

EARLY FORMATIVE SUBSISTENCE AND AGRICULTURE
IN SOUTHEASTERN MESOAMERICA

by

VICKI LYNN FEDDEMA

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The University of British Columbia
Vancouver, Canada

Date Sept. 14, 1993

ABSTRACT

This thesis addresses questions regarding the nature of subsistence strategies practiced by Early Formative inhabitants of the Mazatán area on the Pacific Coast of southeastern Mesoamerica. Previous archaeological research indicates that estuarine and riverine faunal resources provided the main basis for subsistence. Here, I propose that cultivation of indigenous food plants was also an important component in the subsistence system and was established prior to the introduction of non-local domesticated plants such as maize. The development of cultivation practices probably occurred as a gradual progression from casual to more deliberate cultivation of favored plant species. Incentives for such practices may have been related to nutrition, seasonal availability, efficiency and/or storability. Non-local domesticates may have been adopted into the existing cultivation regime for similar reasons, or for reasons related to sociopolitical complexity, which appears to have emerged around the same time.

Research questions generated by this hypothesis are addressed through the analysis of carbonized plant remains that were recovered from 147 flotation samples collected from four archaeological sites in the study area. Of the seven botanical taxa that were identified, maize, beans and avocado are the most ubiquitous and indicate that the cultivation of domesticated plants was well underway by the beginning of the Early Formative period (about 3500 years ago). It is, however, difficult to assess the actual importance of these species in the subsistence economy. Because post-depositional processes and differential patterns of plant utilization and preservation influence the amount and type of plant material that will be preserved, archeobotanical remains provide, at best, an indirect reflection of plant resource utilization by ancient human populations. Statistical treatment of recovered data is therefore problematical, and inference based upon simple identification of species present in archaeological contexts is the approach used here to examine trends in taxon occurrence.

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CHAPTER ONE INTRODUCTION AND OVERVIEW

INTRODUCTION

In this study, I address questions regarding subsistence practices by the Mokaya people in the Mazatán area of southeastern Mesoamerica in the Early Formative period, approximately 3500 years ago. Previous archaeological research has demonstrated that some agriculture was being practiced at this time but that a mixed economy, based on the exploitation of a naturally rich estuarine and riverine resource base, formed the major part of the subsistence economy. Why, in an area where a wide diversity of plant and animal resources was readily available, did people choose to practice agriculture? What role did cultivated plants play in their subsistence economy? What was the nature of the transition to a subsistence economy that included cultivation?

Questions related to the origins and development of agriculture have provided food for thought for generations of anthropologists and other scholars. Early explanations for the development of agriculture tended to focus on universally-applicable "prime movers" that were ultimately responsible for the transition to food production. The limited ability of such explanations to address developments in specific areas has resulted in the development of an approach that encourages the investigation of regional variations through consideration of a range of possible explanations.

In the Mazatán case, I hypothesize a sequential development of the local agricultural process, in which cultivation of local food plants formed an important part of the subsistence economy and was occurring prior to the introduction and adoption of non-local domesticates at the beginning of the Early Formative period. This hypothesized development, described in greater detail in Chapter Two, raises a series of research questions which direct the study. These are related to the range of plants under cultivation, the relative importance of local wild and cultivated plants versus non-local

domesticates, change through time in emphasis on various plant foods, and so on.

The original domestication of a certain plant is a distinctly different process from its subsequent spread to other areas and its adoption by other human groups. It is, therefore, highly unlikely that the same general model will be appropriate for explaining both processes. The complexity of the hypothesized situation demands consideration of explanations that apply to the various stages of the sequential development. In Chapter Two, I discuss two main stages – the origins of local cultivation practices in the Mazatán area, and the adoption of non-local domesticates into an existing cultivation regime – and consider some possible means for explaining developments in each.

To test the general hypothesis and to assess how well the proposed explanations address the research questions generated by the hypothesis, I have analyzed paleoethnobotanical data from four Early Formative period archaeological sites on the coastal plain near the present town of Mazatán, Chiapas. Paleoethnobotany is the analysis and interpretation of plant remains from archaeological contexts (Pearsall 1989; Popper and Hastorf 1988). Because paleoethnobotanical studies provide important information about the nature of prehistoric human-plant interactions, they are now a routine part of most archaeological excavation programs. They have been used to address such issues as the nature of ancient vegetation and climate (Piperno 1985a; Schoenwetter and Smith 1986), reconstruction of prehistoric dietary and economic pursuits (Byers 1967; Quilter et al. 1991; Roosevelt 1980; Siemens et al. 1988), changing human/environmental relationships (Delcourt et al. 1986; Minnis 1978), and origins of plant domestication (Crawford 1983; Ford 1985; Rindos 1984). While the analysis of archaeological plant material is just one of numerous possible avenues for pursuing these questions, it is an extremely important one, and probably the most direct. It establishes which genera of plants are actually present in the archaeological record and therefore provides a substantive basis for inquiry into their possible utilization by prehistoric peoples.

In Chapter Three, I describe the methods used in the analysis of the botanical data. These data consist of charred seeds and other plant remains that were recovered primarily through the process of water flotation. In the first section, I provide a detailed description of this process. In the second section, I discuss the criteria involved in the selection of samples for analysis. In the final section, I describe the techniques involved in the two stages of the laboratory analysis: sorting the flotation samples and identifying the recovered archeobotanical material.

In Chapter Four, I present the results of the analysis. Following a description of the characteristics of the recovered taxa, I describe the occurrence of these taxa in quantitative terms and present this information in tabular form. Finally, I discuss observed patterns in the data.

Chapter Five includes a summary of the objectives of the project and a discussion of the implications that the results have for our understanding of subsistence practices and the development of agriculture in the Mazatán area during the Early Formative period. In conclusion, I reiterate some of the limitations that I faced in this project and make recommendations for other researchers contemplating similar studies.

The remainder of the present chapter consists of an environmental and archaeological overview of the Mazatán area. Because of the important role that local environmental conditions appear to have played in the development of the subsistence system, I discuss the local topography, climate, hydrography and biotic communities. In the subsequent section, I describe the archaeological background of this area and present a brief summary of what is currently understood about the subsistence economy during the Early Formative period.

THE MAZATAN ENVIRONMENT¹

The Mazatán area is located in the geographic region known as the Soconusco² (Voorhies 1989:2). This region consists of a section of the southern Pacific coast of Chiapas, Mexico, that extends approximately 240 km southeast from near the present town of Mapastepec to just east of the Mexico-Guatemala border (Figure 1.1).

Topographic and meteorologic factors distinguish the Soconusco region from the coastal areas to the northwest and the southeast.

Local topography and climate

The Soconusco region is bordered by the Pacific Ocean to the southwest, and by the Sierra Madre mountains to the northeast. The Sierra Madre chain rises in elevation from 765 m at Arriaga, on the northern boundary of the Chiapas coast, to its maximum elevation of 4110 m at Tacaná volcano on the Mexico-Guatemala border. This elevation change creates distinct variations in the amount of rainfall along the coast. The lower elevations in the area to the northwest of the Soconusco permit the Gulf of Mexico trade winds – hot and dry after dropping their moisture in the interior highlands – to pass through to the coast, creating arid conditions in the costa seca, or "dry coast". In the Soconusco region, the higher elevations of the Sierra mountain peaks prevent these dessicating winds from reaching the coast. In addition, they prevent moisture-laden winds from the Pacific from passing over into the interior basins, forcing them instead to condense as they strike the high peaks. Because of these more humid conditions, the Soconusco has a greater agricultural potential than does the more arid costa seca (Voorhies 1989:2).

Even within the Soconusco itself, there is a good deal of climatic variation. Most precipitation falls on the mid-slope and piedmont zone, creating a humid tropical climate (Koeppen's AMWG1). The mean annual precipitation ranges from 2433 mm at Tapachula (170 m a.s.l.) to 4654 mm at Unión Juárez (1400 m a.s.l.). In contrast, the

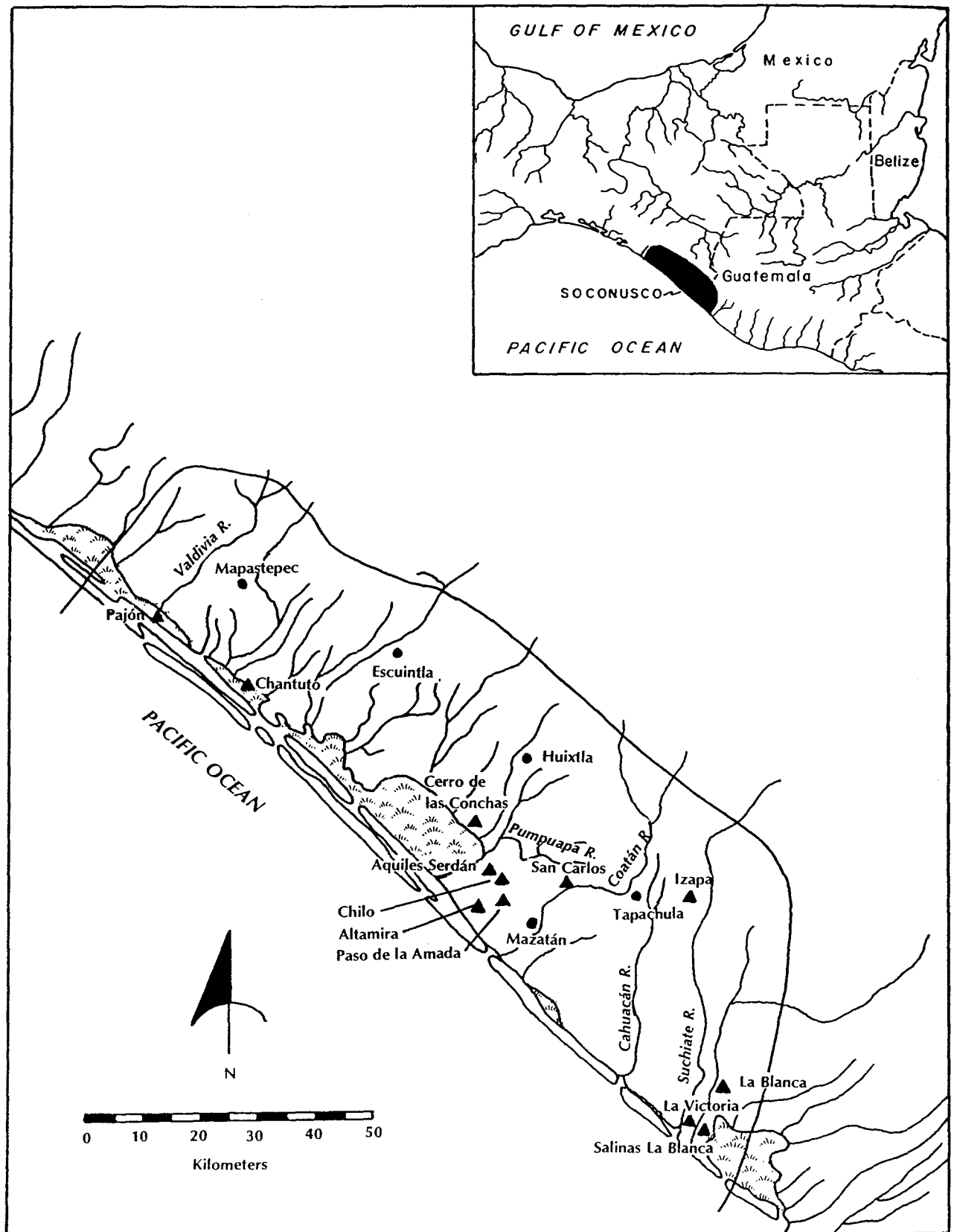


Figure 1.1. Map of the Soconusco region, showing modern towns (circles) and archaeological sites (triangles). Redrawn from Clark (n.d.) and Voorhies (1989:3).

narrow (approximately 15 km wide) strip of coastal plain on which the Mazatán area is located has a semi-arid tropical climate (Koeppen's AWG1). Rainfall data for the town of Mazatán show that the mean annual precipitation is less than 1500 mm, most of which falls between May and October (de la Peña, translated in Lowe et al. 1982:59-60). During the dry season, from November to April, the comparative lack of precipitation in the Mazatán area is one of the primary limiting factors in cultivation practices.

Rainfall is also more unpredictable as one moves from the piedmont to the coast. While it rains almost every day in the piedmont during the wet season, it rains only every other day in the semi-arid zone. Moreover, the canícula (a short dry period during the rainy season) that may last for eight days in the more humid zone – with no harmful effects – sometimes extends for up to thirty days during July and August in the more arid zones, with devastating effects on crops (ibid. p.61).

Geology

The coastal plain of Chiapas is composed largely of alluvium deposited from the numerous streams and rivers that descend from the Sierra Madre volcanic range (Ceja 1985:7; Clark n.d.). There are few natural stone or mineral resources, except for cobbles and pebbles in the river and stream beds. In the Mazatán area, these cobbles consist mainly of pyroxene andesites and porphyries, with some vesicular basalt in the Huixtla River to the northwest (Clark n.d.). These provided raw materials for grinding tools in the Early Formative period, but stone suitable for chipped tools does not occur naturally on the coastal plain and was imported from volcanic sources in Guatemala.

Soils in the semi-arid zone of the coastal plain consist of sandy and silty loams – the mollisols and inceptisols (Velázquez 1977, cited in Clark n.d.). Although there is considerable variation in the natural fertility, organic content, drainage, porosity and moisture retention of these soils, they are generally of high quality. With the exception of some pockets of clayey soil and some saline soils near the estuary, they provide

favorable conditions for agriculture with little human intervention. In the piedmont zone, the higher clay content and acidity of the andosol and Acrisol soils result in comparatively lower agricultural potential.

Hydrography

Because of the narrow width of the coastal plain, the rivers and streams are short and form a parallel system perpendicular to the Pacific Ocean (Ceja 1985:9). They are deeply cut through the piedmont and upper coastal plain, and offer little agricultural potential except where they widen out near their mouths (Clark n.d.). Near the beach, most of these rivers

flow parallel to the coast before breaking through to the ocean and forming a mouth. These openings to the ocean are not wide enough to permit the flow of tidal water and so are not true estuaries but bayous [Helbig 1964:100], unlike the situation farther up the coast near Escuintla described by Voorhies [1976]. During the dry season the debouchments of most rivers are sealed off by sand bars, forcing the rivers to back up and flow into the estuary-swamp system that parallels the coast; these are known as "sweet water" estuaries (Clark n.d.).

At the beginning of the rainy season in the Sierra and piedmont areas, these rivers fill with runoff and replenish the swamps and estuaries of the coastal plain several weeks before the rains begin there (Clark n.d.). This increases the agricultural potential for low-lying areas, since they receive moisture while still in the dry season.

The major river in the Mazatán area is the Coatán. Traces of old river channels (known locally as bajos) evident in aerial photographs from the 1960s and 1970s indicate that the Coatán's course has changed over time. The overflow properties of these old channels make them favored locations for agriculture at the end of the dry season, since they receive the earlier rains from the piedmont and dry out much more slowly than the surrounding land. In addition, they are fertilized by the annual deposition of silt from the flood waters, and they provide a seasonal source of aquatic resources, such as fish and turtles, which are stranded as the bajos slowly dry out. Bajos

which are used for agricultural production are referred to as chahuites.

Environmental Zones and Biotic Communities

The complexity of the physiographic and climatic conditions of the Soconusco is reflected in the diversity of local floral and faunal resources. The Mazatán area is characterized by several major environmental zones (see Figure 1.2), each with its own distinct biotic communities. Studies of archaeological fauna (eg. Voorhies 1976) and ethnohistoric descriptions of the area during the early historic period (eg. Acuña 1982) suggest that these biotic communities are broadly similar to those of the paleoenvironment. It is likely, however, that considerable variation in their precise location, extent, and content has occurred over the years as a result of human intervention. The following brief descriptions of these environmental zones are based primarily on the detailed information recently synthesized by Clark (n.d.) following extensive research and informant interviews in the Mazatán area. Other descriptions appear in Breedlove (1981), Coe and Flannery (1967), Eccardi and Alvarez del Toro (1987), Helbig (1964), McBryde (1947), Miranda (1952), Miranda and Hernandez X. (1963), Rzedowski (1978), Rzedowski and Equihua (1987) and Voorhies (1976). Appendix One lists some of the dominant plant and animal species documented for each environmental zone.

1. The littoral

The straight coastline in the Mazatán area has no natural harbours and its heavy surf generally discourages extensive use of the ocean resources (Voorhies 1976:3; Clark n.d.). At the mouths of the rivers, however, where sand bars have formed, there is a greater potential for utilization of the diverse plant and animal resources that occur there. This zone consists of two major biotic communities: the beach and the estuary.

The beach is a narrow, infertile sand ridge separating the ocean from the estuary.

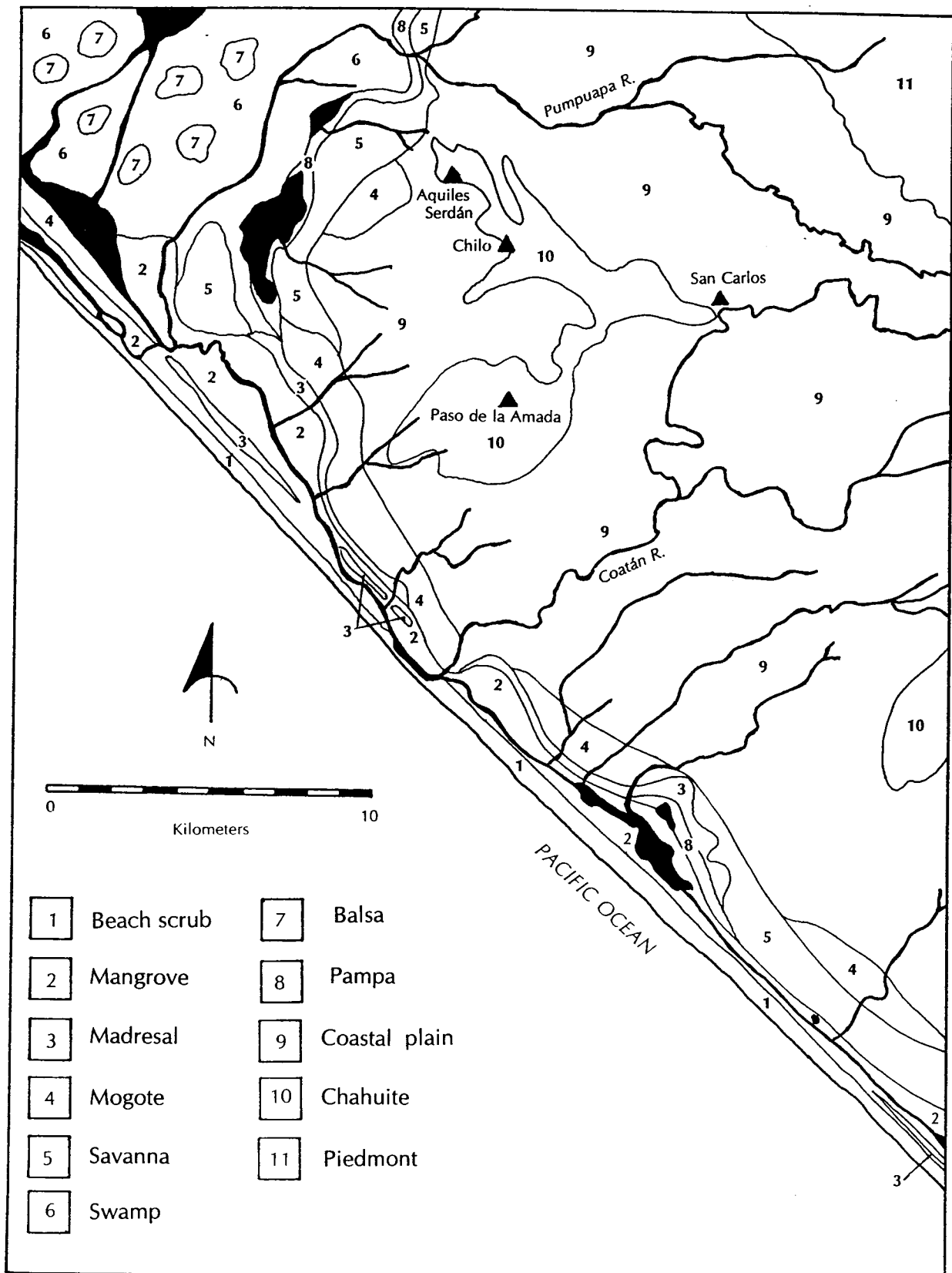


Figure 1.2. Environmental zones in the Mazatán area. Adapted from Clark (n.d.).

