of marshes and other wetlands as well as grasslands, savannas and some forests. Pollination vectors vary based on habitat, where open area species and those found in aquatic environments tend to be wind pollinated while those growing in forested areas tend to be insect pollinated due to the lower wind velocity (Thomas 2004). Pollen of the Cyperaceae Family are generally sub-triangular with a distinct pore along the broad end and three less obvious pores around the periphery with an intectate verrucate surface (Kapp et al. 2000). This similarity in configuration makes it difficult to identify sedge pollen below the family level. In the neotropics, uses for sedges include basketry, mat making and even as an emergency food (Thomas 2004).

Nymphaea

Nymphaea is a member of the family Nymphaeaceae, the Water Lily Family. *Nymphaea* is the largest of three genera found in the American neotropics with 18 species. This genus is also the most widespread throughout the world, present in both temperate and tropical environments (Padgett and Les 2004). Members of the water lily family prefer to grow in shallow freshwater pools or sluggish rivers with rich organic substrates that may be seasonally dry (Padgett and Les 2004). Bees are the primary pollinator for many species of *Nymphaea* with beetles and flies also contributing (Padgett and Les 2004). Economic uses of the various species of *Nymphaea* include cultivation as an ornamental, use of the seeds and rhizomes as food, or as a hallucinogen in religious rituals (Padgett and Les 2004). Pollen from plants of this genus is distinctive from other members of the Nymphaeaceae Family, and can readily be identified to the genus level. The low frequency of *Nymphaea* pollen, 0.5 - 1 percent, suggests it was not a significant component of the local flora (Figure 7).

Rhizophora

Rhizophora is a genus of the Rhizophoraceae or Red Mangrove Family. Botonists recognize three species of *Rhizophora*, two of which are present in coastal Chiapas (Gustafsson 2004). Red mangroves occur in all of the tropical and some subtropical regions of the world. *Rhizophora,* in particular, grows in most tropical coastal areas, and is frequently the dominant constituent of mangrove swamps and tropical estuaries but can also be present in wetland forests (Gustafsson 2004). Red mangrove tends to prefer brackish environments while their white and black counterparts prefer fresh and salt water, respectively. These trees provide an important source of timber and firewood to people living near the mangrove habitat. Mangroves are also a provider of nutrients and help to stabilize shorelines to keep fisheries healthy (Gustafsson 2004). *Rhizophora* comprised less than 1 percent of the entire pollen assemblage from SOC05-4 (Table 4).

Typha

Typha is an aquatic herb and is one of two genera of Typhaceae, the Cattail Family, and is the only genus present in the American tropics (Stevenson 2004). Pollen of this family is distinctive to the genus, and frequently species level. *Typha* pollen can be single grains or in a tetrad formation (Kapp et al. 2000) and both varieties are wind pollinated. *Typha* pollen encountered in this study was all of the single grain variety, representing the species *Typha angustifolia* (narrowleaf cattail). These plants grow in damp areas and shallow water such as marshes, ponds, lakes, and along rivers (Stevenson 2004). It is common to find members of this genus growing in roadside ditches or canals. These plants have a wide variety of uses to people; various parts of the plants are edible, while others can be used to make baskets, mats, or as padding in pillows and mattresses (Stevenson 2004). *Typha* was a common component of this core with frequencies ranging from 2-20 percent (Table 4 and Figure 7).

Herbs and Cultigens

Nearly a third, 30.4 percent, of all fossil pollen recovered from SOC05-4 were from herbs and cultigens (Table 4). This category is important in reconstructing the activity of people living in the vicinity of the coring location.

Acalypha

Acalypha is a member of the Euphorbiaceae or Spurge Family, and the Acalyphoideae subfamily. The *Acalypha* genus has 225 different species and is generally wind pollinated (Webster 2004). Differentiation of these species by their pollen morphology is not possible. Members of *Acalypha* grow in both lowland rain forests and montane forests. According to Webster (2004), weedy species of *Acalypha* are commonly opportunistic colonizers in tropical rain forests. Some members of Acalyphoideae are cultivated today for seed oils (Webster 2004), though pre-contact uses of this species are unknown. This genus was present in a single sample in a frequency of 0.7 percent.

Alternanthera

Alternanthera-type pollen, from plants of the *Alternanthera* genus, is distinctive from pollen produced by other non-tropical members of the Amaranthaceae or Pigweed Family. Tropical America is home to 21 native genera of Amaranth, and *Alternanthera* is the largest genus (Nee 2004a). Members of the Pigweed Family frequently grow in disturbed areas and are commonly present along roadsides although a few species grow in seasonally dry forests or exposed lake bottoms (Nee 2004a). Economic uses specific to *Alternanthera* are currently unknown. When found, this pollen type was representative of 1-5.5 percent of the pollen assemblage (Table 4 and Figure 7).

Asteraceae

Identified in Core SOC05-4 were two varieties of Asteraceae pollen. High-spined pollen grains, from the subfamily Helianthae, are those with spines exceeding 2.5µ in length. Pollen grains with spines of less than 2.5µ in length, from the subfamily Ambrosinae, made up the low-spined category. Surface decoration on pollen is often associated with pollination vectors, and elaborate surface decoration usually indicates that the plant is insect pollinated. The two varieties of Asteraceae present in these samples indicate that both wind and insect pollinated Asteraceae were in the catchment region reflected by this core. Asteraceae pollen is only rarely distinguishable to the genus and species level. Many of the plants in this family produce spined pollen and analysts distinguish between low and high spines to give an idea of pollination vectors. Asteraceae is one of the largest flowering plant families in the world with 1,535 genera, 580 of which occur in the neotropics (Pruski and Sancho 2004). Members of the Aster Family in the American neotropics are usually perennial herbs and shrubs, found in most environments but most commonly in disturbed or minimally forested areas (Pruski and Sancho 2004). Members of this family have a variety of indigenous uses including medicinal, fish poisons, pesticide, and as pigments. Evidence has not been found to indicate that members of the Asteraceae Family are used for food. High-spined varieties were an important component of the samples with frequencies up to 7.4 percent. Low-spined Asteraceae were a significant part of this collection and were encountered in frequencies of between 5-40 percent in the samples (Figure 7). The presence of low-spined grains usually signal disturbance in the area.

Cheno-Am

Cheno-Am is a category that combines grains from the family Chenopodiaceae and *Amaranthus* pollen. Recent studies have shown the Chenopodiaceae and the Amaranthaceae Families are closely related with molecular evidence suggesting the two should be merged (Clemants 2004). *Amaranthus* pollen and Chenopodiaceae pollen are round grains covered by numerous pores and are usually indistinguishable. In many regions including Mesoamerica and the North American Southwest, the two are tallied as a single category called Cheno-Am. Pollen produced by some tropical members of the Amaranth Family tend to be more angular than that produced by temperate members of the family and may sometimes be identified to the genus level.

Members of the Amaranthaceae Family are herbaceous weeds that occasionally grow into semi-woody or soft-woody vines. Plants of this family frequently grow in disturbed areas and are commonly present along roadsides although a few species grow in seasonally dry forests or exposed lake bottoms (Nee 2004). These plants have adapted to, and become very successful at, colonizing farmland and can be used as indication of agriculture when other evidence of cultigens are absent. This weed grows prolifically in fields. Evidence has not been found of the cultivation or utilization of members of the Amaranth and Chenopod families as a foodstuff in the Soconusco. The presence of Cheno-Ams is interpreted as indication of ground disturbance and agricultural activity because of their tendency to colonized disturbed ground and farmland. Grains identified as Cheno-Ams were very common in this study, found in frequencies from 2-30 percent and present in nearly all of the samples (Table 4 and Figure 7).

Croton

Croton is a member of the Euphorbiaceae or Spurge Family and the Crotonoideae subfamily. About 450 members of this genus grow in the neotropics. Similar to *Acalypha*, members of the *Croton* genus are opportunistic plants and are frequent secondary successors (Webster 2004). Pollen grains produced by members of this genus have distinctive surface decoration of triangular shaped rods that are either clavate or gemmate (Kapp et al. 2000). Members of the Spurge Family have a tendency to produce pollen that is distinguishable to the genus level, and nearly all members are insect pollinated. Members of the *Croton* genera grow in lowland rain forests, montane rain forests, and deserts (Webster 2004). Like *Acalypha*, some *Croton* species are cultivated for seed oils (Webster 2004). Pollen of this genus was encountered in only one sample from Core SOC05-4.