On its exposed outer edge, it is unstable and shifting. The most important food resources include invertebrates (such as crabs, snails and clams) and eggs of the green sea turtle. On the more stable backslope of the beach, iguana and armadillo are also found. The dunes are stabilized by a thin fringe of palm trees and dense spiny scrub species. Modern farmers cultivate melons, soy beans, sesame and other xerophilous plants.

The "sweet-water" estuary in the Mazatán area is formed through the backing up of the Coatán river at its debouchment, and it is relatively unaffected by tidal action. Some mollusks are available on a seasonal and periodic basis, but not in the quantities characteristic of more brackish estuaries. The abundant vegetation and proximity of fresh water in the estuary zone creates a favorable habitat for a variety of fauna, including fish, turtles, reptiles, waterbirds, and mammals (see Appendix One).

The estuary is flanked by a narrow strip of mangrove forest, dominated by species tolerant of inundated and saline soils, such as the red mangrove and white mangrove. On the inland side of the mangrove forest, where the ground is only seasonally inundated, there is a biotic community known as the madresal, dominated by the black mangrove. Salt-tolerant grasses and palms also inhabit this community. Economically, this zone is most important for construction materials such as mangrove wood and palm thatch (Clark n.d.). In the past, fishing and salt-making were also important economic activities (Acuña 1982:48, Andrews 1983:68).

2. Short-tree savanna

The term "short-tree savanna" (also known as pastizal or sabana [Miranda 1952; Miranda and Hernández X. 1963]) refers to an association of grassland and spaced low trees that usually occurs on shallow, poorly-drained soils (Breedlove 1981:16). In the Mazatán area, it is a transitional zone between the littoral and the lower coastal plain. Only a narrow strip of seasonally inundated land near the Cantileña swamp would have been natural savanna, but forest clearance associated with cattle ranching has

significantly extended this zone in recent years.

The most common plant species include nance, gourd and oak trees, leguminous species, coarse grasses, and occasional species of palms. Isolated stands of vegetation (known locally as mogotes) dominated by wild bamboo or palm species also occur. This environmental zone is a favored habitat for water birds, rodents, snakes, rabbits, deer, armadillos, and foxes (see Appendix One).

3. Cantileña Swamp

The estuary described above is connected to the Cantileña swamp, a huge body of fresh water bordered by pampas, or seasonally inundated areas which support savanna vegetation. Islands and fossil beaches exist in its interior. Today, the edges of the swamp are choked with dense thickets of water hyacinths introduced early in the century, but in the past the major plant species was probably cattails, as Voorhies describes for the herbaceous swamps in the Chantuto system (1976:20). A variety and abundance of fish inhabit this part of the swamp, including bass, alligator gar and snook. Several species of mollusks and turtles are also common.

The interior part of the swamp is open and contains balsas, or floating islands of large trees maintained erect by extensive interweaving of their branches and roots. These islands provide nesting places for migratory waterfowl, and until recently they were inhabited by a wide abundance of animal species. Alvarez del Toro (1990) lists numerous species of mammals, reptiles, birds, fish and invertebrates witnessed during exploration of the swamp in 1954, when conditions were relatively pristine. Yet, thirty years later, over-exploitation of the natural resources had caused the serious depletion or extinction of many species. Presumably, this part of the swamp would have provided bountiful resources to the foragers who first exploited this area during the late Archaic and Early Formative periods. Over-exploitation may, however, have occurred at various points in the more distant past as well.

4. Coastal Plain

The Soconusco coastal plain was once covered in forest, but agricultural intensification for cash crops (such as cotton, bananas, soybeans, sesame, cacao and sugar-cane) has greatly reduced the primary vegetation (Ceja 1985:10). Two biotic communities can be described for this zone: Tropical Deciduous Forest and Evergreen Seasonal Forest. There is, however, a great deal of overlap between these communities.

Moving from the estuary to the more arid part of the coastal plain, the Short-tree Savanna gives way to the Tropical Deciduous Forest (Bosque Tropical Caducifolio [Rzedowski 1978], or Selva Baja Caducifolia [Miranda and Hernández X. 1963]). This is an association of deciduous and semi-deciduous trees, normally between 10 and 20 m high, that remain leafless during the long dry season (Breedlove 1981:14-16). On the upper, more humid part of the coastal plain, the Tropical Deciduous Forest blends into Evergreen Seasonal Forest (Bosque Tropical Perennifolio [Rzedowski 1978], or Selva Alta o Mediana Subperennifolia [Miranda and Hernández X. 1963]). This transitional forest consists of a high (25-35 m) canopy of deciduous and evergreen trees and a lower understory of shrubs, lianas, and epiphytes (Breedlove 1981:12). There is a marked dry season, with great seasonal variation in herbaceous plants. Many economically-useful trees occur in these forest formations, and their fruits attract a wide variety of fauna (Coe and Flannery 1967:14) (see Appendix One).

Within these two forest formations, several discrete biotic communities create pockets of internal resource diversity. Mogotes, as discussed above, are one example. Variation also occurs along the banks of rivers that flow through these forests from the piedmont to the estuary. In these riparian formations, the vegetation is Evergreen Tropical Forest. Bajos would probably once have supported a similar vegetation, since they extend soil moisture conditions well into the dry season.

5. Piedmont forest

The piedmont forest is generally outside of the specific area under consideration here, but its proximity to the Mazatán area and its abundance and diversity of resources raise the possibility that it was used at least occasionally by the coastal people. As noted above, the piedmont zone receives substantially more rainfall than does the more arid coastal plain, and this is reflected in the Lower Montane Rain Forest (Bosque Tropical Perennifolio [Rzedowski 1978]; Selva Alta Perennifolia [Miranda and Hernández X. 1963]) biotic community characteristic of the lower part of the zone. This formation has a high canopy (25-45 m) of trees typical of Tropical Rain Forest and an extremely dense thicket of underbrush (Breedlove 1981:10) (see Appendix One).

Summary

The previous paragraphs illustrate the degree of environmental variation between the littoral and piedmont areas. Recent ethnographic research on modern farming practices shows that this variation has resulted in the development of diverse and variable agricultural practices, determined primarily by the availability of rainfall and chahuite land. Low-lying areas which are most likely to receive overflow water, especially run-off water from the more predictable and abundant rainfall in the piedmont area, are favored areas for planting (Clark n.d.). Ethnographic studies from other areas have documented similar means of overcoming limitations imposed by rainfall regimes. Farmers in the wetland areas of southern Veracruz and Tabasco plant on river levees early in the dry season and advance progressively further downslope as waters recede during the dry season. One additional crop (the marceño) can be gained by late planting in the lowest part of the wetland (Coe and Diehl 1980; Siemens 1983:88). Similar dry season crops have been documented in southern Belize where the Kekchi Maya plant mata hambre (the "hunger killer") on seasonally emergent floodplain land. This crop carries them through the end of the dry season, when other plant foods may be unavailable (Turner

and Harrison 1980, cited in Siemens 1982:40).

If it is simplistic to speak of modern agriculture in normative terms, it is equally naïve to ignore local variability in our consideration of Early Formative subsistence practices. Food resources in the various environmental zones of the Mazatán area would probably have been plentiful and easily available to late Archaic and Early Formative food-seekers. The various biotic communities provide a good deal of diversity in plant and animal resources, with relatively little seasonal or year-to-year variation (Blake et al. 1992a:138). As we see in following sections, some people also began to practice agriculture around this time. It is plausible that ancient farmers in the Mazatán area, like those of the present day, took advantage of the conditions presented by bajos and other seasonally-inundated low-lying areas. As Siemens (1983:88) suggests, wetlands with regular, limited fluctuation in water level are especially well-suited for "fugitive" agricultural practices, and "were probably the venues for some of the earliest moves in the direction of agriculture within Mesoamerica".

ARCHAEOLOGICAL INVESTIGATIONS IN THE MAZATAN AREA

The present study is part of the Early Formative Project, a long-term study of social, political and economic change on the Pacific coast of Chiapas. This project was initiated in 1985 by John Clark (Brigham Young University/New World Archaeological Foundation) and Michael Blake (University of British Columbia) in an attempt to answer questions raised by previous archaeological research in the area. In this section, I briefly summarize these investigations and the resulting interpretations of the subsistence strategies practiced by the Early Formative residents of the Mazatán area.

History of archaeological investigations

Archaeological investigations in the Soconusco region were initiated in 1941 by Matthew Stirling at the site of Izapa (Stirling 1943) (see Figure 1.1). In 1947, as part of a

reconnaissance of the Pacific Coast, Philip Drucker carried out test excavations at Izapa and documented a Late Classic presence there. A Late Preclassic occupation was also noted there in 1956 (Lowe et al. 1982). During Drucker's (1948) coastal survey, he discovered pre-ceramic Late Archaic levels at the Chantuto estuary site, which was later investigated briefly by José Luis Lorenzo (1955).

In the late 1950s, Michael Coe (1961) carried out excavations at La Victoria, a coastal site in the Soconusco. With his designation of the Ocós (1500-1000 B.C.) and Conchas (1000-300 B.C.) ceramic phases, Coe constructed the first chronological sequence for the area. Subsequent investigations at nearby Salinas La Blanca (Coe and Flannery 1967) refined this sequence, which was broadened to include the Cuadros (1000-850 B.C.) and Jocotal (850-800 B.C.) phases. Beginning with the Cuadros phase, the ceramic complexes showed similarities with those of the early Gulf Coast Olmec and related cultures in coastal Guatemala and Central Chiapas (Ceja 1985).

In 1961, the New World Archaeological Foundation initiated a five-year research program in the Soconusco area. This program focused on the Izapa site and established a long sequence of occupation from the Early Formative through the Early Postclassic (Ekholm 1969; Lee 1973; Lowe et al. 1982). Between 1963 and 1972, Carlos Navarrete and Eduardo Martínez E. carried out an extensive survey of the Soconusco zone. This resulted in the location and investigation of several Early Formative sites, including Altamira (Green and Lowe 1967), a site with ceramics similar to those recovered at La Victoria and Salinas La Blanca (Ceja 1985). Pre-Ocós ceramics that were also recovered from Altamira resulted in the establishment of the Barra phase, dating to between 2000-1500 B.C. (Lowe 1975:1). The sudden appearance of these well-developed ceramics renewed efforts to clarify the cultural sequence of the Early Formative period.

In 1968, Navarrete excavated at Aquiles Serdán, a site near Altamira, and found Ocós deposits buried below the Olmec-related Cuadros and Jocotal layers. In 1973 and 1974, Jorge Ceja T. and Gareth Lowe carried out a surface reconnaissance in the Coatlán

region in order to locate additional Barra and Ocós occupations. The Barra to Ocós sequence was confirmed by test excavations at the Early Formative site of Paso de la Amada (Ceja 1985) and by investigations of the Early Formative Project in 1985 and 1990 (Clark et al. 1987, 1990). As a result of these and other investigations, the Ocós phase was subdivided into three distinct phases, further refining the Early Formative sequence into its current manifestation: Barra (1550-1400 B.C.), Locona (1400-1250 B.C.), Ocós (1250-1100 B.C.), Cherla (1100-1000 B.C.), Cuadros (1000-900 B.C.), and Jocotal (900-850 B.C.)³ (see Figure 1.3).

Following the work of Coe and Flannery in the Guatemala Soconusco, subsequent investigations were carried out in the Salinas La Blanca area by Shook (Shook and Hatch 1979) and by Love (1986, 1989). Further down the Pacific coast in the El Mesak region, a survey carried out by Demerest, Pye and others (Pye 1989) located several Early Formative sites in the estuary zone. However, no sites from the Late Archaic period or from the Barra phase of the Early Formative period have yet been found on the Guatemala coast (Clark 1991).

In the Chantuto area, Barbara Voorhies followed up Drucker's and Lorenzo's brief explorations with her investigations of Late Archaic adaptations at pre-ceramic sites (Voorhies 1976, 1989, 1990). Clark and Blake (Clark et al. 1987, 1990) recently located and excavated a Late Archaic shell-midden site in the municipality of Huixtla.

Early subsistence strategies in the Mazatán area

The investigations described above have produced an emerging synthesis of the cultural history of the Mazatán area. Blake et al. (1993b) provide the most recent and detailed discussion of the chronology of the Late Archaic and Early Formative periods and the following summary of subsistence strategies is based on their discussion.

The Mazatán area was first occupied during the Archaic-period Chantuto A phase (ca.3800-2700 B.C.) as represented at Cerro de las Conchas, a shell-midden site in the

Radiocarbon Years B.C. (uncalibrated)	Phase Name
850 —————	Jocotal
900 —————	Cuadros
1000 —————	Cherla
1100 —————	Ocós
1250 —————	Locona
1400 —————	Barra
1550 —————	?
1800 —————	Chantuto B
2700 —————	Chantuto A
3800 —————	

Figure 1.3. Chronology for the Late Archaic and Early Formative periods along the Pacific Coast of Southeastern Mesoamerica. Adapted from Blake et al. (1993b).

municipality of Huixtla (Blake et al. 1992b:85; Clark et al. 1990). The subsequent Chantuto B phase (2700-ca.1800 B.C.) is represented by sites such as Tlacuachero in the Chantuto zone (Voorhies 1976; Voorhies et al. 1991). Although data are still scarce for these phases, there appears to have been a change from a more generalized exploitation of estuary and lagoon resources in the Chantuto A phase to a more specialized exploitation of local aquatic resources such as shellfish, fish and possibly shrimp in Chantuto B (Clark et al. 1990; Voorhies et al. 1991). Voorhies interprets Chantuto B sites as seasonal procurement and processing stations. At other times of the year, Chantuto people may have moved farther inland on the coastal plain where they exploited wild plants and animals (Michaels and Voorhies 1993). Recent stable carbon isotope analyses of human bones from Tlacuachero indicate high C₄ or CAM plant use and suggest that Chantuto people may have been consuming maize (Blake et al. 1992b:89).

During the Barra phase (1550-1400 B.C.), which marks the beginning of the Early Formative period and the first use of ceramics, occupation at the estuary shell middens seems to have become less intense (Voorhies 1976:137) and sedentary villages were founded on the banks of rivers or bajos on the coastal plain. These Early Formative villagers have been dubbed the "Mokaya", an anglicized version of the Mixe-Zoque word mok' haya, meaning "corn people" (Clark 1991:13; Clark and Blake 1989). However, subsistence practices for this period remain somewhat ambiguous.

Lowe (1975) has suggested that manioc, rather than maize, was the staple food during this period. This idea was based on: 1) the absence of maize remains; 2) the absence of maize grinding implements; and 3) the presence of abundant obsidian chips which, Lowe reasoned, could have served as manioc graters. Recent research, however, does not support Lowe's hypothesis on these bases. Charred maize remains have now been identified from flotation samples from Barra through Cuadros phase contexts (see Chapter Four), and fragments of manos and metates have recently been recovered from Barra and later deposits (Clark et al. 1990). While it is possible that these ground stone

implements were used for other purposes, ethnohistoric and ethnographic practices support the idea that they were used for grinding corn. Finally, analysis of the frequency and morphology of the obsidian chips from these deposits does not appear to support the manioc grating hypothesis (Clark et al. 1987).

This evidence does not disprove Lowe's hypothesis that manioc was a staple crop. Roots are notoriously difficult to recover from archaeological deposits in tropical areas. According to Donald Lathrap (1977:742), "manioc tissue is 1000 times less likely to yield preservable fragments than either maize or the avocado". Many root crops do not deposit silica into the soil and are unlikely to be identified through phytolith analysis (Pearsall 1989:343). In the absence of direct botanical evidence, researchers are using more indirect ways of addressing this question. Historical linguistic data, for example, suggest that the Mixe-Zoque word for manioc was borrowed by speakers of other Mesoamerican languages (Campbell and Kaufman 1976:84). Mixe-Zoque languages were spoken in an area extending across the Isthmus of Tehuantepec and along the Pacific coastal plain to the Guatemalan border (Campbell 1988; Voorhies 1989:11). The glottochronological time depth of these languages is estimated to be at least 3,500 years (around 1500 B.C.), which correlates with the Early Formative presence in the Mazatán area. Other borrowed Mixe-Zoque words that refer to indigenous Mesoamerican cultigens include cacao, gourd, squash, tomato, bean and sweet potato.

Evidence for the cultivation of maize, beans and avocados throughout the Early Formative period is more direct, as demonstrated by the charred seeds, kernels and cobs recovered from archaeological deposits. However, chemical analyses of Early Formative human bones indicate that the Mokaya in the Mazatán area had a mixed subsistence economy, based largely on freshwater, estuarine and terrestrial faunal resources (and, presumably, on C₃ plant resources such as roots and fruits) and that maize did not form a significant component in the diet (Blake et al. 1992b; but see Ambrose and Norr 1992). Maize may not have been very productive at this time, but even in the Middle Formative,

when it had become important in neighboring zones such as Acapetahua and La Blanca, it apparently did not play a very important role in the diet of Mazatán-area villagers.

This has interesting theoretical implications. The development of social complexity⁴ in Mesoamerica has often been considered a consequence of a maize-based agricultural mode of production. Until recently, the general consensus among archaeologists was that the roots of social complexity and the great Mesoamerican civilizations were to be found in the Olmec culture of the Gulf Coast area (Coe 1987:13; Sharer and Grove 1989). However, Clark (1991) proposes that the Olmec beginnings can be traced back 500 years earlier to the Mokaya of the Pacific Coast. Social complexity appears to have been present in this area by the Locona period, as indicated by settlement pattern data (Clark and Blake 1989), obsidian and ceramic data (Clark and Salcedo 1989; Clark and Blake 1993), domestic architecture (Blake and Feddema 1990; Blake et al. 1993a) and mortuary data (Clark et al. 1987). If maize was not an important part of the diet, then the development of social complexity in the Mazatán area demands a different explanation. Clark and Blake and other researchers involved in the Early Formative Project are seeking to address this question.

Summary

This brief discussion demonstrates that many issues concerning the nature and development of the Mokaya subsistence base remain unresolved. For example:

1. How important were plant resources in the subsistence economy? What were the major local plant species being collected and utilized?
2. How did the transition from plant collection to agriculture occur? When did people in the Mazatán area begin cultivating local plant species, and what were their incentives for doing so? Which species did they cultivate? What effect did such practices have on the subsistence economy?
3. Why were non-local domesticates such as maize adopted, given the natural

richness and diversity of the local resources? What were the conditions under which this occurred?

4. Was the transition from plant collecting to agriculture linked in some way to the shift from egalitarian to non-egalitarian society which appears to have occurred around the same time?

It is clear that more archaeological research is required before we can hope to answer these questions. This thesis represents the first attempt to address these questions through substantive analysis of plant remains from archaeological sites in the Mazatán area. The theoretical framework that guides the analysis is outlined in Chapter Two.

NOTES

1. Much of the information in this section derives from environmental data in John E. Clark's Ph.D dissertation-in-progress (Clark n.d.) which was generously made available to me.
2. The "Soconusco" was originally a political district or province controlled by the Aztec. At the time of Spanish contact, its inhabitants were providing tribute to the Aztec capital of Tenochtitlán (Gasco and Voorhies 1989:48).
3. These dates are from Blake et al. (1993b). Unless stated otherwise, all dates refer to uncalibrated radiocarbon years.
4. By "social complexity" (or "complex society"), I refer to a form of sociopolitical organization based on hereditary socioeconomic inequality – similar to Fried's (1967) "rank society" or Service's (1971) "chiefdom", but not necessarily exhibiting all of the typological characteristics proposed by these authors. I see the definitive factor to be the institutionalization of hereditary status distinctions.

CHAPTER TWO THE TRANSITION TO AGRICULTURE IN THE MAZATAN AREA

INTRODUCTION

The transition to food production was one of the most significant developments in the course of cultural evolution. The attempt to explain this transition has motivated a search for causes and generated a host of diverse explanations. Some of the major factors that these explanations have emphasized include climatic change (Childe 1956; Wright 1977), "familiarity" with plants in their "natural habitats" (Braidwood 1960), population pressure (Binford 1968; Flannery 1969, 1973; Cohen 1977), broad-spectrum adaptation (Flannery 1969), plant-human symbiosis and co-evolution (Rindos 1984), and social differentiation (Bender 1978, 1990; Hayden 1990).¹

Many of these explanations are quite broad in scope and focus on a single "prime mover" which was ultimately responsible for effecting the transition. However, regional variations in ecological conditions and in the forms of interaction between humans and the resources that they exploited limit the usefulness of such explanations for effectively addressing developments in specific regions (Blake et al. 1992a; Flannery 1986; McCorriston and Hole 1991). Rather than ignoring variations from the expected patterns, we should investigate these situations on a smaller scale in order to explain how and why they developed. Because the actual developments in each particular case were likely much more complex than a "prime mover" type of explanation is able to address, several overlapping explanations may be required.

Theoretical perspective

The assumptions underlying the following discussion are based on a cultural-ecological perspective. The concern is primarily with the interactions between people and plants. Developments in the transition to agriculture are viewed as gradual changes

on an evolutionary continuum, induced by humans manipulating their ecosystems and by human adaptation to various ecological and social phenomena. These changes are not inevitable, unidirectional or irreversible; the variability in cultural and ecological systems from one area to another results in a corresponding diversity in the forms of interaction between humans and plants.

Cultivation, domestication, agriculture

In considering questions about the nature of the transition to agriculture in any given region, we must clarify what we mean by terms such as cultivation, domestication, and agriculture. Confusion resulting from misuse of these terms prevents understanding of the processes involved in the transition.

While the terms "domesticated" and "cultivated" are often used synonymously, their meanings are actually quite different. Cultivation implies activities involved in caring for a plant, such as tilling, fertilizing, sowing, watering, weeding, protecting, transplanting, and harvesting. Domestication, on the other hand, deals with the genetic responses of the plant to these human activities (Harlan 1975:63). Whereas one cultivated plant may differ little, if at all, from its wild form, another may have undergone major adaptive changes as a result of cultivation. During the process of domestication, a plant may pass through numerous intermediary states. If it reaches the state of full domestication, sustained human intervention will have so drastically altered it from its wild state that it can no longer reproduce without human assistance (ibid. pp.63-64).

"Horticulture" is similar in meaning to cultivation. Here, it refers to cultivation in the context of small-scale gardening to distinguish it from more intensive field cultivation.

"Agriculture" is a broad, rather generic term that is often used synonymously with cultivation. Webster's Dictionary (1986:65) defines it as "the science or art of cultivating the soil, producing crops, and raising livestock". Here, following Harris (1989:14), it refers specifically to the cultivation of domesticated crops. Given the fact that

domestication is a cumulative process, it is sometimes difficult to make absolute distinctions between domesticated and undomesticated plants. However, this definition allows us to distinguish between cultivation, which can apply to domesticated or undomesticated plants, and agriculture, which applies only to domesticated plants.

Origins vs. spread of domesticated plants

It is also important to distinguish between two related but significantly different processes involved in the transition to agriculture: the origins of domesticated plants, and their subsequent spread or diffusion from their place of origin. The initial domestication of a certain plant would have occurred under a unique set of ecological and cultural circumstances. As the plant spread to a different area and was introduced to a new group of people, the reasons for its adoption might be quite different from the reasons for its original domestication (Blake et al. 1992a:134). In addition, the various roles that the plant played in the subsistence economy of the new group may have been quite different from its original roles.

Given these distinctions, it is clear that models generated to explain the gradual development of local domesticates in a particular area may be inappropriate for explaining how and why such domesticates spread to different areas and were subsequently adopted by other human groups.

RESEARCH OBJECTIVES

Our current knowledge of the prehistoric subsistence economy in the Mazatán area is limited, especially in terms of the nature and degree of cultivation practices. Without some basic data, it is premature and difficult to develop and attempt to test specific hypotheses. The objective of this study is therefore more concerned with providing data from this relatively unstudied area which can be used to generate hypotheses to be tested by future research. The working hypothesis is therefore quite general, but it raises some

important questions that guide the study and may help to generate more specific hypotheses.

Hypothesis

The general hypothesis is that some cultivation – and perhaps domestication – of indigenous food plants was an important component of the subsistence economy and was occurring prior to the adoption of non-local domesticated food plants such as maize. As noted in Chapter One, ecological and archaeological data indicate that a wide variety of wild plants and animals were available for exploitation by early inhabitants of the Mazatán area. This suggests that a correspondingly diverse set of subsistence strategies would have been practiced. While fishing and hunting were apparently important pursuits (Flannery and Mudar 1991; Blake et al. 1992a), the abundance and diversity of edible food plants indigenous to this area make it highly unlikely that the gathering or harvesting of wild plants would not also have played an important role in the domestic economy. It would not have been a big step – nor would it have required a great deal of sophisticated horticultural knowledge – to begin "helping" or favoring certain species by pulling weeds, watering, transplanting closer to home, or fertilizing.

It seems improbable that at least some basic cultivation techniques were not being practiced on indigenous lowland food plants from a very early date. A well-established regime of plant cultivation would have enhanced the likelihood that introduced non-local domesticates would be more readily accepted and adapted to the local conditions. Ethnohistoric documents (eg. Acuña 1982) for the Soconusco area at the time of the Spanish conquest suggest a pattern of mixed subsistence economies, with fishing, hunting, and plant collecting occurring hand-in-hand with plant cultivation in gardens, orchards and forests (Clark n.d.). While these practices were documented 3000 years after the period of primary interest here, there is a good possibility that they were also occurring by the Early Formative period when our first evidence for agriculture occurs.

Research questions

This hypothesis raises several questions that direct this study. First, which indigenous lowland food plants were being used by the Early Formative inhabitants of the Mazatán area? To what degree were cultivation techniques being practiced and local plant domestication occurring? How can we best explain the origins of agriculture in this tropical lowland area?

Second, which non-local domesticated food plants were adopted, and when? What were the conditions under which this process occurred? Which models can help us understand how and why the adoption of these new domesticates took place?

Third, is there any relationship between these agricultural developments and the sociopolitical changes that appear to have occurred around the same time? Social complexity has been viewed as a consequence of the development of agriculture at least since the Enlightenment period in Europe, when Rousseau linked the disappearance of equality with the economic surpluses, increased populations, and notion of private property that accompanied the emergence of food production (Rousseau 1755, cited in Smith 1976). Recent research suggests that we should perhaps reconsider this scenario. Hayden (1990), for example, argues that social inequality was not a consequence of agriculture but actually stimulated the emergence of food production. In some areas, social complexity certainly appears to have developed in the absence of agricultural-based economies.² What happened in the Mazatán area?

It is clear that a general, all-encompassing model will be inadequate for addressing this complex situation, where some cultivation of local food plants was likely already occurring when non-local domesticates were introduced and adopted. If there was a sequential nature to the development of the local agricultural process, as the hypothesis implies, then we must seek explanations that apply to each stage of the sequence – to the origins of cultivation practices and plant domestication in the Mazatán area, to the adoption of non-local domesticates and to the development of sociopolitical complexity.

LOCAL DEVELOPMENTS IN THE MAZATÁN AREA

How can we best explain the development from the gathering of wild plants to their deliberate cultivation – and possibly domestication – in the Mazatán area? If this "zone of plenty" (Blake et al. 1992a:135) provided such a wide range of naturally-occurring and productive plant (and animal) foods throughout the year, it is unlikely that people were forced to turn to food production, especially since the first significant population increases in the area probably did not occur until well after cultivation practices had begun (Clark and Blake 1993). What, then, were the incentives for developing cultivation practices? Below, I discuss some possible reasons. Examples from other tropical areas provide some insights, or at least points of departure for these speculations.

One incentive may have been related to nutrition. In the Mazatán area, as noted above, animal resources appear to have contributed a great deal to the diet. The collection and/or cultivation of starchy, carbohydrate-rich plants may have occurred to supplement a diet that was rich in protein. While various local plants may have been able to provide the necessary starch, roots and tubers may have been especially important. These highly productive plants can be planted at almost any time and harvested when needed, since they can remain in the ground for more than two years (Bronson 1966:271). Through their ability to store starch in their roots, they are well adapted to survive extended dry periods (Harris 1969:10). Bronson (1966) suggests that these characteristics resulted in the utilization of root crops such as manioc and sweet potatoes by the lowland Maya early in the Preclassic period. It not unlikely that they were also being cultivated, and possibly domesticated, in the Mazatán area prior to the Early Formative period. Hawkes (1989:482) writes that such crops originated

not in the rain forests, where continual humidity allows year-round vegetative growth, and there is no strong natural selection favouring the development of underground storage organs, but in the summer-green rain forests and woodlands with a well-marked dry season where the development of underground starchy food reserves helps the plant to survive the dry season and to regenerate quickly when the rain returns.

The pronounced dry season of the Pacific coast of southern Chiapas places it within the area delineated by Hawkes (1989, map p.483) as a possible place of origin for six distinct species of root and tuber crops. These are Manihot esculenta (cassava, manioc, yuca), Ipomoea batatas (sweet potato, camote), Dioscorea trifida (Indian yam, yampee), Maranta arundinacea (arrowroot, ereu), Xanthosoma sagittifolium (coco-yam, malanga), and Dalathea allouia. Most of these probably have their origins in South America, but manioc may have been first domesticated in the dry Pacific coast area of Mexico and Central America (Hawkes 1989:487-91; Rogers 1962,1963). Unfortunately, this is difficult to substantiate, because few archaeological remains have preserved. Nor can phytolith analysis provide much assistance, since roots such as manioc, sweet potato and yam deposit little or no silica in vegetative tissue and are unlikely to be recovered from archaeological contexts (Pearsall 1989:343; Piperno 1985b).

Another incentive for cultivation may have been to compensate for seasonal gaps in the availability of some foods, or for decreased resource availability due to environmental perturbations. Detailed studies have yet to be carried out on the seasonality and availability of the numerous plant and animal species in the area, but in general there appears to be little seasonal variation in the availability of most species (Blake et al. 1992a:138). This may, however, be more true for animal species than for plants, since the pronounced wet and dry seasons mean that many plant species would flower and produce fruit only at certain times of the year. Moreover, even normally-dependable resources can occasionally fail. Avocados, for example, are prone to alternate bearing and often fail to produce satisfactory crops, even under apparently favorable environmental conditions (Hodgson 1950:258). Under unfavorable conditions, such as abnormally low precipitation in the wet season, other food plants would produce lower yields as well.

Cultivation techniques may therefore have been performed to encourage growth and productivity of: 1) plants that produced fruit which could be stored for consumption

during periods when it would otherwise be unavailable; or 2) plants that produced fruit in periods when other desired plant foods were unavailable. The latter may have been accomplished by planting in bajos. As noted in Chapter Two, this would have extended soil moisture conditions well into the dry season, allowing cultivators to overcome some of the limitations imposed by coastal rainfall regimes.

A third incentive may have been convenience. In recent years, a great deal of scholarly attention has been directed toward the study of fixed-plot horticulture ("kitchen gardens"), which involves the long-term cultivation of small garden plots adjacent to the cultivators' homes (Harris 1973:398). Permanent gardens producing useful plants (for food, medicine, construction materials, shade, etc.) in immediate proximity to the household compound would provide diversity and seasonal spread in an efficient and non-labor-intensive way. Selective harvesting, transplanting and other cultivation techniques could replicate forest diversity in small areas close to the household compound, eliminating the need to go farther into the forest to collect and harvest.

Netting (1977) describes fixed-plot horticulture in the Pacific coastal region of Nicoya, Costa Rica. Like Wiseman's (1978) "artificial rain forest", these highly-productive gardens consist of several levels of plants from which non-favored species have been eliminated. The more shade-tolerant herbaceous, bush and twining plants are situated below the larger fruit trees. Fertilizing with household wastes creates a high organic content which, with the shade provided by the upper canopy, helps retain soil moisture. The proximity of these gardens to the household means that less travel time is required, crops can be easily protected from predators, and harvesting of produce can occur selectively, as required by household needs. In their study of the ethnobotany in the Puuc region of Yucatán, Smith and Cameron (1977) found that primary subsistence crops (such as maize, beans and squash) were grown in the more distant milpa, but the greater variety of foodstuffs (mainly cooking herbs and fruit such as papaya, guava, lime, zapote, chirimoya, mango, avocado, nance, chayote, and breadnut) came from the gardens

adjacent to the house.

The variable of social complexity introduces another dimension to the discussion and suggests other possible reasons for the development of cultivation practices. If sociopolitical inequities were emerging at this time, it is likely that there was at least some degree of controlled access to favored resource areas, through habitual use if not by actual claims of status. Individuals who had less social or political clout in terms of access to preferred natural resources, or those who would have been last in line to receive resources that may not always have occurred in quantities sufficient for the whole community, may have cultivated certain plant species as alternative food sources. In the archaeological record, low-status contexts would be expected to display a higher cultigen ubiquity and a lower frequency of other local resources than high-status contexts.

Conversely, some species may initially have been cultivated for use as security resources by people who had a vested interest in maintaining a continual supply of resources. In many small-scale societies, sociopolitical inequality derives from unequal gift-giving, where self-interested individuals can develop and maintain prestige by giving more than they receive, often in competitive feasts and similar displays of status (Clark and Blake 1993; Fried 1967; Gosden 1989; Mauss 1967). Successful social display and competition, necessary for the long-term maintenance of status, require uninterrupted exploitation of a reliable, productive resource base with which to build up surpluses. Unexpected shortages at a crucial time could spell disaster for an aspiring elite if support was transferred to a more reliable source. Cultivation of certain plant species could have provided a means of maintaining the necessary level of surplus for competitive purposes during occasional gaps in the availability of preferred resources. Species that could be stored for extended periods would probably have been especially attractive.

The preceding paragraphs address the question of why people began to cultivate the naturally-occurring food plants in the Mazatán area. We are also interested in how this process occurred. Instead of a rapid and complete switch from collecting to cultivating, I

visualize a gradual progression in which people first began to tend and encourage some of the useful root and tree crops that they were collecting, through simple practices such as weeding, composting, and pest control. More complicated and deliberate practices, such as selective harvesting, soil preparation and transplanting, eventually culminated in the deliberate planting of some favored crops for the reasons discussed above. Some of these plants would eventually become domesticated through continued human manipulation of their reproductive systems, and others would remain closer to their wild forms. Adoption of non-local cultigens, domesticated or not, could have taken place anytime during this process.

ADOPTION OF NON-LOCAL DOMESTICATES

Extant archaeological data indicate that at least one domesticated highland crop – maize – was being used by the Barra phase (1550-1400 B.C.)³. With the resource base as characterized above, one must wonder why this and other non-local plants (such as beans, if they were non-local) were adopted, and what role they played in the subsistence economy in the early period of their use. The following passage from Blake et al. (1992a:136) provides a point of departure for discussion of these questions:

Were domesticates, such as maize, staples during this early period or were they merely supplements? Were they incorporated as part of expanding systems of sociopolitical inequality, or were they regular parts of the diet consumed by people regardless of emerging status differentiation?

If these imported domesticates were rapidly adopted as new dietary staples, we might assume that: 1) the existing subsistence base was in some sense insecure or lacked something that the new domesticates had to offer, or 2) the new domesticates were more productive and it made economic sense to change the old system in their favor.

As described above, the resource base appears to have provided an abundance and diversity of wild plant and animal foods. It therefore seems unlikely that the new domesticates would have been adopted out of pure necessity. Even if the resource base

was insecure, it is questionable whether major innovations in food production techniques would occur, since these inevitably involve some level of risk and are generally not undertaken in periods of resource stress or unless the innovator is in a position to absorb the possible losses (Cancian 1979; Wills 1992).

On the other hand, it is quite possible that the new domesticates provided something that the old system lacked. Maize is a good source of carbohydrates, and beans are the highest source of plant protein. Together, the two form a complementary and fairly complete nutritional complex. However, if root crops or other local starchy plant foods were being utilized, carbohydrates would not have been lacking, and the wide variety of faunal resources would presumably have supplied sufficient protein to meet dietary needs.

If the new domesticates were more productive⁴ and/or desirable than the existing staple plant foods, their adoption as primary staples would make more sense. Maize, however, may not have been very productive for much of the Early Formative period, given the small size of the cob fragments recovered from sites in the area to date. Until size and nutritional yield had been increased by genetic changes or more productive varieties had been introduced from other areas, it is questionable whether maize would have functioned as a dietary staple. This is supported by stable carbon isotope data which indicate that maize was not a significant dietary component in the Mazatán area during the Early Formative period (Blake et al. 1992b). Beans, on the other hand, may have played a more important dietary role following their adoption into the existing subsistence regime. In addition to their protein value, they provide about the same caloric value as cereals (Heiser 1981:127).

If either or both of these new domesticates were adopted as dietary staples, we would expect the recovered remains to demonstrate that they had passed the threshold of marginal productivity (eg. seed size and maize cob size should be relatively large) and such remains should be ubiquitous. Unless there was differential consumption of these

cultigens, this ubiquity should extend evenly across all contexts. In addition, analysis of the archaeological plant remains should reflect a greater reliance on these non-local domesticates than on local wild or domesticated plants.

If these non-local domesticates were adopted and used not as primary staples but as dietary supplements, the incentives for such use may have been similar to those discussed above for the cultivation of local plants – to create greater diversity, to provide nutritional balance to the diet, or to fill seasonal gaps in the availability of some foods. If these people were already cultivating local plants, the accommodation of the new crops to the existing horticultural regime would have been a low-cost option. Such occasional use of maize, at least, would explain the dietary patterns implied by the results of the stable carbon isotope analyses.