Poaceae

Poaceae is the grass family. All grasses produce pollen that has a psilate or smooth exine with a single annulate pore (Kapp et al. 2000). Grass pollen is rarely identifiable below the family level. Domesticated grasses, such as barley, rye, oats, wheat, and maize, have enlarged pollen grains with the same morphology as their wild counterparts, making them identifiable to the levels of Cerealea or maize (*Zea mays*). An estimated 267 genera and 2,500 species of grass are present in the American neotropics (Davis 2004). Grasses are ubiquitous across all continents of the world and are found in every possible habitat. Grasses are wind pollinated and wild grass pollen can travel great distances from its source. Indigenous uses of grass includes weaving and as a food source. Poaceae was encountered in frequencies between 10-41 percent in the samples from SOC05-4 (Table 4 and Figure 7).

Recovery of the domesticated cultigen, *Zea mays,* from this core indicates maize grew near the sampling locale at one time. *Zea* pollen is a very large and heavy grain and 95 percent of the pollen produced by the *Zea* plant falls within three to six feet of its source, though it can move further if it the wind deposits it in flowing water (Moore et al. 1991). *Zea* was most common in the basal 70 cm of Core SOC05-4. In this portion of the core 13 *Zea mays* grains were encountered, an indication that it was likely grown in close proximity to the coring location (Table 4 and Figure 7).

Polygalaceae

Core SOC05-4 contained fossil pollen from the Polygalaceae family, also known as the Milkwort Family. Neotropical American is home to 11 genera and 400 species of the Polygalaceae family (Persson 2004). Members of this family grow in a wide variety of habitats from semi-arid to rainforest but are primarily present at low elevations (Persson 2004). Plants of this family can be herbs, shrubs, trees, or *lianas*, and the herbs can be annual or perennial (Persson 2004). Pollen produced by this family is stephanocolpate or stephanocolporate although the pores are often difficult to identify (Kapp et al. 2000). Pollination vectors for this family include bees, birds, and butterflies (Persson 2004). There are few known indigenous economic uses for members of this family, though some types are used as herbal medicines, the roots of some are used as a tooth cleanser, and as a skin treatment (Persson 2004). Polygalaceae was found in four of the 47 samples analyzed from Core SOC05-4 and ranged in frequency from 0.5-6 percent (Table 4 and Figure 7).

Polygonum

Polygonum is one of 13 genera of the Polygonaceae Family (Knotweed Family) present in the American neotropics. This genus is widespread across Mesoamerica and is a weedy plant with species present in mid-montane to lowland habitats (Atha 2004). Pollen produced by *Polygonum*, although polymorphic, is distinctive as is the pollen of several other genera in the family. Bees and wasps facilitate pollination of *Polygonum* (Atha 2004). *Polygonum* was used historically for its astringent and anti-inflammatory properties and it is still utilized for these characteristics today (Hemphill and Hemphill 1995). *Polygonum* was encountered in 16 samples but was an important component in samples from 370 cmbs to 426 cmbs in which it occurred in frequencies up to 11 percent (Table 4 and Figure 7).

Solanaceae

Solanaceae or the Nightshade Family is comprised of 63 genera in neotropical American. Pollen grains produced by members of this family are often tricolporate and have a psilate surface. Plants of this family can be shrubs, vines, or herbs with the greatest variety occurring in the tropics and subtropics (Nee 2004c). According to Nee (2004c), pollination is zoophilous and in the neotropics the genera do not produce nectar to attract bees. Many important domesticates belong to the Solanaceae Family including potatoes, eggplant, tomatoes, and chilies. Members of this family have also adapted to growing in disturbed and nutrient rich habitats, becoming a weedy nuisance in fields and pastures (Nee 2004c). Solanaceae pollen was encountered in a single sample from Core SOC05-4.

Arboreal

Arboreal pollen was relatively scarce in Core SOC05-4, comprising 9.3 percent of the entire assemblage.

Alchornea

Alchornea is a member of the Euphorbiaceae Family. Researchers have found some species of this genus to be adapted to water inundation (Webster 2004). *Alchornea latifolia* is one member of this genus that grows from southern Mexico to Panama, and prefers wet and semi-deciduous forests (Alvarado et al. 2003). Most of the members of the Euphorbiaceae Family are insect pollinated but *Alchornea* is one of a few that utilize the wind for pollination (Webster 2004). The wood of *A. latifolia* is susceptible to rot, and damage from termites, and is not particularly durable though it is easy to dry and preserve. Despite these tendencies, people do use it in light construction such as furniture, floors, beams, and fence poles among other items (Alavarado et al. 2003). *Alchornea* was encountered in two samples, comprising 0.03 percent of the entire assemblage (Table 4 and Figure 7).

Alnus

Alnus is a member of the Betulaceae or birch family and is one of three genera present in the neotropics. Members of the birch family usually prefer cool, moist habitats. Two species of *Alnus, A. acuminata* and *A. jorullensis*, grow in Latin America. *A. acuminata* ranges from the Sierra Madre Occidental in Sonora, Mexico to the Andes of Bolivia (Lentz 2004). *A. jorullensis* grows between Mexico and the Andes as well but is unevenly distributed, and is generally associated with oaks (*Quercus*) (Lentz 2004). *Alnus* grains are wind pollinated and produce pollen of a diagnostic morphology. The pollen is stephanoporate with multiple semi-aspidate pores with corresponding archi, where it appears under magnification to have an arch connecting each pore to the next (Kapp et al. 2000). The wood produced by *Alnus* is very durable and useful. Researchers have noted that its sap is used to tan and dye leather, and the wood is useful in furniture construction, and the trees for shade (Lentz 2004). *Alnus* is present in over half of the samples in low frequencies of up to 2.5 percent (Figure 7). The presence of *Alnus* in these samples is suggestive of long distance wind transport.

Bursera

Bursera is a genus of Burseraceae, the Torchwood Family, of which there are about 100 species. In Mexico, this genus is a major component of many dry forests, which are the native habitat of 90 species of *Bursera* (Daly 2004), although the most widespread species, *B. simarouba*, is often an important swamp forest component. These trees are insect pollinated. In Mexico, some members of *Bursera* were a source of linaloe oil while the wood of others was soft enough for woodcarvings (Daly 2004). *Bursera* was found in a single sample and was not a major constituent of the pollen spectra recorded in Core SOC05-4.

Chaetoptelea

Chaetoptelea is a member of the Ulmaceae or Elm Family and some botanists consider this genus synonymous with *Ulmus*. Only two species of this genus are present in the neotropics. These plants favor a highland environment and the presence of pollen from these trees in this core likely signal long wind distance transport. According to Gentry (1996) this is an extralimital genera of Ulmaceae that is found in Central America. This pollen type was found only in samples from the depths of 255 cmbs and 288 cmbs and occurred in frequencies of up to 2.5 percent.

Coccoloba

Coccoloba is a member of the Polygonaceae or Knotweed Family. This genus is relatively widespread in the neotropics, where it commonly grows in the form of lianas or as trees (Atha 2004). *Coccoloba* was seen growing near the coring location as a tree. It is unlikely that its presence is due to contamination, as the core was not opened until returning to the field laboratory in Esquintla. *Coccoloba* are markers of the seasonally flooded short tree savanna and swamp forests (Miranda 1998, Pennington and Sarukhan 1998) and insects usually pollinate members of this genus. Indigenous inhabitants of this region use *Coccoloba* as firewood and for its edible fruit.This genus was an important component of this collection occurring in nearly all samples with 200 grain counts, in frequencies of 0.5-12.3 percent.

Gymnopodium

Gymnopodium is another member of the Polygonaceae Family and grows exclusively in Central America (Atha 2004). This tree is strictly insect pollinated. Pollen from this genus was found in a single sample, 0.01 percent of the assemblage. Economic uses of this species in the Soconusco are currently unknown.

Heliocarpus

Heliocarpus is a genus in the Tiliaceae or Basswood Family. *Heliocarpus* is one of about 20 genera present at higher elevations in the neotropics (Fryxell 2004). Members of the Tiliaceae Family are generally trees or shrubs and insect pollinated with wind assistance (Fryxell 2004). Economic uses for members of the genus *Heliocarpus* are unknown. This genus was found in five samples in frequencies of 0.5-2.5 percent.

Juglans

Juglans is a member of the Juglandaceae or the walnut family and is one of four genera present in the American neotropics. This pollen type was encountered in eight samples from SOC05-4. Ten species of *Juglans* are present in the neotropics (González 2004). The pollen produced by the various species of *Juglans* is generally morphologically indistinct. This genus ranges, in the Western Hemisphere, from North American into the Southern Hemisphere in montane or premontane forests (González

2004). *Juglans* is a deciduous and, typically, resinous tree and is wind pollinated (González 2004), thus the presence of *Juglans* pollen in Core SOC05-4 likely signals long distance transport.

Moraceae

Moraceae or the Mulberry Family, has 19 genera present in tropical America, and the pollen produced by members of this family is usually not distinctive to the genus or species level. Woody members of Moraceae are important components of lowland rain forests (Berg 2004). Wind and insects act as pollination vectors for some genera but for others it is unknown (Berg 2004). Members of this family have many purposes. Archaeologists at one time thought *Brosimum alicastrum* (breadnut) was a food source of the Maya because they frequently find it growing in the rocky sediments of archaeological sites. The plant's preference for rocky sediments has created this association rather than human utilization of the plant encouraging its growth (Adams 2005). Some members of the genus *Ficus* are useful in the manufacturing of paper in Mexico and latex is made from *Castilla* (Berg 2004). Pollen of this family was encountered in 12 samples, and comprises 1.07 percent of the assemblage.

Pinus

Pinus (pine) is a genus of the Pinaceae Family, and is a wind pollinated coniferous tree. In the tropics, these trees prefer to grow in mountainous regions, such as the highlands of Chiapas. Stands of pine-oak (*Quercus*) and oak were formerly extensive in the Chiapas highlands but the stands have become fragmented due to human utilization of these resources and clearing for agriculture (Galindo-Jaimes et al. 2002). Pine pollen in sediments from coastal Chiapas is suggestive of long distance transport of the pollen grains. *Pinus* was an important component of this core occurring in frequencies of up to 5.9 percent.

Quercus

Quercus (oak) is a genus of the Fagaceae or Beech Family and is one of three genera present in tropical America (Nixon 2004). According to Nixon (2004), Mexico has the greatest diversity of species of the beech family represented predominantly by the genus *Quercus*. The majority of oak species grow in mid- to high-elevation forests with a few found in lowland forests. Oak is wind pollinated and produces vast amounts of pollen. In Chiapas today, agriculture and grazing livestock have restricted oak to the highlands though it was previously the dominant forest species in Mexico. Human activity has fragmented these old stands and today pines dominate secondary growth forests in the upland regions (Galindo-Jaimes et al. 2002). The presence of oak pollen in the sediments collected in Core SOC05-4 is indicative of long distance transport. *Quercus* was a minor constituent of this collection as it occurred in only two samples. Low frequencies of oak are not unexpected as it would have to be transported over great distances by wind or water to reach the coring location.

Salix

Salix is a genus in the Salicaceae or the Willow Family, and one of two genera present in tropical America. This genus was identified in a single sample and was not a major component of the pollen spectra from Core SOC05-4 (Table 4). In the neotropics, there are roughly ten species of *Salix*, growing in both the lowlands and highlands, and generally near freshwater wetlands or waterways (Gentry 1996, Nee 2004b). It is possible for this genus to colonize unstable riparian areas or sandbars (Gentry 1996, Nee 2004b). *Salix* is both wind and insect pollinated, producing an abundant amount of pollen.

Sapotaceae

Sapotaceae (the Sapodilla Family) is distributed throughout the tropics, where it prefers undisturbed, non-flooded forests occurring as both small and large trees (Pennington 2004). Pollen produced by this family of plants can sometimes be distinctive to the genus level. Research indicates that most members of this family have zoophilous pollination (Pennington 2004). In the neotropics, members of this family have a wide variety of uses from hardwood for construction to producing edible fruit. *Manikara zapota*, a native of southern Mexico, is now cultivated for fruit in the Americas and Asia (Pennington 2004), the wild variety was likely utilized during prehistory as a food source. Other economically important members of this family for Mesoamerica included *Chrysophyllum* (star apple), and *Mastichodendron* (mastic), while *Manilkara chicle* is the source of chicle, a base used in chewing gum. This family was a common component in samples between 255 cmbs and 300 cmbs occurring in frequencies of 0.5-5.9 percent.

Spondias

Spondias is a member of the Anacardiaceae or Cashew Family and is one of about 33 genera present in the neotropics. Members of *Spondias* prefer to grow in moist lowland forests (Mitchell 2004), and insects are the primary pollination vector. Trees of this genus provide edible fruit, and are thought to have been encouraged by the Maya (Jones 1994). This genus was encountered as an individual grain in a single sample from Core SOC05-4 (Table 4).

Tiliaceae

Tiliaceae is a plant family that, in the neotropics, has about 20 genera and 150 species. Members of this family are generally trees or shrubs and are insect pollinated with some assistance from the wind (Fryxell 2004). According to Fryxell (2004), members of this family occur as trees in forested habitats and as shrubs in weedy environments. Pollen identified to this family did not possess characteristics to distinguish it to the genus level. Tiliaceae pollen occurred in frequencies of 0.5-2.4 percent.

Zanthoxylum

Zanthoxylum is a member of the Rutaceae or Rue family and was found in two samples from SOC05-4. This is one of the largest genera of the family with about 180 species total, about 72 of which occur in the Western Hemisphere (Kallunki 2004). In tropical America member of the Rue Family are in the understory of moist forests (Kallunki 2004). Current observations suggest that insects are the pollination vector. Today, *Zanthoxylum flavum*, commonly known as West Indian silkwood, is valued for its timber (Kallunki 2004). Individual *Zanthoxylum* grains were identified in two samples from Core SOC05-4, roughly 0.03 percent of the entire assemblage.

CHAPTER FIVE

INTERPRETATION AND DISCUSSION

The 31 fossil pollen grains identified in these sediments create a picture of the past environment near Cerro de las Conchas. Concentration values for these samples remained relatively steady indicating that preservation is consistent throughout the core and that none of the trends noted are caused by better preservation in one section versus another. The largest overall constituent of this record were the aquatic taxa, primarily due to the large amount of sedge pollen recovered. The herbs and cultigens were the second most prevalent pollen type and are the most sensitive to human activity in an area. The arboreal component of these data may be the smallest but it provides insight into how the coring location is capturing pollen as well as the interaction between the swamp forest and wetland environments in the vicinity of the collection area. Evidence of human occupation of the coring area was revealed through the deposition of pollen and particulate matter.

Three sediment samples were submitted to the University of Arizona Radiocarbon Laboratory. The first was a sediment sample from near the base at 466-467 cmbs (Sample #AA63357), which returned with a corrected date of 2316±61 years BP (Table 5). A second sample was taken from a layer of black peat at 461 cmbs (Sample #AA63356). This sample returned a corrected date of 1870±41 years BP (Table 5). The third sample was sediment from 301cmbs (Sample #AA69143), at an environmental change near the top of the pollen bearing sediments, and returned a corrected date of 1252±39

Table 5. Radiocarbon dates for samples submitted from SOC05-4.

Sample #	Provenance	Lab #	Type	14C Age	Error	Cal BP (2 Sigma)		Cal B.C.-A.D. (2 sigma)	
						Range	Probability	Range	Probability
AA69143	301-302 cmbs	AA69143	Organic/Sediment	1252	39	1280-1080	1.000	A.D. 670-870	1.000
AA63356	461 cmbs	AA63356	Black Peat	1870	41	1890-1710	1.000	A.D. 58-240	1.000
AA63357	466-467 cmbs	AA63357	Organic/Sediment	2316	61	2490-2150	0.970	B.C. 540-200	0.970

years BP (Table 5). These dates bracket the majority of the analyzed sediments indicating that the deposition of the 240 cm of analyzed sediment occurred in about 1,900 years during the Late Formative and Classic Periods. The two basal dates indicate that the bottom five centimeters of this core were deposited during the Late Formative Period, while the remainder of the analyzed sediments is representative of the Classic Period.