In their model for the emergence for social inequality in the Mazatán area, Clark and Blake (1993) suggest that these domesticates were imported from external regions as special items designed to increase competitive advantage and social status during a period of emerging sociopolitical inequality. In particular, they suggest that they may have been imported for use as social leverage in competitive displays such as feasting. As Hayden (1990:36) suggests,

one of the most important characteristics of these feasts is that highly desirable, rare, valuable, and often labor intensive foods or delicacies (too effort demanding for daily consumption) are employed to impress guest competitors with the host's wealth and power, and to increase the magnitude of the debts incurred by the guests.

Clark and Blake (1989, 1993) suggest that maize may have been used, initially, for making chicha, an alcoholic beverage with prestige value that could have been used in feasting contexts. Alternately, it could have been mixed with chocolate in atole, another beverage with ritual significance. The social practice of drinking is well-documented in traditional small-scale societies (Douglas 1987) and archaeological evidence suggests that it was an important component of competitive feasting in prehistoric times as well

(Dietler 1990; Moore 1989).

This suggestion has several archaeological implications. First, maize and beans were not primary staples; they were introduced into a mixed subsistence economy which probably included fishing, hunting, and the collection and possibly cultivation of plant foods. Analysis of the archaeological plant remains from early contexts should reflect a greater reliance on local plants than on these non-local domesticates.

Second, archaeological evidence for non-local domesticates should first appear during the Barra phase, when the first indications of inequality begin to emerge (Blake and Clark 1992; Clark and Blake 1993).

Third, evidence for these plants would presumably be found primarily in high-status contexts, at least for the period immediately following their introduction. However, if the competitors were regaling these products upon their supporters, then this distinction would not be valid and a fairly even spatial distribution of these archaeobotanical remains should occur.

Fourth, if maize was consumed initially in the form of a beverage, we might find material evidence for its preparation and consumption. In his study of the pre-Hispanic production of chicha in coastal Peru, Moore (1989) outlines the archaeological correlates for the three basic steps in the chicha-making process. For the first step, in which the maize is malted to convert its starch into sugar, we might expect to recover maize cobs, vessels for soaking the kernels, areas for germinating the kernels, the germinated kernels (jora) and milling stones for grinding the jora. The second stage involves cooking the jora and might be indicated by hearths, fire-altered vessels, stirring utensils and charcoal. In the final stage, the liquid is separated from the by-products. Material indicators of this process might include sieves and the by-products (small fragments of malted kernels and their outer skins). Evidence for the actual preparation of chicha should be found in or near the domestic structures, where this activity likely took place. Ethnographic descriptions of drinking in small-scale societies suggest that while the primary consumers

of such beverages are men, women frequently provide the raw material and do the brewing (Dietler 1990:364)⁵.

The final step – consumption – is indicated by containers used for this purpose. Underhill (1990) observes that in chiefdom societies, displays of largesse or generosity involve prestige vessels, which are distinct from everyday food storage, preparation and consumption vessels. They involve more intensive labor in their construction and symbolize the wealth and status of the giver. The fancy tecomates typical of the Barra ceramic assemblage would be suitable for serving chicha if straws were used, a practice which has been documented ethnographically among the Tiriki in Kenya (Katz and Voight 1986, Fig.6a). These vessels are thought to have replaced containers of perishable materials, such as elaborately decorated gourds, which were used for these special purposes before ceramic technology was introduced to the area (Clark and Blake 1993). Ethnographic studies have reported the use of decorated gourds for the consumption of chicha and other beverages (Cobo 1956:242; Hayden and Cannon 1984, Figs. 99-100).

If chicha was being made on a regular basis, the by-products would presumably be visible archaeologically, although the degree of visibility would depend on factors such as the method and location of deposition and the degree of preservation. Moore's (1989:687) calculations indicate that the production of 25 liters of chicha requires approximately 100 kg of jora and results in 60 kg of by-products. However, if the early maize in the Mazatán area was small and relatively unproductive, the production of chicha may have been an infrequent event, or it may have involved much smaller quantities, leaving less archaeological evidence. In either case, its rarity may have made chicha a special and valued commodity.

If maize was introduced to the Mazatán area as a novel item to be used for competitive purposes by political aspirants, it probably would not have taken long for the rest of the population to obtain access to kernels for their own cultivation and use. While it would likely have continued being used as an ingredient in special beverages, its more

common usage in the subsistence economy would extend the methods by which it was processed and prepared for general consumption. It may have been roasted, popped or otherwise prepared near the hearth, increasing its chances for long-term preservation. Maize remains should therefore be increasingly ubiquitous over time in the archaeological record, in both elite and non-elite contexts.

This discussion has focused almost exclusively on maize. What about beans, the other domesticate that appears in archaeological deposits at this time? Clark and Blake suggest that, like maize, this domesticated cultigen may also have been adopted as a sumptuary good to be used for advantage in competitive feasting. The implication is that beans would have been associated primarily with aspiring elites during the early period and would have become more widespread as the novelty wore off and as access to them became more generally available. This hypothesis rests, of course, on the assumption that beans were not domesticated locally. Because the specific area(s) of their original domestication are not strongly supported by botanical evidence, it must be regarded somewhat cautiously.

Again, we must consider the idea discussed above that in order to maintain prestige and status over time, it would have been essential to maintain a continual supply of resources which could be used for competitive feasting and display. If maize and beans were not initially adopted as specialty items to be used for these competitive purposes, they may have functioned instead as storeable security resources for people who could not risk losing their supporters through unexpected resource shortages.

SUMMARY

The hypothesis that guides this study is that people in the Mazatán area were cultivating and perhaps domesticating local food plants prior to the introduction of non-local domesticates. It is by necessity very general, given the paucity of available data concerning subsistence practices in the Mazatán area. The research questions that it

generates focus on 1) the origins of local cultivation practices of indigenous plant species, and 2) the adoption of non-local domesticated species. It is proposed that the former occurred as a gradual progression from simple to more deliberate cultivation practices of favored plant species for reasons related to nutrition, availability, efficiency and/or the development of food surpluses. The adoption of non-local domesticates -- for use as dietary staples or as supplements to the local subsistence economy -- may have occurred for similar reasons. Alternately, it may have occurred for reasons related to emerging sociopolitical inequality. The analysis of archaeological plant remains from sites in the Mazatán area was carried out in an attempt to test these ideas. The analysis and results are described in the following chapter.

NOTES

1. For reviews of these models, see Cohen (1977), Flannery (1986), Gebauer and Price (1992), Redding (1988), Rindos (1984), and Wright (1971).
2. Well-known examples include the chiefdoms of the Northwest Coast (Coupland 1988; Matson 1983) and southwest Florida (Widmer 1988) and the Natufians of the Levant (Henry 1989).
3. Beans were also likely domesticated in highland areas, but there is no strong evidence pointing to a specific point of origin. This is discussed at more length in Chapter Five.
4. "Productive" is, of course, a relative term, and is usually measured in terms of yield per area under cultivation or per unit of labor expended. Here, it is used in an admittedly general sense, since no figures are available for comparative purposes. It should be noted that, as Harlan (1975:138) points out, high yield is seldom a factor in traditional agriculture; what is more important is consistence and reliability.
5. In more complex societies, chicha production apparently occurred in different social contexts and by specialized producers. Cobo (1956:232-233) describes a group of "chosen women" (mamakuna) who brewed the beverage under the economic support of the Inka state. On the Peruvian coast, male chicheros specialized in chicha production to the exclusion of all other economic activities (Rostworowski 1977, 1978, cited in Moore 1989:688).

CHAPTER THREE DATA RECOVERY AND ANALYSIS

INTRODUCTION

The questions outlined in the preceding chapter are directly related to the use of local and non-local plant foods by the Early Formative residents of the area. The analysis of preserved plant remains from that period is therefore likely to yield unique information relevant to these questions. As indicated in Chapter One, paleoethnobotany is one of the most direct means of addressing questions related to prehistoric subsistence and plant use. While total dietary reconstruction is obviously impossible, an examination of archaeological plant remains has the potential to provide important substantive data concerning ancient agricultural and subsistence practices.

In particular, the identification of specific plants from Early Formative sites in the Mazatán area will help in the reconstruction of the subsistence economy by allowing us to determine which plant foods were at least present, and probably being used. It may also give some indication of the level of cultivation that was occurring, both of local and non-local plant foods. The morphological characteristics of the macroremains can help in determining the state of a domestication of a plant at the time of its use. If avocado seeds, for example, are consistently smaller than modern domestic species and more similar to local wild species, they probably had not come under full domestication. By studying temporal distributions of plant remains, we have some basis for assessing the hypothesis that the Mokaya were cultivating local plants prior to their adoption of non-local domesticates. Analysis of the ubiquity of macroremains in different chronological contexts can also provide some indication of changes through time in the use of certain cultigens. The comparison of spatial distributions of plant remains from contexts displaying differential social status may provide clues about whether differential consumption of specific cultigens was occurring. Such information could have important implications for questions related to the emergence of social inequality.

To date, no substantive analysis of plant remains from archaeological contexts in the Mazatán area has been carried out. Our current understanding of subsistence practices in the Early Formative period is growing as a result of faunal analyses, chemical analyses of human bone, and so on. However, as noted in the two preceding chapters, many key issues remain unresolved. The present study is an attempt to fill some of these gaps in our understanding.

Nature of the data analyzed in this study

Categories of data currently employed in paleoethnobotanical studies include pollen, phytoliths, and macroremains. In this analysis, the focus is on macroremains, which are charred, dessicated or waterlogged plant remains that are visible to the naked eye and large enough to be identified at low-power magnification (Pearsall 1989:15). Because it is unlikely that non-carbonized plant remains will have preserved over millennia in the tropical climate of the Mazatán area, any non-carbonized materials were assumed to be modern and were eliminated from the sample.

Sources of bias in paleoethnobotanical analysis

The interpretation of plant distributions in archaeological contexts is somewhat problematical, because carbonized macroremains are not preserved in predictable proportion to the quantities in which they were used (Roosevelt 1984:12). The botanical material that ends up in the lab probably represents only a very small and biased sample of the original assemblage, making quantification and statistical analysis problematical (see Chapter Four). Any interpretations must take into consideration such factors as the physical and preservational properties of individual plant species, the frequency and methods of their use and disposal, characteristics of the surrounding soil matrix, and post-depositional site disturbance. Techniques of data recovery and analysis can also introduce bias to the sample (Popper and Hastorf 1988:5). In the following sections, I

describe the methods used in this project for the recovery of macroremains from their archaeological contexts and for their subsequent laboratory analysis.

DATA RECOVERY TECHNIQUES

The botanical material that is analyzed in this project was recovered from archaeological deposits at four sites in the Mazatán area: Aquiles Serdán, Paso de la Amada, Chilo, and San Carlos. The excavations were carried out over three field seasons in 1985 and 1990 (Clark et al. 1987, 1990) and some variation inevitably occurred in recovery and processing techniques.

The primary method of data recovery was flotation of soil samples collected from excavation units. However, *in situ* collections were made during excavation when large seeds or concentrations of seeds were observed in the matrix, and plant remains were also occasionally collected from excavated material that was dry-screened through 1/4 inch mesh. In general, few plant remains were recovered through these methods and flotation techniques were used to systematically recover more representative samples.

During excavation, soil samples for flotation were routinely collected from features likely to contain preserved macroremains, such as hearths and middens. They were also collected when charred plant material was observed in the matrix. Because of the variable nature of the contexts from which the samples were collected, there was no standardized sample size.

Unlike *in situ* and screen recovery, water flotation techniques permit the recovery of all size classes of plant material, thereby enhancing the quantity and range of materials that can be recovered archaeologically. They are based on the principal that differences in density cause organic remains to separate from the inorganic soil matrix within a body of liquid. The flotation system used in this project is an adaptation of Struever's (1968) Apple Creek or manual "tub" system (see Figure 3.1). In this system, a soil sample is immersed in water and the organic material floats to the surface and is scooped off. The

flotation equipment used in this project consisted of three main items:

1. A large metal tank which served as a water reservoir. A release valve in the constricted opening at the base allowed the removal of water and accumulated sludge.
2. A smaller flotation tub, which was a round galvanized steel washtub with the bottom cut out and replaced with screen. The tub was attached to a fitted iron bracket which supported the tub's screen bottom and which could be hooked over the rim of the tank, allowing the tub to rest partially immersed in the water. In the 1985 season, 1.0 mm window screen was used for the flotation tub; in 1990, 0.5 mm mesh was used in order to capture smaller botanical remains.
3. A hand sieve used to capture floating material (the light fraction) from the flotation tub. This sieve was constructed by attaching 0.5 mm wire mesh to a metal hoop.

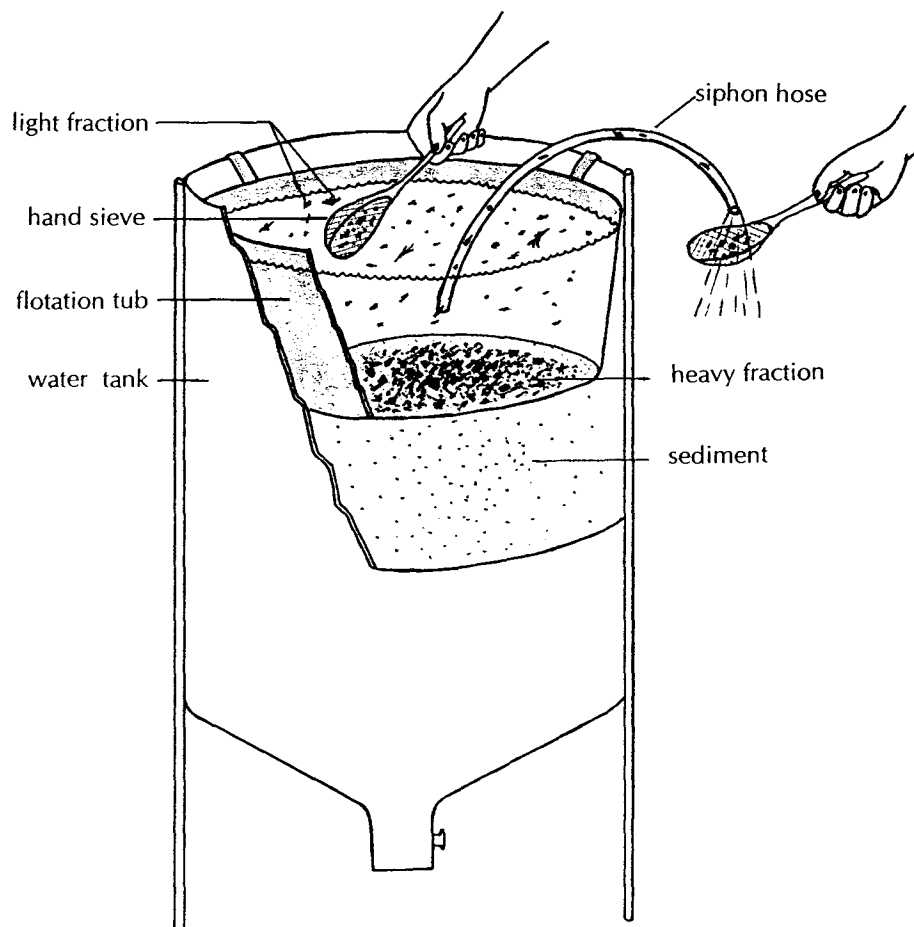


Figure 3.1 Diagram of flotation system equipment.

The flotation procedure was carried out by two operators. The flotation tub was partially immersed in the tank, which was filled with water. While one person manually agitated the water in the tub, the other slowly poured in the dried soil sample and scooped off the floating material. This light fraction was deposited on newspaper to dry. When all visible floating material was collected, the tub was removed from the water and the heavy fraction (the non-floating material captured by the screen bottom) was deposited on newspaper. When dry, both fractions were bagged and labelled.

This flotation system was of limited success during the 1985 field season, since little organic material actually floated (Michael Blake, personal communication). This could be due to several factors, such as failure to allow soil samples to dry completely before floating them, pouring soil into the water too rapidly, or not achieving sufficient agitation of the water during pouring (Pearsall 1989:51). Consequently, the entire heavy fraction was saved and was later sorted or scanned for botanical materials in the lab.

In 1990, we had greater success in recovering a light fraction, but we observed that a large amount of charcoal was floating well below the surface. We were able to capture much of this sub-surface floating material by using a 1/2 inch clear plastic hose to siphon the water from the tub through the hand scoop, a method similar to one described by Gumerman and Umemoto (1987) (see Figure 3.1). This improved the recovery rate, although some charcoal was still observed in the heavy fraction.

The interpretation of recovered plant remains requires knowing the volume of soil that was floated (Pearsall 1989:98; Wagner 1988:29). Such information was not consistently recorded for each sample in either of the field seasons. This oversight makes comparisons more difficult and limits the options available for data quantification (see Chapter Four).

SAMPLE SELECTION

A total of 187 samples was recovered from seven different sites during the 1985 and 1990 excavations. For the present analysis, I selected samples from the four sites which promised to yield information most relevant to the research problems under consideration. The criteria which guided this selection were: 1) location of sites in similar environmental zones, so that differences in patterning of the data will more likely reflect changes in plant use than differences in site settings; 2) chronological depth, so that changes in plant distributions and characteristics over time might be detected; and 3) availability of numerous flotation samples for analysis. Aquiles Serdán, Paso de la Amada, Chilo, and San Carlos met these criteria, and the following analysis is based on 147 samples from excavations at these sites (see Tables 3.1 and 3.2). Samples with unknown or mixed temporal proveniences were omitted, as was one sample that dated to the Post-Classic period.

Table 3.1. Summary of analyzed samples.

Site	No. of samples	Phases represented	No. of samples per phase
Aquiles Serdán	83	Cuadros	14
		Cherla	19
		Ocós	50
Paso de la Amada	34	Cherla	1
		Ocós	8
		Locona	23
		Barra	2
Chilo	17	Cherla	3
		Ocós	2
		Locona	12
San Carlos	13	Jocotal	2
		Locona	5
		Barra	6
Total	147		147

Table 3.2. Key to sample numbers.