The pollen data collected from SOC05-4 was analyzed in consideration of environmental change (i.e., wet/dry periods, receding wetlands), human activity, the presence of agriculture, and, when possible, how environmental change and human activity relate. Environmental change within a sediment sequence is evaluated in reference to the sequence as a whole, generally bottom to top reflecting deposition. Presence and absence of pollen types and their relative frequencies are considered when determining environmental changes. Increases, decreases, or absence of certain taxa can indicate a dry period, an abundance of moisture, or the expansion of brackish water habitat, for example (Table 6). Plant species that thrive in disturbed sediments will increase with the presence of people and after natural disasters such as a forest fire. This is reflected in the pollen record by increasing amounts of grains from these plant species (Table 6). For example, Cheno-Ams prefer disturbed soil and increased cultivation would provide more area in which the weed could grow. The presence of people in an area is marked by a sharp increase in particulate charcoal and an influx of taxa that grow well in disturbed areas. People clear areas upon arrival by cutting down and burning the vegetation to create living space. This activity causes an initial increase of charcoal into the air, which is then perpetuated by cook fires and other activities and deposited in the local sediments with the pollen rain. This clearing alters the vegetation spectrum by decreasing the amount of arboreal pollen types and creating opportunities for other weedy plant species to take root. The practice of agriculture is reflected in the pollen record through the presence of cultigens (i.e., *Zea mays*) or high frequencies of disturbance indicators (Table 6). In particular, *Zea mays* pollen does not travel more than three feet from its flower (Moore et al. 1991) and indicates that cultivation occurred in the immediate area. Squash and the common bean, the other two common Mesoamerican domesticates, are rarely found in the pollen record because squash produces large difficult to transport grains and beans are self-pollinating (Fish 1994). Interaction between the environment and human activity is evaluated by considering where environmental and human activity indicators coincide (i.e., dramatic decreases in charcoal and weedy species occurring with a dry period indicated by a sharp decline in wetland taxa).

Table 6. Summary of plant taxa and behavior indicating disturbance, human activity/cultivation, and environmental change.

Indicator Type	***Taxa***	**Pollen Response**
Environmental	Alismataceae	Disappears in dry conditions
	Cyperaceae	Decrease in productivity in dry conditions
	Nymphaeaceae sp.	Disappears during dry periods
	Rhizophora sp.	Increases with the expansion of salty habitat
	Typha sp.	Increases with people, decreases in dry periods
Disturbance	Asteraceae	Increases with disturbance and diminished forest
	Alnus sp.	Long distance transport, open areas in canopy
	Charcoal	Increases with the burning
	Cheno-Ams	Increases with ground disturbance
	Heliocarpus sp.	Long distance transport, open areas in canopy
	Juglans sp.	Long distance transport, open areas in canopy
	Pinus sp.	Long distance transport, open areas in canopy
	Poaceae	Colonizes open spaces
Human Activity and Cultivation	Asteraceae	Grow in disturbed or minimally forested areas
	Charcoal	Spikes at field clearing, declines without people
	Cheno-Ams	Colonizes disturbed areas
	Solanaceae	Colonizes fields and pastures

Table 6. Summary of plant taxa and behavior indicating disturbance, human activity/cultivation, and environmental change.

Typha sp.	Increases with people, decreases with drying
Zea mays	A cultigen

The same fluctuations in pollen presence and frequency that aid interpretation enable the division of the pollen record into zones. Zones are biostratigraphic units based solely upon pollen content and are designated where a change in the pollen distribution is most apparent. This division allows greater ease in discussing and interpreting the data (Moore et al. 1991). Six zones have been identified in the Core SOC05-4 pollen record (Table 7). These zones are reflective of past environmental conditions and human interaction with the environment in the coring area (Figure 1). These zones strongly reflect the impact upon the environment through human activity.

Table 7. Summary of biostratigraphic zones identified for Core SOC05-4.

Zone Number	Provenience (cmbs)	Description
6	255-230	Freshwater habitat, abandoned by human occupants
5	300-255	Records expansion of the mangrove forest with people still utilizing local area for shifting agriculture
4	335-300	Return to a wetter environment, re-occupation by people practicing shifting agriculture
3	400-335	A drying period in which people move away from the immediate vicinity of the coring locus
2	435-400	Expansion of freshwater habitat, continued occupation by people practicing shifting agriculture
1	468-435	Fresh water depositional environment, people living in the area practicing shifting agriculture growing maize

Interpretation

Zone 1 is the basal unit of this core and refers to the sediments from 468 to 435cmbs (Figure 7). High frequencies of sedge (Cyperaceae) and cattail (*Typha*) are dominant in this zone as well as lesser amounts of Alismataceae, a fresh water aquatic herb (Haynes 2004). The presence of these plants in high percentages indicates a fresh water depositional environment with shallow, slow moving water. Red mangrove (*Rhizophora*) is present in this zone but in very low percentages, implying it was present in the general area but not in the immediate coring location. Red mangrove usually favors a more brackish environment though it can also be found less commonly in fresh water areas, thus low frequencies of red mangrove also support the interpretation of the area as freshwater.

The presence of *Alnus*, *Pinus* (pine) and *Heliocarpus* in Zone 1 are indicative of long distance transport either through wind or water action and elevated percentages often reflect the presence of open areas for the pollen to settle. Clearings or gaps in the local vegetation act in a similar fashion to a lake or pond, serving as catchments for airborne pollen grains (Moore et al. 1991) and thus would trap any pine or *Heliocarpus* grains blown over the area. Both of these species grow at much higher elevations in the Sierra Madre Occidental. This, in conjunction with a high frequency of weedy disturbance indicators including Asteraceae, Cheno-Ams, and grass (Poaceae), suggest that disturbance was occurring in the coring location at the time of sediment deposition (Table 6).

In Zone 1 the weedy species are accompanied by the cultigen *Zea mays.* These taxa indicate that agriculture was taking place in the coring location as all of these taxa grow in disturbed soils. The presence of *Zea mays* suggests that maize cultivation likely occurred in close proximity to the coring location. In concurrence with these agricultural markers, the charcoal concentration in this zone of the core is very high. In Zone 1 particulate matter slowly decreases upward. A high amount of particulate matter is common in areas inhabited by tropical agriculturalists. Initial clearing of a field for shifting cultivation causes a spike in particulate matter present in the atmosphere and deposited in the sediments. Human occupation of the immediate area during the use of the fields would create a perpetual low-density influx of charcoal into the air through cooking and other activities until they move to their next field site.

Throughout Zone 1, there is a steady increase in the percentage of disturbance indicators (Table 6 and Figure 7) and a constant but diminishing presence of particulate carbon indicating a continuous human presence within the area around the coring location. Zone 1 suggests a freshwater environment in which people are practicing agriculture.

Zone 2, from 435 to 400 cmbs, is marked by fluctuations in the frequency of cattail, two sudden increases in the frequency of herbs and cultigens and an increase in *Zea mays* (Figure 7). Red mangrove pollen frequency decreases in Zone 2 suggesting that red mangroves are growing further from the coring location or the environment has become less favorable to pollen production, as less red mangrove pollen was deposited. This implies that the brackish water estuary zone migrated seaward and the area remained a freshwater habitat, possibly slightly expanded. The overall high frequency of *Typha* in these sediment supports the interpretation of the area as a freshwater habitat. The sharp decline in cattail in the middle of the zone corresponds with a similar decline in sedges and an increase in weedy species and particulate charcoal. It is possible that the decline is due to an episode of clearing and a slow re-growth of the cattail and sedge communities.

Frequencies of *Pinus* and *Coccoloba* pollen in this zone, suggest an interpretation of increased clearing during Zone 2 deposition (Figure 7). An increase in disturbance is also supported by the increase of Cheno-Am pollen present in this zone. Two spikes are seen in the overall frequency of herbs and cultigens, which correspond with increases in particulate matter. These data suggest multiple episodes of clearing and agricultural production, supported by the presence of *Zea mays* in four samples from this zone; this is an increase in comparison to Zone 1 and suggests an increase in localized agricultural production. The associations of reduced frequency of herbs and cultigens with drops in particulate matter throughout the zone suggest cyclical fallow periods and short term abandonment of the area, consistent with traditional shifting agricultural activities.

The pollen types associated with Zone 2 suggest environmental continuity with Zone 1 with shifting use and abandonment by people growing maize and other plant foods and practicing shifting agriculture. The moist environment provided good conditions for agriculture. The repeated sharp increases in particulate charcoal associated with increased frequencies in weedy species and cultigens indicate more clearing and ground disturbance activities, likely associated with agriculture. Zone 2 represents a period of environmental stability, increased human activity, and agricultural production.

Zone 3, 400 to 335 cmbs, is distinguished by the absence of cattail, the increase in grasses, the decrease then return of sedges, and the lack of cultigens. It is important to note that this segment of the core had few samples run due to poor pollen preservation and low concentration values. Pollen found in this section is generally the same as in all other parts of the core with the exception of cattail, despite the analysis of fewer samples. The similarity of pollen spectra for this and all other zones suggests that the zone is representative of the area around the coring location and that the pollen degradation and low concentrations are due to rapid sedimentation.