Sample No.	Site	Provenience	Context	Phase
1	A.S.	P.1, L.6		Cherla
2	A.S.	P.1, L.9, F.5	sand floor	Ocós
3	A.S.	P.1, L.10		Ocós
4	A.S.	P.1, L.11, F.12	sand floor	Ocós
5	A.S.	P.1, L.12	dark stain	Ocós
7	A.S.	P.1A, L.3		Cuadros
8	A.S.	P.1A, L.4		Cuadros
9	A.S.	P.1A, L.5		Cuadros
10	A.S.	P.1A, L.6		Cherla
11	A.S.	P.1A, L.7		Cherla
12	A.S.	P.1A, L.8, F.6	midden	Cherla
13	A.S.	P.1A, L.9, F.6	midden	Cherla
15	A.S.	P.1A, L.10, F.6	midden	Cherla
17	A.S.	P.1A, L.11, F.6	midden	Cherla
19	A.S.	P.1A, L.12, F.6	midden	Cherla
20	A.S.	P.1A, L.13, F.6	midden	Cherla
21	A.S.	P.1A, L.13		Ocós
22	A.S.	P.1B, L.4		Cuadros
23	A.S.	P.1B, L.5	yellow soil	Cuadros
24	A.S.	P.1B, L.5	dark soil	Cuadros
25	A.S.	P.1B, L.6		Cuadros
26	A.S.	P.1B, L.7, F.6	midden	Cherla
27	A.S.	P.1B, L.8, F.5	sand floor	Ocós
28	A.S.	P.1B, L.8, F.6	midden	Cherla
29	A.S.	P.1B, L.9, F.5	sand floor	Ocós
30	A.S.	P.1B, L.10, F.6	midden	Cherla
31	A.S.	P.1B, L.11, F.5	sand floor	Ocós
32	A.S.	P.1B, L.11, F.6	midden	Cherla
33	A.S.	P.1B, L.12, F.6	midden	Cherla
34	A.S.	P.1B, L.12, F.16	dark soil	Ocós
35	A.S.	P.1B, L.12		Ocós
36	A.S.	P.1B, L.13, F.12		Ocós
37	A.S.	P.1B, L.14, F.6	midden	Cherla
38	A.S.	P.1B, L.15, F.6	midden	Cherla
39	A.S.	P.1B, L.16, F.6	midden	Cherla
40	A.S.	P.1B, L.17, F.6	midden	Cherla
41	A.S.	P.1C, L.3		Cuadros
42	A.S.	P.1C, L.4		Cuadros
43	A.S.	P.1C, L.6		Cherla
44	A.S.	P.1C, L.7, F.5	floor	Ocós
45	A.S.	P.1C, L.8, F.5	floor	Ocós
46	A.S.	P.1C, L.9, F.5	floor	Ocós
49	A.S.	P.1C, L.12, F.12		Ocós

Table 3.2. Key to sample numbers.

Sample No.	Site	Provenience	Context	Phase
50	A.S.	P.1C, L.12, F.13	hearth	Ocós
51	A.S.	P.1C, L.13, F.12		Ocós
52	A.S.	P.2, L.5		Ocós
53	A.S.	P.2, L.7		Ocós
54	A.S.	P.2-3, L.3		Ocós
55	A.S.	P.2-3, F.2	small pit	Ocós
56	A.S.	P.3, L.3, F.3	refuse pit	Ocós
155	A.S.	P.6, L.13	sub-midden soil	Ocós
57	A.S.	TR.1A, L.6		Cuadros
58	A.S.	TR.1A, L.16		Ocós
59	A.S.	TR.1A, L.17, F.1	refuse pit	Ocós
60	A.S.	TR.1A, L.17	yellow soil	Ocós
61	A.S.	TR.1A, L.18, F.1	post-holes	Ocós
62	A.S.	TR.1C, L.8		Cuadros
63	A.S.	TR.1C, L.16		Ocós
64	A.S.	TR.1C, L.17		Ocós
65	A.S.	TR.1C, L.18		Ocós
66	A.S.	TR.1C, L.18, F.1	refus	Ocós
67	A.S.	TR.1E, L.7	dark stain	Cuadros
68	A.S.	TR.1E, L.8		Cuadros
69	A.S.	TR.1E, L.12		Ocós
70	A.S.	TR.1E, L.13		Ocós
71	A.S.	TR.1E, L.14		Ocós
72	A.S.	TR.1E, L.15	post-hole	Ocós
73	A.S.	TR.1E, L.16		Ocós
74	A.S.	TR.1E, L.18		Ocós
153	A.S.	TR.1E, L.19		Ocós
75	A.S.	TR.1G, L.13		Ocós
76	A.S.	TR.1G, L.14	post-holes	Ocós
77	A.S.	TR.1G, L.15		Ocós
78	A.S.	TR.1G, L.17		Ocós
79	A.S.	TR.1G, L.18		Ocós
80	A.S.	TR.1G, L.19		Ocós
81	A.S.	TR.1I, L.18	burial	Ocós
82	A.S.	TR.1K, L.5		Cuadros
83	A.S.	TR.1K, L.15		Ocós
84	A.S.	TR.1K, L.16		Ocós
85	A.S.	TR.1K, L.18		Ocós
86	A.S.	TR.1K, L.19	Floor 4	Ocós
154	A.S.	TR.1K, Burial 1		Ocós
87	Paso	MD.6, I-24, L.8		Locona
88	Paso	MD.6, L.9, Lot 2	Floor 4	Locona
89	Paso	MD.6, L.9, Lot 6	Floor 4	Locona

Table 3.2. Key to sample numbers.

Sample No.	Site	Provenience	Context	Phase
90	Paso	MD.6, L.9, Lot 7	post-hole/Floor 4	Locona
91	Paso	MD.6, L.9, Lot 9	post-hole/Floor 4	Locona
92	Paso	MD.6, L.9, Lot 11		Locona
93	Paso	MD.6, L.9, Lot 12		Locona
94	Paso	MD.6, L.9, Lot 14		Locona
95	Paso	MD.6, L.9, Lot 26		Locona
96	Paso	MD.6, L.9, Lot 36		Locona
97	Paso	MD.6, L.9, Lot 37		Locona
98	Paso	MD.6, L.9, Lot 37	ash lens	Locona
101	Paso	MD.6, TR.1, Str.4	below sand	Ocós
102	Paso	MD.7, P.1, L.8		Barra
103	Paso	MD.7, P.1, L.11		Barra
125	Paso	MD.6, L.3, F-21	Floor 3	Locona
129	Paso	MD.6, A-25, L.16		Locona
130	Paso	MD.6, A-25, L.19		Locona
131	Paso	MD.6, E-23, L.3	Floor 2	Locona
132	Paso	MD.6, E-28, L.5	fill	Ocós
133	Paso	MD.6, E-28, L.9		Ocós
134	Paso	MD.6, E-28, L.12		Ocós
135	Paso	MD.6, E-28, L.13		Ocós
136	Paso	MD.6, E-28, L.16		Ocós
137	Paso	MD.6, E-28, L.17		Ocós
138	Paso	MD.6, E-28, L.18	oven?	Ocós
139	Paso	MD.6, G-22, L.5	fill	Locona
142	Paso	MD.6, G-26, L.5	fill	Locona
144	Paso	MD.6, H-25, L.17	midden	Locona
145	Paso	MD.6, I-23, L.2	burned soil	Locona
147	Paso	MD.6, J-24, L.3		Locona
148	Paso	MD.6, J-26, L.5	fill	Locona
149	Paso	MD.6, K-21, L.16		Locona
151	Paso	P.25, L.5	fill	Cherla
104	S.C.	P.1, Lot 2		Barra
105	S.C.	P.1, Lot 3		Barra
152	S.C.	P.2, L.42, F.2	hearth	Barra
107	S.C.	P.5, F.8	hearth	Barra
108	S.C.	P.5, F.9	pit with hearth	Barra
109	S.C.	P.7, Floor 1	Floor 1	Locona
111	S.C.	P.7, F.4		Locona
112	S.C.	P.12, Lot 13		Barra
113	S.C.	P.14, Str.2		Jocotal
114	S.C.	P.14, Str.3		Jocotal
116	S.C.	P.14, Str.9		Locona
118	S.C.	P.17, Lot 5		Locona

Table 3.2. Key to sample numbers.

Sample No.	Site	Provenience	Context	Phase
119	S.C.	P.20, Sub-floor 1		Locona
162	Chilo	P.1, L.4		Cherla
163	Chilo	P.1, L.5, F.1		Ocós
164	Chilo	P.1, Ext.SE, L.2	dark soil	Cherla
165	Chilo	P.1 profiles, F.1	midden	Ocós
170	Chilo	P.2A, L.4	midden	Locona
171	Chilo	P.2A, L.5	midden	Locona
172	Chilo	P.3, L.11, F.1		Locona
173	Chilo	P.3, L.15	midden	Locona
174	Chilo	P.4, L.5		Cherla
178	Chilo	P.4A, L.13		Locona
179	Chilo	P.4A, L.15	midden	Locona
180	Chilo	P.4A, L.17	midden	Locona
181	Chilo	P.4B, L.12	midden	Locona
182	Chilo	P.4B, L.13	midden	Locona
183	Chilo	P.4B, L.14	midden	Locona
186	Chilo	P.5, L.8	dark soil	Locona
187	Chilo	P.5, L.12	midden	Locona

A.S. = Aquiles Serdán
 Paso = Paso de la Amada
 S.C. = San Carlos

T. = Test pit
 L. = Level
 F. = Feature
 TR. = Trench

MD. = Mound
 Str. = Stratum
 Ext. = Extension

Description of sites

The site of Aquiles Serdán is located in an agricultural area about 2 km northeast of the ejido of the same name (see Figure 1.2). It is approximately 12 ha in area and consists of a large mound that rises 2-3 m above the surrounding plain. The Cantileña swamp is about 3 km to the west, and the Pumpuapa River is about the same distance to the north. Excavations in 1985 (Clark et al. 1987) produced Ocós and Cherla phase house and midden deposits and revealed a long occupation of the site.

Paso de la Amada is a large village site located on agricultural land 2 km west of the ejido of Buenos Aires. It consists of a series of low mounds or elevated areas spread

over 1 square km of coastal plain. There is no permanent source of water, but seasonally inundated bajos or old river channels would probably have held water for most of the year. Excavations at Paso de la Amada point to a large residential occupation of the elevated areas bordering the bajos throughout most of the Early Formative period, especially during the Barra, Locona, and Ocós phases. Domestic architecture suggests the existence of an elite social stratum (Blake et al. 1993a) and recent research at this site has been directed toward investigation of the development of early chiefdoms (Blake et al. 1992c, 1993c).

San Carlos is located on a small ranch about 8 km northeast of Mazatán. The Coatán River presently flows less than a kilometer to the east. The site consists of a single mound, 3 m high and 100 m in diameter, with occupation extending over the low flat lands surrounding the mound. At the time of its occupation, it was adjacent to a large drainage channel. Excavations in 1985 and 1990 (Clark et al. 1987, 1990) produced a possible Late Archaic component, domestic architecture dating to the Barra and Locona phases, and Cuadros and Jocotal materials.

Chilo is one of three sites found on the property of an old tree nursery about 5 km north of Paso de la Amada. All that remains of the site is a scatter of sherds from a small destroyed mound south of a small bajo. Investigations in 1985 (Clark et al. 1987) produced burials and refuse dumps that indicate occupation in the Locona, Ocós and Cherla phases.

TECHNIQUES OF LABORATORY ANALYSIS

Two main stages were involved in the laboratory analysis: sorting the light and/or heavy fractions of the flotation samples and identifying the recovered macroremains.

Sorting procedure

This first analytical stage was the most time-consuming. It involved the separation of the archaeological plant remains from other organic materials (modern plant remains, faunal remains) and from the inorganic component (soil, pebbles, artifacts). Description of the sorting procedures is rather complicated, because some sorting of the 1985 samples had been done prior to my involvement in the project and some procedural variation occurred. A site-by-site description of the samples provides the most concise summary of the methods used in each case.

Aquiles Serdan. The 83 samples from this site consisted mainly of heavy fraction material which had been sent from Mexico to the Laboratory of Archaeology at U.B.C. We also received plant remains recovered from previously sorted heavy fraction material. Seeds with proveniences matching those of heavy fraction samples already in our possession were incorporated into those samples and those with non-matching proveniences were given new sample numbers.

When I began the analysis, several of the samples had already been sorted by student volunteers. The sorting procedure involved the separation of all of the heavy fraction material into one of several categories, including charcoal, seeds/plant material, bone, obsidian, artifacts, pebbles, and soil. For the remainder of the Aquiles Serdán samples, the following procedure was followed. After weighing the heavy fraction, it was passed through a series of geological sieves (4.0 mm, 2.0 mm, 1.0 mm, and 0.5 mm).

These "splits" were made because it is easier to sort materials of similar size.

Each split was examined visually or with low-power (10-30 X) magnification under an illuminated dissecting microscope. All charred materials were removed from the 4.0 mm and 2.0 mm sieve contents. From the 1.0 mm and 0.5 mm sieves, charred seeds were removed, but small charcoal fragments were not. Experiments have indicated that these fragments do not add substantially to the total weight, and their small size makes it difficult to determine species or genus of the wood (Pearsall 1989:117).

Recovered charcoal was weighed and placed in plastic film containers for storage. Recovered seeds and other materials were grouped in like categories and stored in glass or plastic vials until more accurate identifications could be made.

In one case (No. 66), the heavy fraction was particularly large (2578.0 g) and, to reduce sorting time, I decided to examine 25% of the ≥ 2.0 mm split and 25% of the ≥ 1.0 mm split. This brought sorting time down to a more manageable amount, yet the weight of sorted material remained within the range of the weights of the other sorted samples. In other cases (see below), higher or lower percentages were selected, depending on the weights of the size splits. In general, it was feasible to examine more of the larger size splits, since they could be scanned for charred remains much more quickly than the smaller splits which required microscopic examination. Table 3.3 indicates the percentage of the heavy fraction that was sorted for each sample (excluding previously sorted samples for which heavy fraction weights were not available).

Paso de la Amada. The sorting procedure described above was followed for the 34 samples from this site, with minor variations. Because of difficulties in shipping soil and plant materials from Mexico to Canada, I sorted these samples in Mexico at the New World Archaeological Foundation laboratory in San Cristóbal de las Casas, Chiapas. I

was unable to locate sieves with the same mesh size that I used to split the Aquiles Serdán samples, and ended up making just two splits: ≥ 1.0 mm and < 0.1 mm. Wood charcoal was not separated from the smaller split. In all cases except one (No. 92), 100% of the ≥ 1.0 mm split was examined. Interestingly, the 0.5 mm size split was quite large in almost all samples and was sub-sampled for sorting. This appears to reflect the smaller mesh used in the flotation bucket in the 1990 season. The 1.0 mm mesh used in the 1985 season would permit this size of particle to pass through, as the generally low weights of the < 0.1 mm split seem to indicate.

San Carlos. I sorted the 13 samples from this site in Mexico, following the procedure described for the Paso samples. Again, there was a large < 1.0 mm split which was sub-sampled for sorting in most cases.

Chilo. These 17 samples consisted of heavy fraction material which had been shipped to Vancouver from Mexico. I sorted these at the U.B.C. lab, following the procedure described above for the Aquiles Serdán samples. Only one large sample (No. 187) was sub-sampled for sorting.

Table 3.3. Heavy fractions: total weight and percent sorted.

Site	Sample No.	Weight of splits/ percent sorted						Total weight
		≥ 0.5 mm	%	≥ 1.0 mm	%	≥ 2.0 mm	%	
A.S.	1	4.0	100	18.4	100	157.5	100	179.9
A.S.	3	0.2	100	0.5	100	28.2	100	28.9
A.S.	5	2.2	100	15.2	100	136.5	100	153.9
A.S.	7	0.2	100	2.7	100	24.0	100	26.9
A.S.	8	0.1	100	2.2	100	23.2	100	25.5
A.S.	9	0.2	100	2.4	100	20.5	100	23.1
A.S.	10	0.6	100	9.2	100	33.0	100	42.8
A.S.	11	0.5	100	13.2	100	86.2	100	99.9
A.S.	21	0.2	100	2.3	100	4.7	100	7.2
A.S.	22	0.2	100	3.2	100	36.6	100	40.0
A.S.	23	0.2	100	2.6	100	23.1	100	25.9
A.S.	24	0.2	100	2.3	100	40.6	100	43.1
A.S.	25	0.7	100	6.9	100	57.1	100	64.7
A.S.	34	2.2	100	15.3	100	106.9	100	124.4
A.S.	35	0.8	100	9.5	100	65.8	100	76.1
A.S.	41	1.1	100	13.5	100	75.6	100	90.2
A.S.	42	0.2	100	2.0	100	15.8	100	18.0
A.S.	43	0.3	100	4.4	100	33.9	100	38.6
A.S.	44	0.4	100	3.8	100	31.9	100	36.7
A.S.	51	0.1	100	0.7	100	6.9	100	7.7
A.S.	52	0.0	0	0.0	0	39.5	100	39.5
A.S.	53	<0.1	100	23.7	100	33.0	100	56.7
A.S.	54	<0.1	100	21.7	100	16.8	100	38.5
A.S.	55	1.2	100	37.3	100	126.2	100	164.7
A.S.	56	1.1	100	20.2	100	82.3	100	103.6
A.S.	57	3.1	100	27.2	100	112.9	100	143.2
A.S.	58	0.4	100	5.8	100	24.9	100	31.1
A.S.	59	0.3	100	8.5	100	27.9	100	36.7
A.S.	60	0.1	100	3.3	100	3.8	100	7.2
A.S.	62	4.4	100	39.1	100	114.6	100	158.1
A.S.	63	0.2	100	9.4	100	27.2	100	36.8
A.S.	64	6.2	100	132.0	100	483.6	100	621.8
A.S.	65	7.0	100	171.7	100	695.0	100	873.7
A.S.	66	46.0	100	463.0	25	2069.0	25	2598.0
A.S.	67	1.1	100	14.5	100	37.9	100	53.5
A.S.	68	2.7	100	2.4	100	44.6	100	49.7
A.S.	69	0.4	100	10.0	100	33.4	100	43.8
A.S.	70	0.4	100	12.7	100	45.5	100	58.6
A.S.	71	0.2	100	12.5	100	33.2	100	45.9
A.S.	72	0.2	100	12.4	100	33.8	100	46.4

Table 3.3. Heavy fractions: total weight and percent sorted.

Site	Sample No.	Weight of splits/ percent sorted						Total weight
		≥0.5 mm	%	≥1.0 mm	%	≥2.0 mm	%	
A.S.	73	1.3	100	29.0	100	250.0	100	280.3
A.S.	75	0.9	100	14.2	100	32.1	100	47.2
A.S.	76	0.2	100	8.4	100	46.5	100	55.1
A.S.	77	0.2	100	8.0	100	35.9	100	44.1
A.S.	78	12.4	100	85.7	100	371.7	100	389.8
A.S.	79	0.2	100	1.2	100	9.2	100	10.6
A.S.	80	0.1	100	0.7	100	2.5	100	3.3
A.S.	81	0.5	100	2.9	100	5.7	100	9.1
A.S.	82	3.7	100	4.7	100	28.7	100	37.1
A.S.	83	4.0	100	90.6	100	328.7	100	423.3
A.S.	84	0.2	100	2.0	100	2.8	100	5.0
A.S.	85	0.6	100	10.9	100	32.3	100	43.8
A.S.	86	1.1	100	14.0	100	53.1	100	68.1
Paso	87	36.1	50	75.8	100			111.9
Paso	88	491.2	5	778.9	100			1270.1
Paso	89	243.4	10	225.4	100			468.8
Paso	90	174.6	10	204.4	100			379.0
Paso	91	151.1	10	188.8	100			339.9
Paso	92	3410.0	1	6311.9	10			9721.9
Paso	93	877.2	5	1117.5	100			1994.7
Paso	94	407.0	10	481.6	100			888.6
Paso	95	291.8	10	166.8	100			458.6
Paso	96	223.0	10	184.1	100			407.1
Paso	97	246.9	10	238.6	100			485.5
Paso	98	1897.4	2	941.6	100			2839.0
Paso	101	573.8	5	716.4	100			1290.2
Paso	102	102.9	50	43.7	100			146.6
Paso	103	40.1	100	24.2	100			64.3
S.C.	104	369.7	10	61.1	100			430.8
S.C.	105	418.9	10	604.3	100			1023.2
S.C.	107	114.2	10	379.3	100			493.5
S.C.	108	2725.8	3	8714.1	10			11439.9
S.C.	109	119.3	10	183.8	100			303.1
S.C.	111	771.4	5	364.3	100			1135.7
S.C.	112	439.6	5	484.1	100			923.7
S.C.	113	218.9	10	104.0	100			322.9
S.C.	114	334.1	10	86.6	100			420.7
S.C.	116	326.7	10	149.2	100			475.9
S.C.	118	295.2	10	202.0	100			497.2
S.C.	119	50.5	50	12.7	100			63.2

Table 3.3. Heavy fractions: total weight and percent sorted.