Sedges, cattail, herbs and cultigens, and particulate carbon peak at the onset of Zone 3 but then drop off dramatically. The shift in the sedge frequency suggests an initial drying of the environment with a progressive increase in moisture. The lack of cattail is also supportive of a drying of the environment and the shift away from a shallow slow-moving water margin that cattails prefer. In conjunction with the decreasing frequency of freshwater aquatic plants, red mangrove pollen frequencies increase slightly in Zone 3 suggesting the expansion of the mangrove forest and the movement of brackish water inland creating a more favorable environment.

Arboreal pollen types gradually increase then decline during the deposition of Zone 3. *Coccoloba*, a swamp forest tree, is present in higher frequencies in this zone. The increase in *Coccoloba* is consistent with an abandonment of the area for agricultural purposes. It is also possible that the increase in *Coccoloba* may signal a migration in the littoral/savanna boundary seaward but the increase of red mangrove makes this unlikely. The resurgence of the swamp forest habitat is supported by the dramatic increase in *Polygonum* during Zone 3. This weedy species is widespread throughout lowland habitats in the neotropics.

Pollen from high elevation trees; *Alnus*, *Heliocarpus*, and *Juglans* increase slightly in Zone 3. The presence of more open spaces, possibly fallow fields, may be allowing airborne grains to settle in this region. Cheno-Am and grass frequency increase initially in Zone 3 but then slowly taper off with time. Fallow fields would initially provide increased habitat for Cheno-Am and grasses to grow but as the forest reclaimed these areas the weedy species would be displaced. These data indicate an absence of human activity.

Steady levels of particulate carbon deposition, a decline of disturbance indicators, and the lack of cultigen pollen suggest that people may still occupy this general region but have moved away from the coring location. Zone 3 begins with a dry period in the area with a gradual return to wetter conditions. People were likely occupying the area initially but appear to have moved away from the immediate coring location when the environment became drier leaving cleared areas in fallow. Zone 3 represents a drying period where fragile grains; sedges, cattail, Alismataceae and others may have been oxidized by drying episodes thus resulting in the poor preservation encountered in these samples. The El Hueyete Swamp is fed by a shifting stream system and the movement of this system away from the coring locale would cause the area to become drier (John G. Jones personal communication).

The initial change to Zone 4, occurring between 335 and 300 cmbs, is indicated by a dramatic increase in sedges, herbaceous species and particulate carbon (Figure 7). The resurgence of cattail with the decline of the red mangroves suggests a return to a freshwater habitat with slow moving water and a less friendly environment for the red mangroves. Fluctuating frequencies of sedge may suggest periodic dry spells. *Coccoloba* decreases steadily in this zone suggesting that fewer trees are producing pollen. This may be indicative of people moving into the adjacent woodlands and removing more trees from the overall system. People are the likely cause of this shift because all other environmental indicators suggest that the area is favorable to the growth of *Coccoloba*.

A significant increase in the amount of low-spined Asteraceae pollen, reestablishment of cattail, a general increase in disturbance indicators, and the presence of a single *Zea mays* pollen grain distinguish Zone 4 (Figure 7). At a depth between 335 and 320cm BS, the percentages of Cheno-Am, Asteraceae, and grass are all increasing while particulate matter spikes indicating the resumption of agricultural clearing and use fields. The particulate carbon then decreases along with the herbaceous taxa suggesting that people again abandon the area.

Spikes in particulate carbon, herbaceous species, and the presence of a maize grain suggest a reoccupation of the coring locale by tropical agriculturalists. At the base of Zone 4 a peak in particulate carbon followed by a sharp increase in herbs and cultigens indicate the presence of people at the coring location. This initial activity is followed by a sharp decrease in particulate carbon and disturbance indicators. Near the upper reaches of Zone 4 particulate carbon, grasses, and low-spined Asteraceae, the latter two disturbance and agriculture indicators (Table 6), all peak indicating people again inhabit the area. This zone represents a return to a generally wetter freshwater environment attractive to agriculturalists. Each time people are present, the data suggest they are practicing shifting type agriculture in the area.

Zone 5, occurring between 300 and 255cms BS, is characterized by high percentages of sedge and cattail. Disturbance indicators are present in quantities similar to Zone 4 but arboreal pollen is a much greater constituent. The increase of principally long-distance arboreal pollen may be indicating an increase in clearing. The spikes in particulate carbon validate this interpretation.

Red mangrove increase during this period indicating a more productive environment for the mangrove forest but the presence of Alismataceae and *Nymphea* indicates that the coring area is still predominantly a fresh water system with shallow, slow moving water. *Coccoloba* increases again associated with the lack of cultigens, suggesting that people are no longer removing it from the area or possibly that they have shifted out of the forested areas and the trees are growing back. The general increase in arboreal pollen types and pine, in particular, indicate that the coring location is an open clearing.

Cultigens are absent from this zone suggesting that people are not using the immediate area around the coring location as an agricultural field or that the pollen was not recovered. Zone 5 represents the periodic reoccupation of the area by people who are practicing shifting agriculture. The lack of cultigens suggests that the actual fields were not immediately adjacent to the coring location, but were somewhat removed. This zone also records a slight expansion in the mangrove forest but indicates that the immediate area remains a freshwater ecosystem.

Zone 6 represents the last of the pollen bearing sediments from 255 to 230 cmbs (Figure 7). Six sediment samples were analyzed in this section of the core and only two produced 200-grain counts. Sedges and cattail are present in frequencies similar to previous zones indicating the environment was still a freshwater habitat. Weedy herbaceous taxa remain present in large quantities. These two samples had high frequencies of Moraceae and weedy species suggesting a reestablishment of lowland rain forest with a weedy understory. This, combined with a lack of particulate carbon, indicates an abandonment of the area by tropical agriculturalists. This is a highly tentative assessment as two samples are too few to make any firm interpretations.

Throughout the analysis of this core, the environment, disturbance, evidence of agriculture, and the relationship between people and the vegetation of the area were key interpretive frameworks. The environmental indicators (Table 6) suggest that throughout the depositional history of the coring location the area was a freshwater habitat that experienced sporadic drying episodes. The more regional environmental indicators (i.e., red mangrove) record fluctuations in the freshwater-brackish water interaction zone, suggesting oscillating levels of pollen productivity in the red mangrove forest through time. The cyclical disturbance and re-growth of the swamp forest is evident throughout the sediment sequence. Influxes of weedy species coincide with decreases in local arboreal species and increased particulate charcoal throughout this record, as does the inverse. These cycles appear to reflect the occupation of the area by people practicing shifting agriculture. This is supplemented with the presence of *Zea mays* in Zones 1, 2, and 4. Through these data a picture is created of the use of the area around Cerro de las Conchas over a 1,900-year period.

Discussion

Core SOC05-4 provides a detailed picture of the environment around Cerro de las Conchas and how this area might have been utilized by tropical agriculturalists during the Late Formative and Classic periods. The pollen and particulate carbon data recovered from these deposits reflect the local environment and provide some information about the changes in the mangrove forest in the estuary zone. This sediment record is highly sensitive to local environmental changes and reflects human landscape modification, disturbance, and agricultural activities. It is apparent in these samples that people were moving around the area associated with El Hueyete Swamp, clearing and using fields as needed. The coring area was periodically abandoned allowing trees and other plants to reestablish themselves in the area before people returned. This core suggests that shifting agriculture was practiced in the Soconusco during the Late Formative.

Environment

Evidence from the core suggests a catchment area in the immediate vicinity of the coring location. It is difficult to determine the exact dimensions of this catchment but it is apparent from the taxa recovered that it was fairly local in nature, and most of the vegetation represented in the samples was probably within roughly half a kilometer of the coring locale. If this catchment was more regional in nature, more distant pollen types would be more prevalent. Frequencies of pine, oak, *Alnus*, and other distant arboreal taxa would have been greater than presently represented in the samples. The pollen spectrum represented in the analyzed portion of Core SOC05-4 primarily shows the trunk space component of the surrounding area. Trunk space refers to the area below the canopy where pollen grains are moved by wind through the space around the trunks of the trees (Moore et al. 1991, Tauber 1965).

Human alteration of landscape is known to obscure the climatic data provided by fossil pollen (Moore et al. 1991). The unpredictable tendency of human populations to remove and maintain vegetation based upon their needs generally skew data. In this fossil pollen record the primary constituents are freshwater aquatic plants, swamp forest vegetation, and weeds. The freshwater aquatic plants near the coring area are sensitive to habitat change but are also plants that people may have preferentially left in place for future use.