Site	Sample No.	Weight of splits/ percent sorted						Total weight
		≥0.5 mm	%	≥1.0 mm	%	≥2.0 mm	%	
Chilo	162	3.0	100	45.6	100	119.5	100	168.1
Chilo	163	7.6	100	51.7	100	136.0	100	195.3
Chilo	164	0.1	100	1.0	100	3.8	100	4.9
Chilo	165	3.0	100	34.4	100	79.4	100	116.8
Chilo	170	2.7	100	80.4	100	162.4	100	245.5
Chilo	171	9.0	100	189.7	100	407.5	100	696.2
Chilo	172	10.0	100	156.9	100	416.3	100	483.2
Chilo	173	3.5	100	111.9	100	213.8	100	329.2
Chilo	174	6.5	100	61.9	100	208.7	100	277.1
Chilo	178	5.4	100	170.9	100	364.4	100	540.7
Chilo	179	15.6	100	199.2	100	464.6	100	679.4
Chilo	180	14.1	100	166.7	100	261.6	100	442.4
Chilo	181	24.7	100	228.5	100	487.7	100	740.9
Chilo	182	8.7	100	126.2	100	189.8	100	324.7
Chilo	183	11.2	100	293.1	100	673.3	100	977.6
Chilo	186	5.8	100	109.0	100	391.8	100	506.6
Chilo	187	66.9	25	760.9	25	1712.2	25	2540.0

A.S. = Aquiles Serdán
 Paso = Paso de la Amada
 S.C. = San Carlos

All weights are in grams.

IDENTIFICATION OF RECOVERED MACROREMAINS

This was probably the most difficult stage of the analysis. At the same time, it was the most crucial, since the success of the project depended on accurate identification of the recovered archaeobotanical remains. Such identification is usually accomplished through comparisons between known plant specimens and unknown archaeological materials (Pearsall 1989:128). Access to adequate comparative material is essential, especially when the analyst has a limited botanical background and little experience in the identification of archaeobotanical remains.

Because little work of this type has been done in the Mazatán area, a comparative

plant collection has not been established¹. At the beginning of this project, I had hoped to be able to build such a collection. This would involve three basic steps: 1) collecting, pressing and drying plant specimens; 2) identifying these comparative materials; and 3) charring them for the working lab collection. Logistical difficulties prevented the achievement of the first step. Because identifiable specimens must be collected in flower, in fruit, or both (Pearsall 1989:131), an extended period of plant collecting time – at least one year – would be required in order to find flowering and/or fruiting specimens of all the plants in the area. Time constraints and financial considerations made this an unfeasible option.

The best alternative plan was to examine comparative collections for similar biogeoclimatic zones. Following numerous attempts to contact archaeologists and paleoethnobotanists working in similar areas who might have – or know of – useful collections, I spent two weeks at the Universidad Nacional de México (U.N.A.M.) in July of 1992 at the invitation of Dr. Emily McClung de Tapia, director of the Laboratorio de Paleoetnobotánica.

Prior to my visit to U.N.A.M., I had classified the archaeobotanical remains into various "Unidentified" categories, based on similarity in morphological characteristics such as shape and size. I took examples of each of these groups with me and compared the individual specimens with examples from the archaeological collections at the Laboratorio de Paleoetnobotánica. These collections derive primarily from Teotihuacán and other central highland sites. There were also collections from Cobá, a site near the coast in Quintana Roo. Javier González V. provided assistance in making identifications. I was also permitted to examine ethnobotanical collections (from Los Tuxtlas, near the Veracruz coast, and Puertos Morelos, on the Quintana Roo coast) and herbarium

specimens at the Instituto de Biología at U.N.A.M. Assistance in identifications at this institution was provided by Guillermo Ibarra Manríquez and Gilda Ortiz.

In addition to these collections, I made continual reference to illustrated seed manuals (eg. Gunn 1977; Martin and Barkley 1961; Montgomery 1977) and published reports of botanical remains from archaeological deposits.

NOTES

1. Ignacio Sanchez (New World Archaeological Foundation) is currently developing a comparative plant collection as part of his study of the flora and fauna of the Mazatán area.

CHAPTER FOUR RESULTS AND DISCUSSION

Of the 147 flotation samples that were analyzed, 133 yielded archeobotanical remains. A total of seven taxa were identified. Three taxa – Zea mays (maize), Phaseolus spp. (beans), and Persea americana (avocado) – clearly dominate the assemblage. Persea sp. (Laurel family), Mollugo sp. (carpetweed), Polygonum sp. (knotweed), and Brassica sp. (mustard) are represented by fewer specimens. In the first section below, I describe these taxa. In the subsequent section, I discuss their occurrence in quantitative terms and present this information in tabular form. In the final section, I make a few points concerning observed patterns or trends in the data.

DESCRIPTION OF RECOVERED TAXA

Zea mays (maize, corn, maíz; family Graminae)

Zea mays is a domesticate in the grass family, which is represented by approximately 400 genera and more than 6000 species. As with other cereals in this family, maize grains provide an excellent source of carbohydrates. They also contain protein (although this lacks several important amino acids), oil, and some vitamins and minerals. In pre-Hispanic times, maize was the most widely grown plant in the Americas and was an extremely important part of the diet of many native American groups (Heiser 1981:100). The poorly-balanced proteins were enhanced by preparing the grains in a lime-water solution and by the complementary amino acids in beans (see below).

The origin and evolution of maize is a topic that has intrigued botanists for over a century. It is a complex debate and outside of the scope of this study, but the most commonly accepted view has it that teosinte, also in the genus Zea, was the wild ancestor of maize (Beadle 1980; Benz 1987; Doebley 1990; Galinat 1983; Iltis 1983). Proponents of this view reject the idea that maize derived from a hypothetical wild maize

(Mangelsdorf 1974, 1986).

Although it is clear that maize is of New World origin, debate continues over the exact location of its original domestication. This event probably occurred in one geographic area with subsequent spread of the plant and technology to other areas. Archaeological evidence suggests that the earliest maize was from the Tehuacán Valley in central Mexico (ca. 6000 B.P., uncalibrated) (Mangelsdorf et al. 1967), but recent accelerator mass spectrometry dates indicate that this maize is no older than 4700 B.P. (uncalibrated) (Long et al. 1989). It has recently been proposed (Doebley 1990) that maize originated earlier than 7000 years ago in the wetter, low to mid-altitudinal Balsas River valley of southwestern Mexico. This is the geographic range of *Zea mays* subsp. *parviglumis*, the teosinte which molecular studies indicate is the most similar to maize.

Zea mays is clearly the most ubiquitous of the identified taxa. A total of 2280 fragmented or complete maize cupules, kernels and cobs were recovered from samples from all four sites and from deposits dating from Barra through Cherla times (see Table 4.1 and Figures 4.1 and 4.2). Only four cob fragments were sufficiently complete to permit description of their morphological characteristics (see Table 4.2). These are all from Aquiles Serdán; three date to the Ocós phase and one to the Cuadros phase. The fragment from Sample 74 is the only one which has a segment of intact rachis (Figure 4.2, top). The rachis diameter is 6.81 mm, and there are 8 ranks of cupules, or 16 kernel rows. The 3 cupule ranks that are present in the fragment from Sample 25 appear to comprise about half of the rachis diameter, which would make a 12-row cob (Figure 4.2, center). The width of this fragment is 13.86 mm, which is probably close to the rachis diameter. The fragments from the other two samples are too incomplete to determine rachis diameter or number of rows.

I have not attempted to speculate on the races of maize that these cob fragments represent, since there are few specimens which are sufficiently complete for detailed measurements. Moreover, my limited knowledge of the systematic relationships among

the races of maize does not qualify me for an informed discussion of racial diversity. Wellhausen et al.'s (1952) classification of maize has for decades been the standard reference for studies of maize systematics, but recent molecular evidence (Doebley 1990) indicates that a reassessment of this scheme is perhaps in order.

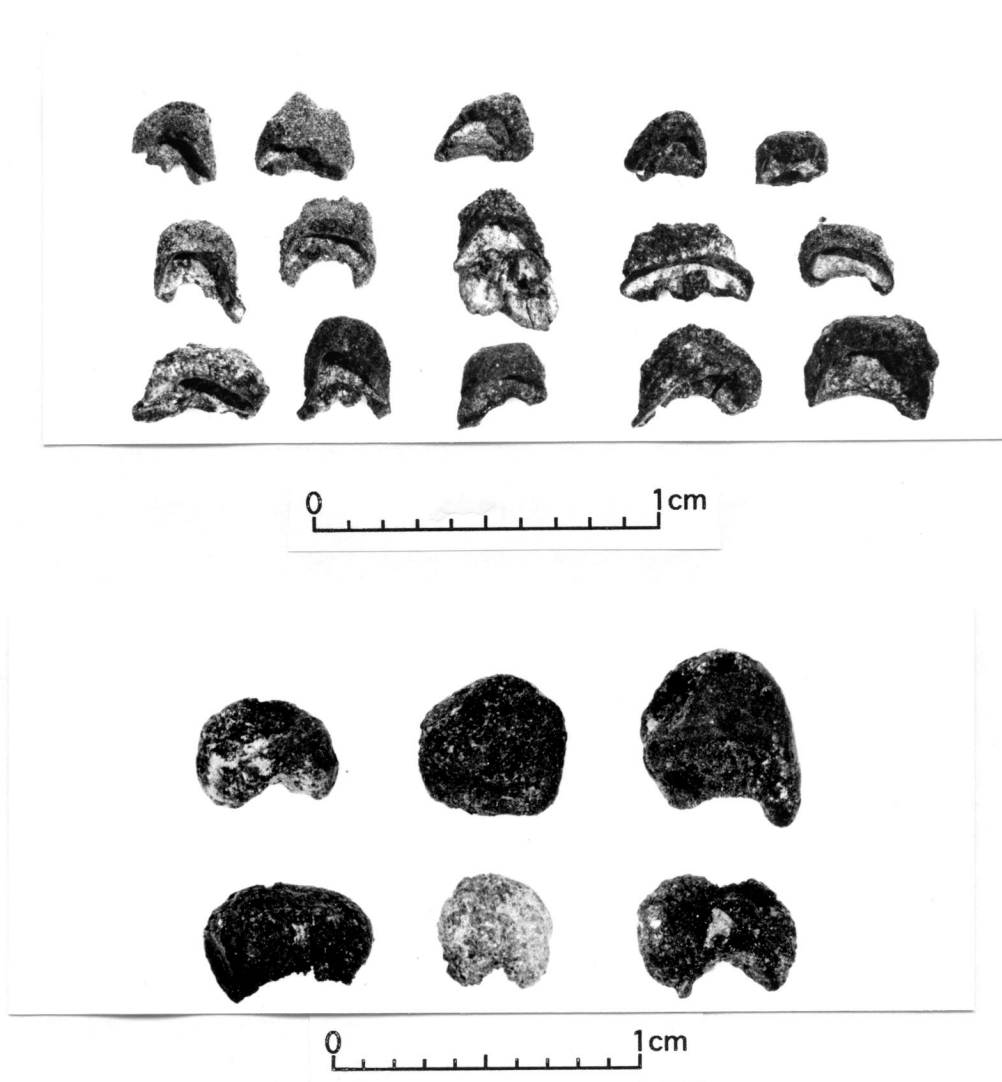


Figure 4.1. *Zea mays* cupules (top) and kernels (bottom).

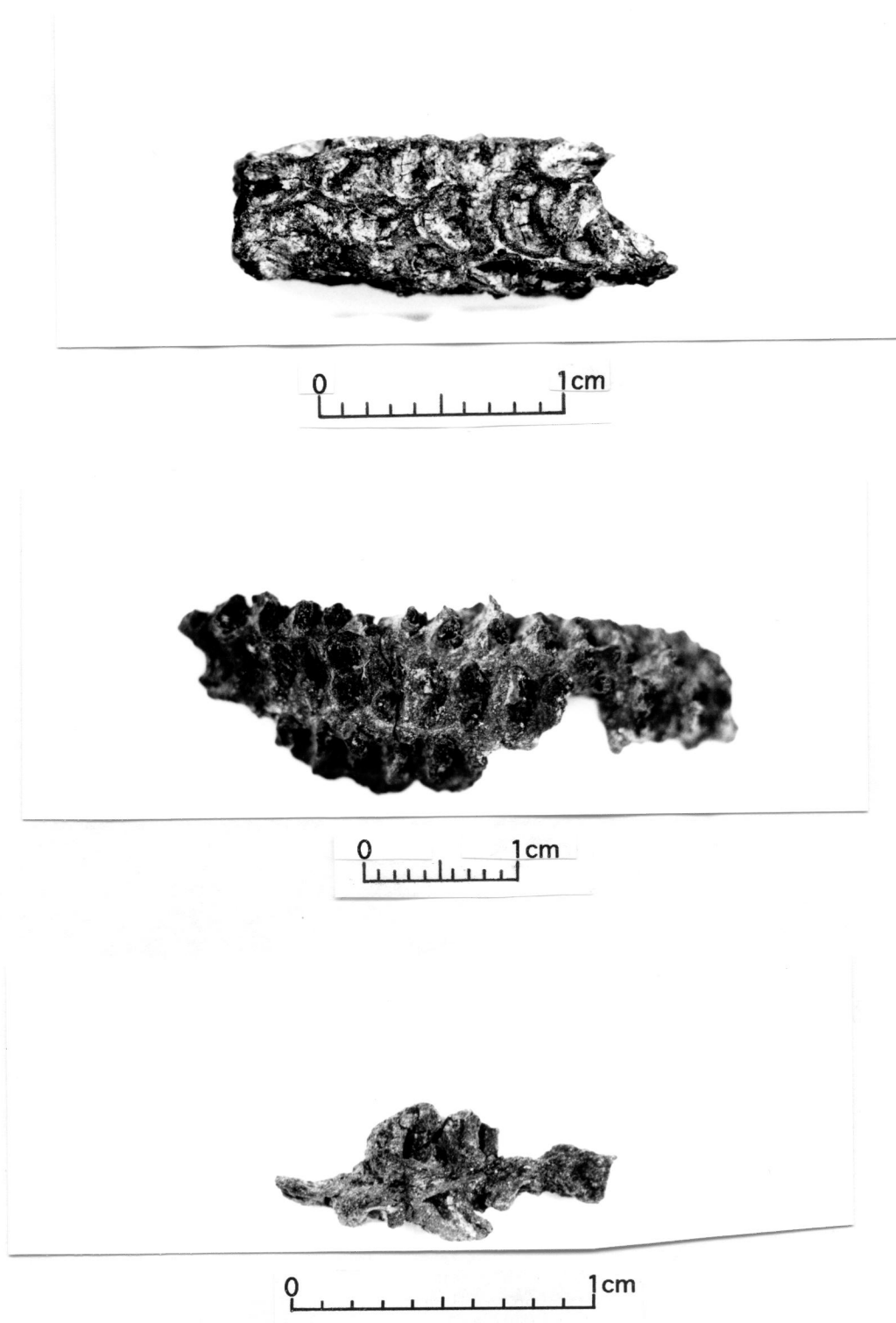


Figure 4.2. *Zea mays* cob fragments recovered from Samples 74 (top), 25 (center) and 34 (bottom).

Table 4.1. Counts of recovered Zea mays specimens.

No.	Phase/ Site	Kernels	Cupules	Cobs	No.	Phase/ Site	Kernels	Cupules	Cobs
<u>CUADROS</u>					<u>OCOS</u>				
7	A.S.		1		65	A.S.	10	64	
25	A.S.	3		5	66	A.S.	37	100	4
41	A.S.	1			71	A.S.		3	
57	A.S.	2			72	A.S.	5	1	
62	A.S.	1			73	A.S.	14	26	
67	A.S.		2		74	A.S.	18	77	1
<u>CHERLA</u>					153	A.S.	9	29	
1	A.S.	1	2		75	A.S.	1		
13	A.S.	11			76	A.S.	3	4	
15	A.S.	9	3		77	A.S.	2		
17	A.S.		3		78	A.S.	2	25	
19	A.S.	8	3		83	A.S.	2		
26	A.S.	13	1		86	A.S.	1		
28	A.S.	12			101	Paso	16	37	
30	A.S.	17	5		132	Paso	1		
32	A.S.	26	5		133	Paso	3		
33	A.S.	7	2		134	Paso	136	4	
40	A.S.	3	1		163	Chilo	8		
43	A.S.	5			<u>LOCONA</u>				
151	Paso	1			87	Paso	1		
162	Chilo	7			92	Paso	25		
174	Chilo	8			93	Paso	6		
<u>OCOS</u>					94	Paso	1		
2	A.S.	79	67	40	95	Paso	3		
4	A.S.	7	3		96	Paso	2		
5	A.S.	3	2		170	Chilo	8	2	
21	A.S.	1			171	Chilo	20	4	
27	A.S.		1		172	Chilo	11	5	
31	A.S.	6	4		173	Chilo	6	4	
34	A.S.	120	85	28	178	Chilo	10		
35	A.S.	7	13		179	Chilo	19	1	
36	A.S.	13	8		180	Chilo	8	5	
44	A.S.	1			182	Chilo	38	273	
45	A.S.	4			183	Chilo	17	10	
					186	Chilo	6	5	

Table 4.1. Counts of recovered *Zea mays* specimens.

No.	Phase/ Site	Kernels	Cupules	Cobs	No.	Phase/ Site	Kernels	Cupules	Cobs
	<u>OCOS</u>					<u>LOCONA</u>			
46	A.S.	1			187	Chilo	14	6	
49	A.S.	14	14	7	111	S.C.	1		
50	A.S.	6	11						
56	A.S.	5				<u>BARRA</u>			
58	A.S.	1	1		102	Paso	6	2	
59	A.S.	1	2		103	Paso	10	12	
61	A.S.	72	126	14	108	S.C.	11	16	
63	A.S.	4	1		152	S.C.	7	19	
64	A.S.	16	83						

No. = Sample number Paso = Paso de la Amada
A.S. = Aquiles Serdán S.C. = San Carlos

These counts refer to fragmented and complete specimens.

Table 4.2. Measurements of *Zea mays* cob fragments.

Sample No.	Phase	Length (mm)	Rachis diameter (mm)	Rachis segment length (mm)	Cupule width (mm)	Cupule wing width (mm)	Cupule aperture width (mm)	Cupule ranks (1/2 no. of rows)
25	Cuadros	38.16	inc.	2.81	4.49	0.86	2.58	3 (inc.)
34	Ocós	11.81	inc.	2.60	3.10	0.80	1.77	2 (inc.)
66	Ocós	9.34	inc.	2.70	3.67	0.65	2.49	2 (inc.)
74	Ocós	18.12	6.81	2.68	2.27	0.68	2.35	8

Phaseolus spp. (bean, frijol; family Fabaceae)

The genus Phaseolus of the legume family comprises about 160 species. Approximately 80 of these are New World natives. Four cultivated species are important as food crops: P. vulgaris L. (common bean, frijol); P. acutifolius Gray, var. latifolius Freeman (tepary bean, escomite); P. lunatus L. (small lima bean, sieva, haba); and P. coccineus L. (runner bean, ayecote) (Kaplan 1967:201).

The principal economic significance of beans is as a source of vegetable protein. The protein content of dry mature seeds is 22%, which is among the highest of all plant foods. Their amino acids complement those of cereals such as maize to provide a much more complete protein than can be provided by any plant alone. In addition, the caloric value of beans is about the same as that of cereals (Heiser 1981:127; Kaplan 1967:202).

Phaseolus spp. remains were present in 31 of the 133 samples and a total of 256 fragments were recovered. Of these, 59 were sufficiently complete to provide length, width, and thickness measurements – 23 from Aquiles Serdán, 33 from Paso de la Amada, and 3 from Chilo (see Table 4.3). Seed length ranges from 3.47 to 14.19 mm (mean = 6.56 mm), width ranges from 2.67 to 9.64 mm (mean = 4.32 mm), and thickness ranges from 1.18 to 6.93 mm (mean = 3.02). Where the seed consists of a single cotyledon, the thickness measurement refers to half of the actual thickness. To calculate the mean thickness, I doubled the measurement of each of the single cotyledons. The majority of the incomplete specimens would have fallen within these ranges.

Most of the Phaseolus remains are probably P. vulgaris, judging by similar descriptions of shape and size in published reports of beans recovered from other archaeological sites (eg. Kaplan 1967; Smith 1979). They vary in shape from reniform to rectangular (see Figure 4.3). The numerous small round-oval specimens in samples 137 and 138 (Figure 4.3, top row) may be seeds of P. acutifolius, which are generally smaller than those of other cultivated beans. The present distribution of this species – from the

Table 4.3. *Phaseolus* spp. seed measurements.

No./Site/Phase	L (mm)	W (mm)	T (mm)	Size index	No./Site/Phase	L (mm)	W (mm)	T (mm)	Size index
25/ A.S./ Cu	13.93	9.64	6.93	134.29	138/ Paso/ O	5.15	3.50	1.28*	18.03
25/ A.S./ Cu	8.92	6.97	3.90	62.17	138/ Paso/ O	5.10	3.26	1.24*	16.63
25/ A.S./ Cu	7.10	4.87	3.11	34.57	138/ Paso/ O	5.20	3.41	1.18*	17.73
15/ A.S./ Ch	14.19	7.05	3.42	100.44	138/ Paso/ O	5.04	3.08	2.70	15.52
32/ A.S./ Ch	11.20	6.04	2.71*	67.65	138/ Paso/ O	4.48	3.30	2.83	14.78
38/ A.S./ Ch	10.57	7.51	4.13	79.38	138/ Paso/ O	4.91	3.37	2.10	16.55
39/ A.S./ Ch	12.43	7.74	4.05	96.21	138/ Paso/ O	5.08	3.47	2.28	17.63
2/ A.S./ O	5.23	3.25	2.12	17.00	138/ Paso/ O	5.74	4.01	2.02	23.02
49/ A.S./ O	7.57	4.00	1.80*	30.28	138/ Paso/ O	5.17	3.28	1.21*	16.95
49/ A.S./ O	5.19	3.78	3.24	19.62	138/ Paso/ O	5.02	3.78	1.32*	18.98
61/ A.S./ O	11.76	8.21	3.45	96.54	138/ Paso/ O	4.96	3.51	1.19*	17.40
61/ A.S./ O	8.58	5.81	4.15	49.84	138/ Paso/ O	4.98	3.26	1.26*	16.23
61/ A.S./ O	7.12	4.45	4.15	31.24	138/ Paso/ O	5.21	3.27	1.24*	17.03
65/ A.S./ O	5.53	3.87	1.77*	21.40	138/ Paso/ O	5.03	3.11	1.18*	15.64
66/ A.S./ O	5.98	4.31	3.12	25.77	138/ Paso/ O	5.28	3.32	1.09*	17.53
73/ A.S./ O	6.30	4.57	2.03	28.80	138/ Paso/ O	4.99	3.19	1.11*	15.91
74/ A.S./ O	8.78	5.55	4.47	48.73	138/ Paso/ O	5.22	3.46	1.24*	18.06
74/ A.S./ O	5.19	2.88	1.69	14.95	138/ Paso/ O	5.20	3.21	1.25*	16.70
78/ A.S./ O	8.20	5.23	3.68	42.89	138/ Paso/ O	4.95	3.13	1.18*	15.49
78/ A.S./ O	6.36	4.74	3.00	30.15	138/ Paso/ O	4.87	3.21	1.16*	15.63
78/ A.S./ O	9.36	5.60	3.17	52.42	138/ Paso/ O	4.91	3.27	1.06*	16.06
153/ A.S./ O	7.49	5.18	4.89	38.80	138/ Paso/ O	5.04	3.23	1.25*	16.27
153/ A.S./ O	11.99	6.88	2.19*	82.49	138/ Paso/ O	5.17	3.20	1.18*	16.54
137/ Paso/ O	6.22	4.30	1.93*	26.75	138/ Paso/ O	4.89	3.04	1.21*	14.87
137/ Paso/ O	3.80	3.14	1.31*	11.93	138/ Paso/ O	4.92	3.11	1.12*	15.30
137/ Paso/ O	4.72	3.81	1.42*	17.98	171/ Chilo/ L	5.07	3.25	1.64	16.48
137/ Paso/ O	4.79	3.62	1.77*	17.34	173/ Chilo/ L	6.39	3.86	2.03	24.67
137/ Paso/ O	4.60	3.65	1.48*	16.79	179/ Chilo/ L	3.47	2.67	1.38*	9.26
138/ Paso/ O	6.93	5.13	4.72	35.55	187/ Chilo/ L	9.01	5.35	1.85*	48.20
138/ Paso/ O	6.54	5.05	4.57	33.03					

No. = sample number

A.S. = Aquiles Serdán; Paso = Paso de la Amada

Cu = Cuadros; Ch = Cherla; O = Ocos; L = Locona

L = length; W = width; T = thickness

An asterisk (*) indicates that only one cotyledon is present.

The size index is computed by multiplying length and width.

Sonora desert south through Jalisco, then a gap until the Tapachula-Guatemala border region – suggests that this is a relic distribution (Kaplan 1967:201), in which case the species may have occurred in the Mazatán area as early as the Early Formative period.

A good indicator of the domesticated status of a plant is seed size, since seeds of domesticated taxa are always larger than the seeds of the most closely allied wild species (Kaplan 1967:203). It is possible that these beans were domesticated, but because no wild specimens were available for comparison, some uncertainty remains. The Phaseolus spp. identifications were made on the basis of archaeological specimens at the paleoethnobotanical laboratory at U.N.A.M., where the various sizes and shapes of P. vulgaris corresponded to the diverse set of seeds from the sites under consideration in this study.

Persea americana (avocado, aguacate; family Lauraceae)

The avocado is the most commonly cultivated species of the genus Persea of the laurel family (Hodgson 1950:254). Several other species occur in Mexico but the majority produce inedible fruits with little other value (McClung de Tapia 1979:149). The fruits of the avocado tree are valued for their flavor and their unusually high nutritive and dietetic properties. The fat content is 5 to 25% of the fruit, and the average protein and mineral content is 2 to 3 times as high as in other fresh fruits. The caloric value is approximately 2.5 times as high as in other fruits, almost as high as in cereals, and far higher than in lean meat. In terms of vitamins, it is high in B-complex factors, good in A and E, fair in D, and low in C (Hodgson 1950:287).

There are three ecological races of P. americana. The Mexican race (P. americana var. drymfolia) is actually a botanical variety of this species, and it is the hardiest of the three groups. It is native to the highlands of Mexico and mountains of Central America and extends south as far as Chile. This variety is characterized by an anise odor in the leaves, young growth, and fruits. Fruits range from 3 to 12 ounces and have a thin

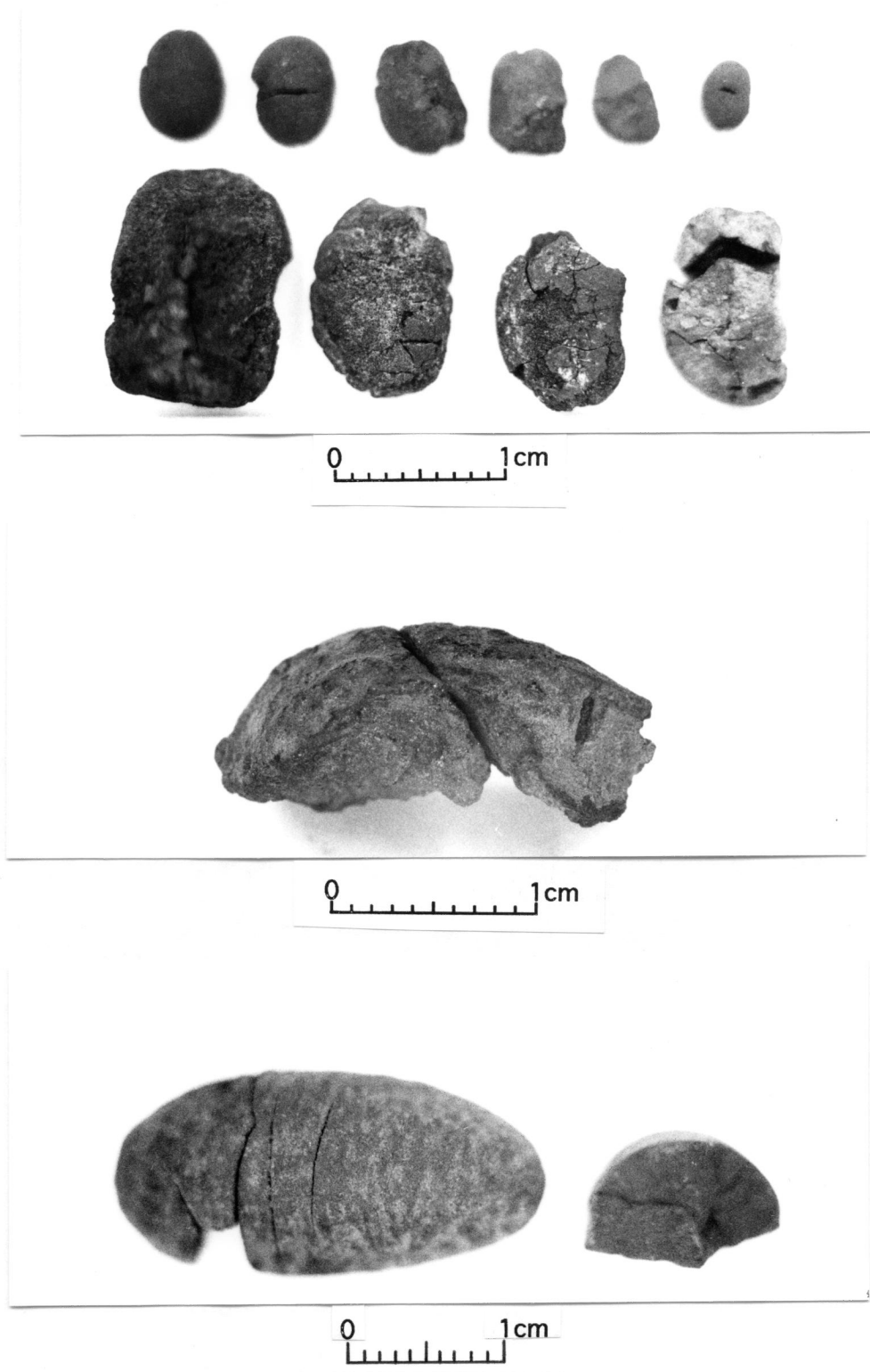


Figure 4.3. *Phaseolus* spp. (top), *Persea americana* (center), and *Persea* sp. (bottom).

smooth skin and a comparatively large seed with smooth cotyledon surfaces.

P. americana includes varieties grouped in both the Guatemalan and West Indian races. The Guatemalan race is native to the highlands of Central America and extends to northern South America. It lacks the anise odor and the larger fruits (from 8 ounces to 3 pounds) have a thick, brittle, hard, warty rind. The seed is large to small, with smooth cotyledon surfaces. The West Indian race, native to the Central American lowlands and northern South America, also lacks the anise odor. Its fruits are generally large, with a smooth, leathery and usually glossy rind. The seed is comparatively large, with rough cotyledon surfaces. This is the least hardy of the three groups (Hodgson 1950:256).

Fruit of the West Indian and Mexican races generally matures considerably earlier and has a much shorter season than that of the Guatemala race. However, because the various races and varieties of avocados differ in their heat requirements, location has a great effect on the periods of blossoming and fruit maturation. Fruit in the Mexican race, for example, normally ripens in late summer or fall of the year of blossoming, but in coastal areas, where flowering commonly occurs in late fall, the fruit ripens the following summer or fall (ibid. p.267). Some varieties of the Guatemalan race mature in summer, while others mature in fall, winter or spring.

All of the avocado seeds recovered from Aquiles Serdán, Paso de la Amada and Chilo are incomplete and most are in fragmentary condition (see Figure 4.3). In a few cases, there are numerous fragments that probably represent a single seed but I was unable to reconstruct them sufficiently to determine either shape or size. The larger fragments suggest that the seeds were spherical. If this were the case, extrapolation of the surface curve suggests that seed diameters were approximately three centimeters.

My identifications were made on the basis of comparisons with P. americana specimens from excavations at Teotihuacán in repository at the paleoethnobotanical laboratory at U.N.A.M. It is difficult to say which races are represented by the seeds from the Mazatán-area sites. Seed size and cotyledon surface are the potential indicators

of race for archaeological specimens. The fragmentary nature of the seeds precludes use of the former indicator. Cotyledon surface generally appears to be slightly roughened, which would suggest the West Indian race native to the Central American lowlands. However, this characteristic could be due to the effects of charring and post-depositional processes. A smooth cotyledon surface would imply either the Guatemalan or the Mexican race.

It is also difficult to say whether these seeds represent domesticated trees. A discernible trend toward larger fruit, as represented by the seeds, cannot be detected by this small sample and the fragmentary nature of the seeds. In addition, I had no wild specimens with which to compare these seeds. Domesticated, cultivated or simply collected, the avocado was evidently an economically important tree crop.

Several examples of another seed tentatively identified as Persea sp. were recovered from the same three sites. These are similar to P. americana but are elongated or ovoid, not spherical, in shape. One complete (but broken) seed has a length of 26.93 mm and a diameter of 13.87 mm at the widest point (see Figure 4.3). One complete (but broken) cotyledon is 26.78 mm long, 13.86 mm wide, and 7.56 mm thick. Fragments of other seeds indicate measurements within a similar range.

It is possible that these are P. americana var. drymifolia of the Mexican race. Smith (1966) and Smith (1979) report both spheroid and elongated seeds of this variety from sites in the Tehuacán Valley and the Cuicatlán Cañada in Oaxaca. However, Smith (1969) describes predominantly elongated seeds from the Valley of Oaxaca which are probably not of the drymifolia variety. It appears that seed shape cannot be used as a reliable indicator of race. Because I had no archaeological examples of the elongated variety for comparative purposes, I was hesitant to assign a species identification to the elongated seeds. I found very similar seeds that were identified simply as Persea sp. among the vouchered specimens at the herbarium of the Instituto de Biología at U.N.A.M. Breedlove (1986:124) lists 13 species of Persea in his Flora de Chiapas, not

including the two varieties of P. americana. Biologist Gilda Ortiz (U.N.A.M.) told me (personal communication 1992) that it is often very difficult to identify this genus to species, and I therefore decided to leave these identifications at the generic level.

Mollugo sp. (carpetweed, anisillo, culantrillo; family Aizoaceae)

Seeds identified as Mollugo sp. were recovered from Aquiles Serdán, Chilo, and San Carlos. These small (mean length = 1.60 mm, width = 1.31 mm, thickness = 0.90 mm) seeds are from weedy field plants in the carpetweed family, and probably do not represent a human food source. They may instead represent plants growing in areas under cultivation. Smith (1981) identified this genus in Formative period deposits in the Oaxaca Valley. My identification was made on the basis of comparison with vouchered specimens at the Instituto de Biología at U.N.A.M. The archaeological seeds are quite similar to M. verticillata, although they are somewhat larger (see Figure 4.4). This is the only Mollugo species that Breedlove (1986:31) lists in Flora de Chiapas.

Polygonum sp. (knotweed, chilillo, moco de pavo; family Polygonaceae)

A single charred seed of the genus Polygonum (buckwheat family) was recovered from a Locona phase deposit at Paso de la Amada. It measures 0.87 mm in length and 0.60 mm in width and thickness (see Figure 4.4). A number of uncharred modern seeds were also found at Paso, as well as at San Carlos. While the charred seed might also be modern, one would expect to find Polygonum spp. (and other plants whose preferred habitats are moist, marshy areas) around Paso, considering that the bajos and low-lying areas probably held water for a good part of the year and would have supported such species. Various species of Polygonum are considered weeds and are noted for their persistence and competitive ability in disturbed areas around buildings and in cultivated fields. Pearsall (1980:200) describes medicinal uses for some species, and reports that others are used as herbs or their roots were consumed. Breedlove (1986:159) lists nine

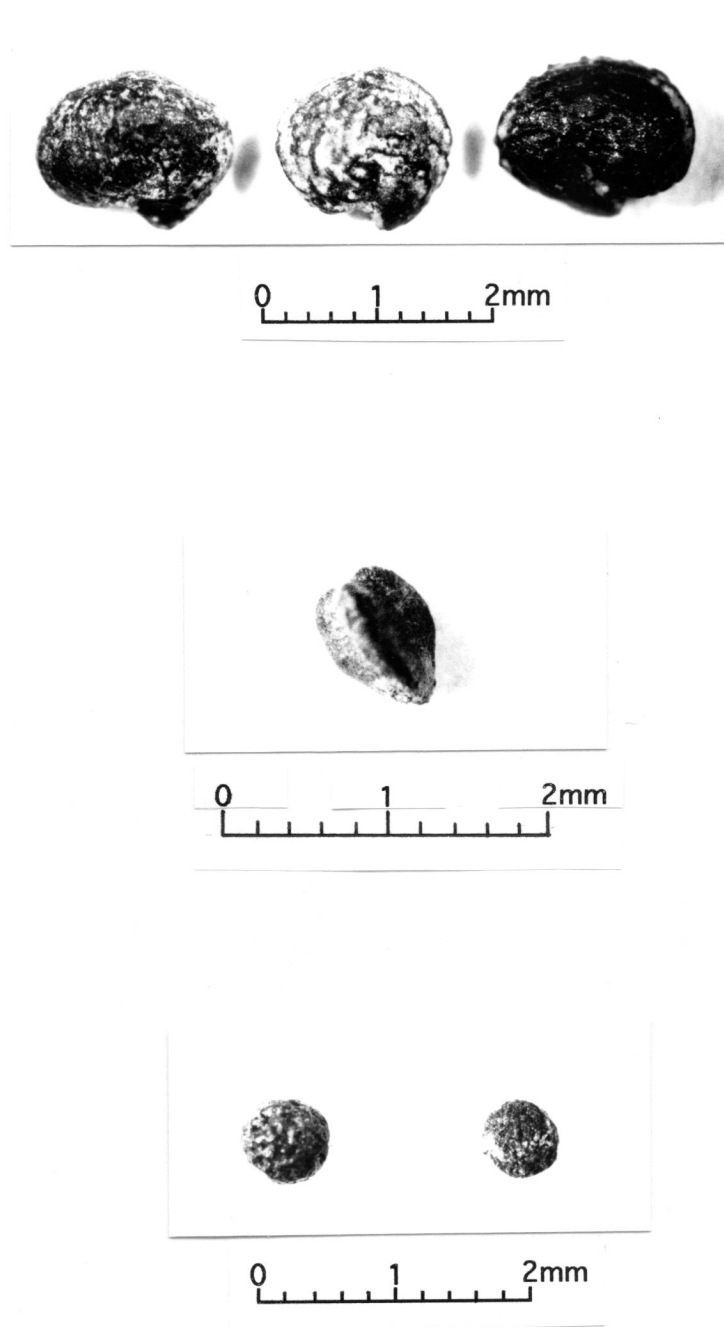


Figure 4.4. *Mollugo* sp. (top), *Polygonum* sp. (center) and *Brassica* sp. (bottom).

species of Polygonum which have been documented for Chiapas. My identification was made by comparing this distinctive triangular-shaped seed with Polygonum seeds at the herbarium of the Instituto de Biología and with photographs in Martin and Barkley (1961).