Overall, the local environment reflected in this record is one of a stable wetland. The high frequencies of sedge and cattail throughout the core indicate the constant presence of freshwater habitat. The environment along the northeast margin of El Hueyete Swamp during the Late Formative to Classic shift, represented by Zone 1, is a transitional area between the slow moving, shallow, freshwater swamp and adjacent swamp forest. This remains stable through Zone 2. The freshwater aquatics are sensitive to any shifts in the moisture levels of the area because many of them grow best under specific conditions, such as typha preferring slow moving, shallow water. This is particularly evident in the sharp decrease of sedges and disappearance of cattail in Zone 3 representing a drying episode likely associated with a shifting stream system. The environment continues throughout the Classic Period as a stable freshwater marsh/swamp forest transition zone. Zone 3 records a short period of drying then return to wetter conditions, which prevailed through the remainder of the analyzed sediments.

A recurring theme in these pollen assemblages is the slight increase then decrease of red mangrove pollen. Red mangrove was not present at the coring location in 2005 and the environment was swamp forest system, although red mangroves were visible only a couple of hundred meters away. It seems unlikely that these changes in red mangrove frequencies are the result of changing quality of preservation as the concentration levels are consistent throughout the analyzed sediments. The red mangrove frequencies appear to reflect shifting of the littoral zone separating the swamp from the Pacific Ocean. The red mangrove pollen present in this core then likely represents fluvially transported grains washed into the sediment from some distance. Shifts in brackish water habitat are known to occur in response to changes in rainfall and hydrology, and in the migration of the shoreline (Voorhies 2004). The fluctuating frequencies of red mangrove are most likely related to either changes in rainfall or hydrology bringing more red mangrove pollen into the catchment and shifts in the brackish water habitat influencing pollen productivity.

The environmental information recorded in these sediments is reflective of the immediate area rather than regional. Core SOC05-4 provides a detailed picture of the minor fluctuations seen in this area over 1,900 years. The record shows overall environmental stability even with repeated use and modification by human populations. Slight fluctuations occurred in level of water in the nearby wetland area and a distinct period of drier conditions was noted at 370 cmbs to 400 cmbs. The date of this cannot be known for certain as only the three previously mentioned dates were acquired on this core. Tighter chronological control on the sediments of this core would make it possible to correlate the changes seen in the local environment to trends identified in the wider scope of Mesoamerica. The northeastern margin of El Hueyete Swamp during the Late Formative and Classic Periods was a stable freshwater wetland on the border of a swamp forest much as it is today.

Human Impact

Shifting agriculture is generally defined as continual system of clearing, cropping for short periods of time, and then fallowing for periods longer than they were cropped (Conklin 1961). A field is cleared and the material burned, then planted and used, then abandoned for the forest to reclaim (fallow). This form of agriculture is one of the oldest known methods and is also one of the most widespread; present at the time of European contact in eastern and southwestern North America, Central and South American, Southeast Asia, and in central Africa (Peoples and Bailey 2006). Today it is still commonly practiced in tropical and subtropical areas around the world (Conklin 1961; Peoples and Bailey 2006).

The general understanding of shifting agriculture is that the process of clearing and burning the biomass of the selected field location results in a short-term improvement of fertility in the sediments. The ash from the fire becomes incorporated into the sediments improving the amount and availability of nutrients, especially phosphorus. This is important in tropical areas as the sediments tend to be acidic and the ash helps make nutrients more accessible (Giardina et al. 2000). The field is cropped until the productivity drops below the productivity threshold of the farmer; the length of use varies with the type of cropping and the sediment chemistry (Harris 1971). After production has ceased, the field is left fallow and the farmer clears a new plot of land or returns to a previous field and repeats the process. The total land cleared by a single farmer is generally enough to support a household. The time period from the establishment of the initial field through the return to that original field has been found to encompass many years, in Quintana Roo, Mexico fallow periods of five to 60 years have been recorded (Dalle and de Blois 2006). In Guerrero, north of Chiapas, farmers of the piedmont and mountains prefer fields that have been fallow for at least 15 years (Lambert 1996).

Studies of indigenous populations in the American tropics have found that people practicing shifting agriculture do not completely clear their fields, but rather they clear the majority of the overstory and understory, leaving behind stumps and unburned material (Dalle and de Blois 2006; Harris 1971). Leaving stumps and some of the materials unburned in the field provides firewood for the farmers and creates a plot with diverse vegetation. This mixing of native forest plants with the cultivated domesticates causes the field to mimic a forest ecosystem and increases the use-life of the field (Dalle and de Blois 2006; Harris 1971). The practice of leaving debris in the field enables the farmer to protect young plants from inclement weather or the scorching tropical sun. The diversity of plant life in the field strengthens the nutrients whereas growing a single crop can deplete a single nutrient very quickly. In his study of shifting agriculture in Venezuela, Harris (1971) found that those fields that were monocropped with maize needed to be more fully burned and the majority of the biomass turned to ash to ensure that the maize grew productively, and that maize fields were only productive for two to three years.

Another important aspect of the shifting agriculture system is the role of active and fallow fields in the collection of non-cultivated dietary items. Fallow fields create cleared space in the forest with forage for prey animals. Early work by Olga Linares (1976) found that mammals that forage in anthropomorphic habitats are likely more common near human habitation sites, providing a reliable food source. In some areas management of fallows to increase attractiveness to game has been recorded ethnograpically. In Amazonia Lacondon Maya farmers planted crops in certain areas or modified the fallow plots to improve the productivity of plants to specifically target prey animals (Balée and Gély 1989; Nations and Nigh 1980). In active garden plots, farmers were generally hunting animals that were damaging their crops. Among the Buglé of western Panama, farmers opportunistically hunted terrestrial and arboreal game while attending their active and fallow fields (Smith 2005). This study found that up to 50 percent of game was captured in either active or fallow fields (Smith 2005).

Fallow and new fields also create an excellent habitat for weedy plants species that prefer disturbed sediments, as mentioned previously. The amount of time a field spends in fallow alters not only sediment nutrient recovery but also the distribution of flora. It has been found that when a field remains fallow for a longer period, the plant distribution begins to be dominated by trees, which will later become important to the farmer for firewood (Dalle and de Blois 2006). Short-fallowed fields have more weedy species of which people only utilize a few, and few trees (Dalle and de Blois 2006). In many areas it has been found that fallow cycles are shortening as people experience population pressure and find less land available for use (Dalle and de Blois 2006). The shortening of this fallow period may be interpreted as an intensification of land use.

The system of burning, cropping, and leaving fallow fits the patterns observed in Core SOC05-4. The lack of finer chronological control of the sediments of Core SOC05-4 does not allow for a discussion of length of cropping and fallow periods. The consistent pattern observed throughout the sediments does allow for a discussion of continuity of agricultural behavior from the terminal Formative through the duration of the Classic Period that has not been examined in earlier studies. Previous research on agriculture in the Cerro de las Conchas area has focused on the transition to an agricultural based subsistence during the Late Archaic and Early Formative Periods (Voorhies 1994, 2004, Voorhies et al. 1991, 2002).

During this previous work, Late Formative and Classic Period pottery were found incorporated into the sedimentary rind that covered the shellmound indicating that people were utilizing the area at that time. It is thought that the receding of the coastline caused the area to become a drier, freshwater habitat and thus more attractive as an agricultural locale (Voorhies 2004). The analysis of Core SOC05-4 corresponds to the results of the phytolith studies conducted on materials from Cerro de las Conchas. Jones and Voorhies (2004) found that during the deposition of the sedimentary rind the vegetation of the surrounding area was composed of predominately weedy species and no longer a forest habitat (Jones and Voorhies 2004). It was also observed that the area was subject to human clearing and the cultivation of *Zea mays*. This, too, was discovered in Zones 1, 2, and 4 of Core SOC05-4 and is supported in this paper.

Core SOC05-4 records a shifting agricultural system in this region unlike what Jones and Voorhies (2004) found in association with the shellmound at Islona Chantuto. The core recovered from Islona Chantuto represents the only dataset from the Soconusco that overlaps in time with the SOC05-4 core. The Chantuto core recorded a freshwater wetland environment with general abandonment by tropical agriculturalists. The signature of a stable wetland observed in this study is similar to that found in the Chantuto core. The pollen spectra recovered from the Chantuto core had low levels of disturbance indicators in the sediments corresponding to the Late Formative and Classic Periods, unlike Core SOC05-4, suggesting very minimal disturbance of the area. Human activity was evidenced most prominently in the sediments of the Chantuto core dating to the Early Formative Period and older. Maize was present in sediments associated with the Early Formative Period indicating tropical agriculturalists were utilizing Islona Chantuto for agriculture at that time (Jones and Voorhies 2004). The lack of agricultural indicators in the subsequent sediments indicates an abandonment of the area from the Middle

Formative Period through the Classic Period (Jones and Voorhies 2004), whereas the Cerro de las Conchas area was the locus of continual cyclical use from the Late Formative likely through the termination of the Classic.

Other palynological studies conducted in Mesoamerica have provided broader perspectives on the interaction of humans and their environment. Core COC05-4 provides a picture of a different agricultural adaptation generally not seen in Classic Period Mesoamerica. Archaeological work in Soconusco and Guatemala indicate that the northwestern portion of Soconusco was refilled during the early Classic after the Late Formative collapse of the cultural centers in the Naranjo Valley (Love 1999; Rosenswig 2006a; Voorhies 1989b). The areas surrounding civic and cultural centers are archaeologically well studied and provide much of the data about life during the Classic Period. Studies in and around Teotihuacan have found extensive agricultural fields created by the drainage of wetlands and the canalizing of water (Adams 2005; Coe and Koontz 2002; Evans 2004). Swamp land around Teotihuacan was filled in to provide more arable land for agriculture while at the same time canals were built to ensure water delivery to all fields (Adams 2005). Significant amounts of time and labor were invested in the fields around Teotihuacan and other cultural centers to ensure the productivity of their field systems. These large populations required large crop yields to sustain them.

Archaeological research in the Maya region has highlighted similar complex forms of agriculture. Early agriculture in the Maya lowlands has been identified as shifting cultivation. In addition, there were numerous rituals attached to agriculture, evidenced in the form of ceramic offerings found in fields, and in an effort to prevent poor weather from ruining the crops (Adams 2005). During the Formative Period, with the increase in site size and population, a shift is seen to more intensive forms of agriculture as population pressure increases the need to produce food in greater quantities. This is reflected in early evidence of field modification and the building of drainage ditches (Adams 2005; Coe and Koontz 2002; Evans 2004, Pohl et al. 1996). By the Classic Period, the Maya were controlling and storing water with canals and reservoirs. Around the site of Colha, it has been found that the swamps were drained for agriculture and foreign fertile soils were brought in to raise fields and fill in terraces (Adams 2005; Coe and Koontz 2002; Evans 2004). Though fields were drained in other parts of the Mayan area, in northern Belize flooded fields were generally abandoned during the Classic Period (Pohl et al. 1996). Cobweb and Pulltrouser Swamps in Belize contain evidence of raised fields, drainage canals, possible sluice gates and other water control features. In his study of sediment cores from Cobweb Swamp, Jones (1991) found evidence of foreign soil and intensive agriculture associated with the Formative Period occupation of this area.

While studies in other regions have focused on those locales with monumental architecture and vast cities, this study provides detailed information about a specific area but provides an idea of how a non-urban area, away from the civic and cultural centers, was utilized. Zone 1 of Core SOC05-4 was dated with two radiocarbon dates separated by seven centimeters of sediment (Tables 5 and 7). The basal date of 2316±61 years BP and the following date of 1870±41 years BP indicate that the sediments at the base of this core were deposited entirely within the Late Formative period. Zone 1 indicates that in the area immediately adjacent to Cerro de las Conchas, within the swamp forest, tropical agriculturalist were living, growing maize, and practicing shifting agriculture.

At this time, to the south of Cerro de las Conchas, the site of Izapa has become a regional center and important in the production and trading of cacao (Lowe et al. 1982). Voorhies' (1989b) settlement survey found increased numbers of Late Formative sites located along the inland portion of the Soconusco coastal plain though the majority of the population congregated in the Rio Naranjo River Valley. It was proposed that the increase of sites represented an intensification of agricultural production in the central Soconusco during this period with specialized procurement sites located in the estuaries. This possible intensification of land usage may be indicative of an increasing reliance on maize agriculture. From currently available data it is unclear how the people along the coastal plain were growing their crops, whether by intensive field modification such as that seen in the Mayan areas and around Teotihuacan or possibly by a shortening of fallow periods within a shifting agricultural system, but there does appear to be an increased reliance on agriculture in the central portion of the Soconusco. Core SOC05-4 data suggest that shifting agriculture may be the mode of production for this region in the Late Formative.

The termination of the Late Formative Period is marked by the collapse of society in the Rio Naranjo valley. The population once concentrated there is thought to have spread out in all directions (Bove 1981, 1993; Love 1999a, 2002, 2007). In the central Soconusco, Izapa experienced its own collapse during the Classic Period. The Classic Period encompasses the remainder of the analyzed portion of Core SOC05-4. The date of 1252±39 years BP (Table 5) from sediment located 301 cmbs, just below the termination of pollen baring sediments, correlates with the decline of the Classic Period.

It is thought that the inhabitants of the Soconusco during the Classic were full-time agriculturalists practicing agriculture as intensively as their contemporaries in the Mayan regions and the Basin of Mexico. Data collected from Izapa suggests an increasing reliance on agricultural products and the domesticated dog for their subsistence (Blake et al. 1995; Hudson et al. 1989; Lowe et al. 1982; Love 1993). At this time there also appears to be a shifting emphasis toward craft specialization with fewer people involved in subsistence activities. Again, there is a lack of a data available to confirm the type of agriculture practiced in the Soconusco during the Classic. The remainder of Zone 1 and Zone 2 of Core SOC05-4 continue to indicate the practice of shifting agriculture in the swamp forest. The abandonment of the swamp forest by agriculturalists in Zone 3 seems to be more related to a drying of the environment rather than to any cultural event in this period, though it is possible it is a reflection of population redistribution after Izapa's fall from prominence. It is not possible to determine a direct correlation without further dating of the sediments. The remainder of the core records the continued use of the swamp forest by people practicing shifting agriculture.

The data collected from Core SOC05-4 indicate that people practicing shifting agriculture inhabited the swamp forest/wetland interaction zone during the Late Formative and Classic Periods. As mentioned previously (Chapter 2), the littoral and estuary zones were areas that maintained traditional pottery forms longer than other parts of the Soconusco and were less influenced by other cultures (Blake et al. 1995). This pattern may have continued into the Late Formative and Classic Periods with people maintaining more traditional subsistence practices rather than adopting new techniques. It is possible that the people of the central portion of the Soconusco all practiced shifting agriculture but it seems more likely that the data provided by Core SOC05-4 is recording a traditional agricultural mode that cannot be extrapolated to the remainder of the region.

CHAPTER SIX

CONCLUSIONS

Archaeologists in the Soconusco have been pondering and researching the larger issues concerning the adoption of agriculture and the development of the state during the Formative Period. Another research focus has been the spread and development of individual state level societies in various parts of Soconusco, such as the portion stretching into Guatemala. Previous research has indicated that the Soconusco estuary and wetland areas were utilized primarily for the acquisition of aquatic resources during the Archaic and found that it was a locus of some of the earliest agriculture during the Late Archaic and Early Formative periods (Voorhies 2004 for a summary of this work). With the focus of research on such specific and important events, the underlying social and subsistence dynamics of the later periods has yet to be explored. This thesis attempts, in some small way, to address this void and provide some information about how a small portion of Soconusco was utilized during the Late Formative through the Classic Periods. Questions addressed by this study include: 1) what was the environment like during this time period? 2) were people using the wetland margins in the Late Formative and Classic Periods?, and 3) were they practicing agriculture, and if so, what kind?.

Core SOC05-4 provided the data to answer these questions. This core was collected adjacent to the oldest known site along the Pacific coast of Chiapas, Cerro de las Conchas. The undisturbed stratigraphy of the core allowed sampling at close intervals. Pollen analysis was conducted upon sediment samples from this core to provide a detailed record of 1,900 years of vegetation history and human occupation of the area.

The human tendency to alter our landscape to suit our needs is reflected in the types of pollen deposited on the ground. This was used to determine how people were using the area around Cerro de las Conchas during the Late Formative and Classic Periods.

The record recovered in SOC05-4 provided a clear picture of the environment along the northwestern margin of El Hueyete Swamp. A subtle, more regional, environmental change found in this pollen record is the fluctuation of the brackish water zone. Throughout this core, the frequency of red mangrove constantly fluctuates by zone. The change in pollen production among the red mangroves suggests changes in their environment. They grow most productively in brackish water environments though they have been recorded on the edges of fresh water habitats (Gustafsson 2004). The shifting frequencies here are likely recording changes in the salinity of the water. In Zones 1, 3, and 5 where the frequencies are the highest it is likely that the brackish water has come further inland causing the water to become saltier, while in Zones 2, 4, and 6 the water is likely to be less salty indicating that the feshwater/brackish water interaction zone was likely closer to the ocean.

The coring location itself was a stable freshwater habitat in a swamp forest that was continually altered by people. The earliest levels of Core SOC05-4 were deposited in a freshwater environment. The pollen record of Zone 1 indicated that a slow moving body of water was near the coring locale. The presence of non-local arboreal pollen indicated that the area was open and lacked a forest canopy. High frequencies of weedy species and of *Zea mays* pollen indicated that the area was being modified by tropical agriculturalists. Environmental continuity is reflected in the subsequent Zone 2 with the continued presence of plants that prefer moist habitats but also in the spectrum of weeds and the presence of maize pollen. The third zone reflects a period of drying which coincided with people leaving the coring location until wetter conditions again prevailed. This drying episode is likely related to the meandering of a portion of the stream system that fed El Hueyete Swamp. The following three zones record a return to a wetter environment. The major differences among the final three zones are the frequency of weedy disturbance indicators—a very prominent feature in Zone 4—and an increase in non-local arboreal taxa in Zone 5. Zone 6 is represented by only two samples and is initiated by a decline in both weedy taxa and arboreal pollen types. The consistent signature of a wet, swamp forest/wetland interaction zone creates a background in which the impact of human habitation stands out sharply.

People were indeed utilizing this interaction zone along the northwestern boundary of El Hueyete Swamp. The presence of *Zea mays* in half of the zones accompanied by high frequencies of disturbance and agricultural indicators (Table 6) indicates that the people in this area were tropical agriculturalists. Another indication that people are modifying the area is the many dramatic spikes in the amount of particulate charcoal deposited in the sediments noted throughout the sequence. Fluctuating amounts of non-local arboreal pollen record the opening and constricting of the forest canopy related to the clearing and fallowing of agricultural fields. Open spaces in the forest canopy create catchments for airborne pollen grains that have traveled great distances. These data indicate that shifting agriculture was practiced in this area.

The drying episode recorded in Zone 3 resulted in the general long-term abandonment of the area around Cerro de las Conchas. During this period, the presence of weedy disturbance species and non-local arboreal pollen types gradually decrease with a gradual increase of the swamp forest tree *Coccoloba* and the weedy forest species *Polygonum*. At the same time, the presence of sedges decrease then return toward the upper reaches of the zone. There is also a leveling off of particulate charcoal indicating that no large-scale burns are occurring during this period. This zone displays the fallow field process and the resurgence of the swamp forest in these plots of land. Without people actively farming and removing forest encroachment through clearings, the forest returns.

In their clearing of field plots, the inhabitants of this area reduce the number of *Coccoloba* trees contributing to the pollen record. The presence of people in this area is always accompanied by the decrease in *Coccoloba* pollen frequencies. This swamp forest tree would have been cleared for the field. It has been recorded that stumps and partially burned portion of trees are left in fields to assist in the growing of crops as well as for providing firewood for the farmer (Dalle and de Blois 2006). It is highly likely that this occurred with the remains of *Coccoloba* trees.

The practice of shifting agriculture during the Late Formative and Classic was vastly different than the much better known Archaic. Current research indicates that this area was used logistically to utilize the shellfish and other aquatic resources present in the estuary, evidenced by the massive shellmounds that dot the coastline today (Voorhies 2004).

Agriculture was in use in this area in the Late Formative and Classic Periods. People were occupying a zone between the short-tree savanna and the El Hueyete Swamp. This may be reflective of some population pressure as the area is seasonally inundated during the rainy season. It has been noted that the area population did increase with the collapse of the centers in the Naranjo River valley (Bove 1981, 1993; Love 1999a, 2002, 2007). This area may only be in use during the growing season, with people moving out of the swamp forest during the rainy season.

The issue of agricultural intensity is more difficult to address. It is commonly accepted that the practice of agriculture in association with Teotihuacán or within the Maya lowlands is intensive. People in these areas invested vast amounts of time and labor in the building, maintaining, and controlling of their agricultural landscapes by draining swamps, raising fields, and building canal systems to ensure water for the growing plants. These efforts led to intensive land use strategies and the production of surplus agricultural product to help sustain their hierarchical societies. Unlike intensive agriculture, shifting agriculture has been determined by researchers to be a subsistence pursuit. It has been noted that shortening the length of the fallow period for plots of land is an intensification of land use (Dalle and de Blois 2006). Monocropping fields to produce large amounts of a single crop may also be considered a form of intensification as it produces a marketable surplus (Harris 1971). To evaluate this type of increase in land use it is necessary to determine the duration of cropped fields as well as the duration of fallow periods through time. It is not possible at this time to give an assessment of how "intensely" the agricultural plots were being utilized in this region. The sedimentary record is a composite of many years of deposition, subject to erosion and mixing during the time it takes to be buried. Another issue is determining if people are monocropping or not. Some species of domesticated plant produce very little pollen and rarely enter the archaeological record.

The use of shifting agriculture in this area during the Late Formative and Classic fits trends identified by others through the examination of ceramic assemblages. Blake et al. (1995) found that logistical procurement sites in the estuary zones, such as shellmounds, tended to have more traditional pottery forms and be less likely to adopt new ceramic styles though they are in close proximity to trade routes utilizing the natural canal though the esturary. This trend was found into the Middle Formative. The pattern may have continued into the Late Formative Period and through the Classic, with people maintaining more traditional subsistence practices rather than adopting new techniques imported from areas outside of Soconusco or the Rio Naranjo valley. It is possible that the people of the central portion of the Soconusco all practiced shifting agriculture though the amount of influence from other groups apparent in other parts of the Soconusco makes it unlikely. It seems more plausible that the data provided by Core SOC05-4 is recording a more traditional mode of agriculture practiced in this specific region of swamp forest. This core records activities of a population living and subsisting in the area of the coring location from the Late Formative through the decline of the Classic inhabiting the transition zone between wetlands and the short-tree savanna.

This project provided insight into how people were living in a region out of the immediate influence of a cultural or civic center. It was located in a region not far from the natural canals in the estuary, yet it was an area that maintained traditional aspects of their material culture for much longer than other sites. In a period generally typified by complex agricultural systems and state level societies, this small portion of the Soconusco was inhabited by people practicing what appears to be a less complex lifestyle.

Future Research

These data have provided a glimpse of a very small portion of Mesoamerica. Shifting agriculture may occur in other parts of Mesoamerican distant from cultural centers and not be isolated to Soconusco. It may also be possible that this type of agriculture wasn't entirely replaced by more intensive varieties in more heavily inhabited areas. The collection of more sediment cores in other wetland environments throughout Mesoamerica could verify whether or not shifting agriculture in the Soconusco in the later periods is an isolated occurrence.

It would be beneficial to the understanding of the Soconusco settlement and subsistent patterns in the Classic to explore the possibility that the use of the swamp forest was the result of population pressure caused by the collapse of the Naranjo River valley. The Classic Period may be further understood by investigating whether or not the use of shifting agriculture in this area is isolated to the swamp forest/wetland interaction zone or if it is a more widespread pattern. More extensive studies of pollen records in association with regional centers and large settlements, as well as surveys targeted to identifying remnant field systems, would be beneficial in evaluating the agricultural practices of the inhabitants of the Soconusco.

The strong signature of cleared forest evidenced in this core suggests that it would be possible to identify human landscape modification prior to the advent or adoption of agriculture. Would it be possible to determine if people were altering their landscapes to improve production of their preferred plant species before the advent of domestication? Would it be possible to compare patterns of shifting agriculture to practices of non-agricultural groups in other parts of the world to evaluate how they are modifying their landscape? The strong signature of shifting agriculture suggests that it may be possible to evaluate whether or not a cultural understanding of how fire influenced plant productivity may have existed among the hunter-gatherer groups that preceded agriculturalists. It would be interesting to compare patterns of burning and clearing seen ethnographically in the northwest to those of a region of the neotropics in which shifting agriculture is practiced.

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