Brassica sp. (mustard, mostaza; family Cruciferae)

Two charred seeds of the genus Brassica (mustard family) were identified from Locona deposits at San Carlos. These measure 0.66 mm and 0.61 mm in diameter (see Figure 4.4). Several species of Brassica are important food plants, but most of these have Old World origins. Other species are weedy plants that inhabit fields, gardens, roadsides and disturbed areas (Harlan 1975:68; Heizer 1981:194; Martin and Barkley 1961:9).

Breedlove (1986:78) lists four species of Brassica for Chiapas. None of those which I examined at the herbarium of the Instituto de Biología matched the archaeological seeds completely, and I therefore left the identification at the generic level.

Unidentified

Much of the charred plant material recovered from the flotation samples remains unidentified. In most cases this material consists of small fragments which lack distinguishing characteristics and are probably unidentifiable (Emily McClung de Tapia, personal communication 1992). Of the few relatively complete seeds, there was no more than one of each type. I attempted to identify these by comparing them with archaeological, ethnographic and vouchered biological specimens at U.N.A.M. and with photographs and descriptions in illustrated seed manuals (Gunn 1977; Martin and Barkley 1961; Montgomery 1977), but most were either badly weathered or lacked key distinguishing features.

DATA PRESENTATION AND QUANTIFICATION

Methods for presenting and quantifying the botanical data are constrained to a large degree by the nature of the data. As indicated in Chapter Three, botanical remains recovered from archaeological contexts provide, at best, an indirect reflection of plant resource utilization by ancient human populations. We cannot assume that recovered plant remains occur in the proportions actually consumed. Differential patterns of preparation and utilization of plants influence the amounts of material that will be preserved, as well as the parts of the plants that will be discarded and possibly preserved. Post-depositional processes and differential rates of preservation further affect the representation of plant remains (Begler and Keatinge 1979:221).

Given these differing circumstances of deposition and preservation, statistical treatment of archeobotanical data for the purpose of reconstructing prehistoric dietary and subsistence practices is very problematical. Quantification by absolute counts (the number of each taxon in each sample) is generally of limited use, although standardization (converting counts into ratios, such as the number or weight of charred items per volume of processed sediment) can help to even out differences in sample size or sample abundance (Popper 1988:60). The failure to record the volume of soil processed in this project, as noted in Chapter Three, precludes consideration of this potentially useful method.

The absolute counts in Table 4.4 provide a summary of the raw data and an indication of the quantity of recovered botanical remains from each sample, but they are not intended to accurately reflect the prehistoric use or importance of specific plants. The counts are often misleading, since they refer to tiny fragments as well as whole seeds. Fourteen fragments may be part of a single seed, or they may represent fourteen different seeds. Determination of the minimum number of individuals of a particular species, as attempted by MacNeish (1967) and Pozorski (1976), is probably impossible. Except for wood charcoal, I do not include weights because in most cases they are negligible.

Table 4.4. Absolute counts of recovered archeobotanical remains.

No.	Site/ phase	<u>Zea</u> mays	<u>Phaseolus</u> spp.	<u>Persea</u> americana	<u>Persea</u> sp.	<u>Mollugo</u> sp.	<u>Polygonum</u> sp.	<u>Brassica</u> sp.	Unident- ified	Char- coal
7	A.S./ Cu	1							1	
9	A.S./ Cu								1	
22	A.S./ Cu								1	0.01
23	A.S./ Cu								2	
25	A.S./ Cu	5	5	7	1				7	3.35
41	A.S./ Cu	1							11	0.14
42	A.S./ Cu					1			3	
57	A.S./ Cu	2			1				5	
62	A.S./ Cu	1								0.03
67	A.S./ Cu	2	1						2	
1	A.S./ Ch	3							8	0.14
10	A.S./ Ch								1	
11	A.S./ Ch								1	0.04
12	A.S./ Ch									0.09
13	A.S./ Ch	11							6	0.02
15	A.S./ Ch	12	7	1					17	0.10
17	A.S./ Ch	3			2				56	0.16
19	A.S./ Ch	11	2						15	0.05
20	A.S./ Ch				1				4	0.39
26	A.S./ Ch	14							4	0.56
28	A.S./ Ch	12							7	0.10
30	A.S./ Ch	22							27	0.32
32	A.S./ Ch	31	7						20	0.32
33	A.S./ Ch	9		1					10	0.26
37	A.S./ Ch								2	
38	A.S./ Ch		4						3	0.23
39	A.S./ Ch		1		1				7	0.25
40	A.S./ Ch	4							13	0.09
43	A.S./ Ch	5							14	0.12
2	A.S./ O	188	1	45					41	6.72
3	A.S./ O								2	0.10
4	A.S./ O	10		4					20	5.07
5	A.S./ O	5							9	0.43
21	A.S./ O	1				1			2	
27	A.S./ O	1							1	0.10
29	A.S./ O								12	0.26
31	A.S./ O	10							5	1.05
34	A.S./ O	233		4	5				2	2.17
35	A.S./ O	20			3	3			12	0.85
36	A.S./ O	21								0.81
44	A.S./ O	1								0.06
45	A.S./ O	4							13	0.63
46	A.S./ O	1		1					6	0.55
49	A.S./ O	35	3	5					23	26.64
50	A.S./ O	17	1			1			4	10.64
51	A.S./ O								1	0.26
55	A.S./ O								10	0.08
56	A.S./ O	5							10	0.05
58	A.S./ O	2	2						7	0.18
59	A.S./ O	5							7	0.92
60	A.S./ O									0.01
61	A.S./ O	212	14	6					41	10.43

Table 4.4. Absolute counts of recovered archeobotanical remains.

No.	Site/ phase	<u>Zea</u> mays	<u>Phaseolus</u> spp.	<u>Persea</u> <u>americana</u>	<u>Persea</u> sp.	<u>Mollugo</u> sp.	<u>Polygonum</u> sp.	<u>Brassica</u> sp.	Unident- ified	Char- coal
63	A.S./ O	5							3	0.12
64	A.S./ O	99	6						16	1.28
65	A.S./ O	74	7	5					5	1.01
66	A.S./ O	141	9	5					40	1.15
69	A.S./ O		1						3	0.01
70	A.S./ O								3	0.09
71	A.S./ O	3	1						10	0.38
72	A.S./ O	6	1						7	0.14
73	A.S./ O	40	5						15	2.61
74	A.S./ O	96	9	18	3				9	5.83
75	A.S./ O	1		20					1	0.07
76	A.S./ O	7								0.08
77	A.S./ O	2							1	0.05
78	A.S./ O	30	5						11	1.31
81	A.S./ O								1	
83	A.S./ O	2							23	0.25
84	A.S./ O									0.10
85	A.S./ O								5	0.01
86	A.S./ O	1							8	0.07
153	A.S./ O	38	7	9					7	3.32
154	A.S./ O								1	
155	A.S./ O								7	
151	PASO/ Ch	1								
101	PASO/ O	53		1					11	0.03
132	PASO/ O	1								
133	PASO/ O	3		2					6	
134	PASO/ O	140							10	
135	PASO/ O			4					3	0.02
136	PASO/ O		1		1					
137	PASO/ O		16						1	
138	PASO/ O		109						9	
87	PASO/ L		1				1			0.33
88	PASO/ L								2	0.02
90	PASO/ L									0.02
91	PASO/ L									0.08
92	PASO/ L	25							11	0.18
93	PASO/ L	6							6	0.05
94	PASO/ L	1							3	0.01
95	PASO/ L	3							1	0.02
96	PASO/ L	2							7	0.06
97	PASO/ L									0.03
98	PASO/ L								6	0.08
125	PASO/ L								2	
129	PASO/ L								1	
130	PASO/ L		2							
131	PASO/ L			9						
139	PASO/ L			2						
142	PASO/ L			1						
144	PASO/ L								1	
145	PASO/ L								1	0.04
147	PASO/ L			18						

Table 4.4. Absolute counts of recovered archeobotanical remains.

No.	Site/ phase	<u>Zea</u> mays	<u>Phaseolus</u> spp.	<u>Persea</u> americana	<u>Persea</u> sp.	<u>Mollugo</u> sp.	<u>Polygonum</u> sp.	<u>Brassica</u> sp.	Unident- ified	Char- coal
148	PASO/ L								14	
149	PASO/ L			3						0.14
102	PASO/ B	8								0.02
103	PASO/ B	22								0.02
162	CHILO/Ch	7				1			29	0.22
174	CHILO/Ch	8				1			16	0.03
163	CHILO/ O	8							21	0.01
165	CHILO/ O								5	0.01
170	CHILO/ L	10							23	0.76
171	CHILO/ L	24	5			1			30	2.15
172	CHILO/ L	16				1			28	2.23
173	CHILO/ L	10	7			1			13	0.72
178	CHILO/ L	10				1			24	0.49
179	CHILO/ L	20	1			1			21	2.04
180	CHILO/ L	13	15						10	0.72
181	CHILO/ L								24	0.18
182	CHILO/ L	311				2			16	0.69
183	CHILO/ L	27		2					12	0.17
186	CHILO/ L	11			1				27	1.77
187	CHILO/ L	20	1						12	0.98
114	S.C./ J								3	
109	S.C./ L									0.01
111	S.C./ L	1							5	0.10
116	S.C./ L								4	0.02
118	S.C./ L								7	0.04
119	S.C./ L					1		1	9	0.01
104	S.C./ B								3	0.08
105	S.C./ B									0.08
108	S.C./ B	27				1			10	0.18
152	S.C./ B	26				2				
Totals		2280	256	173	19	19	1	2	1126	107.50

No.: sample number.

Sites: A.S. = Aquiles Serdán; PASO = Paso de la Amada; S.C. = San Carlos

Phases: J = Jocotal; Cu = Cuadros; Ch = Cherla; O = Ócós; L = Locona; B = Barra

Counts include whole and fragmented specimens.

Wood charcoal is measured in grams.

For common English and Spanish names, see "Description of Recovered Taxa" in this chapter.

Inference based upon simple identification of species present in archaeological contexts is probably the most reliable and useful approach to the quantification of archeobotanical data. Ubiquity or presence analysis minimizes the impact of absolute quantity on the evaluation of taxon importance by looking at overall trends in taxon occurrence (Pearsall 1989:212-14).

The ubiquity of a particular taxon refers to the number of samples in which the taxon appears within a group of samples (Ford 1979:305; Popper 1988:60). A taxon is scored present or absent in each sample; the actual number of times it occurs is not counted. The frequency score is the number of samples in which the taxon is present expressed as a percentage of the total number of samples in the group. If avocado seeds occur in 2 of 10 samples in a particular group, avocado receives a frequency score of 20%, regardless of how many actual seeds or fragments of seeds occur in each sample.

In this analysis, samples are grouped in what I call "component groups". This term refers to all samples deriving from a particular chronological phase at a particular site. For example, the 22 Locona-phase samples from Paso de la Amada constitute one component group; the 8 Ocós-phase samples from the same site constitute another. These are distinct from Ocós and Locona-phase samples from other sites. The score of a taxon in one group does not affect the score of another taxon in the same group, or in any other group; they are independent. A single frequency score has significance only in comparison with other scores of the same taxon. We can say that maize is more ubiquitous in Ocós-phase samples from Aquiles Serdán than from Cuadros-phase samples from the same site, or from Ocós-phase samples from Paso de la Amada. However, it is difficult to make direct comparisons of the absolute importance of this taxon between different sites or time periods, and even more difficult to compare the importance of two

Table 4.5. Ubiquity of identified taxa: occurrence and frequency scores.

Site/ Phase	No.	<u>Zea</u> <u>mays</u>		<u>Phaseolus</u> <u>spp.</u>		<u>Persea</u> <u>americana</u>		<u>Persea</u> <u>sp.</u>		<u>Mollugo</u> <u>sp.</u>		<u>Polygonum</u> <u>sp.</u>		<u>Brassica</u> <u>sp.</u>	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
<u>A.S.</u>															
Cuadros	10	6	60	2	20	1	10	2	20	1	10	—	—	—	—
Cherla	19	12	63	5	26	2	11	3	16	—	—	—	—	—	—
Ocós	45	33	73	15	33	11	24	3	7	3	7	—	—	—	—
<u>PASO</u>															
Cherla	1	1	100	—	—	—	—	—	—	—	—	—	—	—	—
Ocós	8	4	50	3	38	3	38	2	50	—	—	—	—	—	—
Locona	22	6	27	1	5	5	23	—	—	—	—	1	5	—	—
Barra	2	2	100	—	—	—	—	—	—	—	—	—	—	—	—
<u>CHILO</u>															
Cherla	2	2	100	—	—	—	—	—	—	2	100	—	—	—	—
Ocós	2	1	50	—	—	—	—	—	—	—	—	—	—	—	—
Locona	12	11	92	5	42	1	8	1	8	6	50	—	—	—	—
<u>S.C.</u>															
Jocotal	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Locona	5	1	20	—	—	—	—	—	—	1	20	—	—	2	40
Barra	4	2	50	—	—	—	—	—	—	1	25	—	—	—	—
Total	133	81		31		23		11		14		1		2	

No.: number of samples for each component group which yielded archeobotanical remains.

#: occurrence (the number of samples in which the indicated taxon is present).

%: frequency score (the number of samples in which the taxon is present, expressed as a percentage of the total number of samples in the component group). This score has been rounded off to the nearest percentage point.

A.S.: Aquiles Serdán; PASO: Paso de la Amada; S.C.: San Carlos.

or more taxa, given the inherent problems in the representation of plant remains.

Table 4.5 shows the occurrence and frequency scores of the identified archeobotanical taxa for each component group. Because of the small number of samples in some groups, some of the frequency scores may be inflated. For example, the frequency score for maize in the Chilo/Cherla component group (100%) is higher than that in the Aquiles Serdán/Ocós group (73%), but the former score is based on 2 samples while the latter is based on 33. Obviously, interpretations must be cautiously drawn when there are few samples in a group.

DISCUSSION

Taking into consideration the many unknown factors of utilization, deposition, post-deposition, and preservation that influenced the quantity and distribution of the recovered macroremains, a few points can be made regarding observed patterns or trends in the data.

Of the seven identified taxa, maize is clearly the most ubiquitous (see Table 4.5). It occurs in 81 of the 133 samples that yielded macrobotanical remains, and is present in samples from each of the five chronological phases represented (because no identified macroremains were recovered from the single Jocotal phase sample, I am excluding this phase from the discussion). The small number of Barra phase samples does not permit us to conclude much more than the fact that maize was present – at Paso and San Carlos – during this phase. Its ubiquity (100% at Paso and 50% at San Carlos) for these component groups is probably inflated and should not be used for comparative purposes. However, the presence of maize in the Barra phase is important, since evidence for this cultigen prior to the Locona period had not been previously documented.

The ubiquity scores of maize in subsequent phases is probably somewhat more representative of its occurrence. We have more samples for these phases, especially for the Locona phases at Paso and Chilo and the Ocós, Cherla and Cuadros phases at

Aquiles Serdán. There is, however, no indication of an observable trend toward increased use of maize over time. If we exclude the phases for which there are few samples (Locona at San Carlos, Ocós at Chilo, and Cherla at Paso and Chilo), we get a percentage presence that varies from 27% - 92% (Locona), to 73% (Ocós), to 63% (Cherla), to 60% (Cuadros). There is also little evidence for greater use of maize at particular sites. Aquiles Serdán demonstrates the most consistently high ubiquity, but this may have more to do with the number of samples – and with the nature of the midden context from which the samples were recovered – than with a greater utilization of maize.

Beans and avocados are the other two most ubiquitous taxa, occurring in 31 and 23 of the 133 samples, respectively. Both of these cultigens occurred at Aquiles Serdán, Paso and Chilo (but not San Carlos), from samples dating to the Locona, Ocós, Cherla and Cuadros phases. The absence of beans and avocados in the Barra phase samples may indicate that these plants were not being used, but it may also be attributed to the small number of samples from this phase. At Chilo, these taxa only occur during the Locona phase, but again it is inadvisable to draw conclusions about their absence in the other phases with the limited number of samples available.

Based on the frequency scores presented in Table 4.5, one might be inclined to conclude that maize was more important than beans, and that beans were more important than avocados. As noted above, it is very difficult to make this kind of comparison between different taxa. We must consider factors such as seasonality and availability, methods of preparation, consumption, and deposition, and differential preservation of plant remains. Was one kind of plant food prepared and consumed in an area where long-term preservation would be more likely to occur? Did consumption usually occur outside, with refuse (such as avocado seeds) being tossed away from the house? What was thrown into the hearth, and what accidentally survived being completely burned? What effect did our sampling strategy have on recovery rates?

We can only speculate on answers to questions such as these, drawing on modern analogies of food production, consumption and discard practices. Ethnoarchaeological studies (eg. Lee and Hayden 1988; Hayden and Cannon 1983, 1984) may prove to be very helpful in interpreting the material remains of activities related to plant use. At this point, all that can be said with certainty is that these plant foods are present in the archaeological record and were probably significant dietary components. If they were infrequently used, it is less likely that they would appear so consistently across such an extended time period at all of these sites.

Summarizing by phase, we can say that maize was present by the Barra phase, and that maize, beans and avocados were present in samples dating to all of the other four phases represented. Mollugo sp. occurs in all five phases, and Polygonum sp. and Brassica sp. occur in the Locona phase. The co-occurrence of these weedy species with maize, beans and avocado is not surprising, given their propensity to grow in areas disturbed by cultivation.

CHAPTER FIVE CONCLUSIONS

REVIEW OF OBJECTIVES AND RESULTS

The recovery and analysis of archaeobotanical remains in this study was directed by questions regarding Early Formative subsistence practices in the Mazatán area of southeastern Mesoamerica. It was proposed that cultivation of indigenous food plants was an important component in the Mokaya subsistence economy prior to the introduction of non-local domesticated food plants. This development probably occurred as a gradual progression from casual to more deliberate cultivation of favored plant species. Incentives for such practices may have been related to nutrition, availability, efficiency, and/or storability. The adoption of non-local domesticates may have occurred for similar reasons. It may also have occurred for reasons related to emerging sociopolitical complexity. The research questions generated by this hypothesis focused on two stages of the local agricultural process: the origins of local cultivation practices of indigenous plant species, and the adoption of non-local domesticated species. In this chapter, I review these questions on the basis of the study results.

Local developments

Several of the questions relating to the origins of local cultivation practices can now be addressed, at least in a preliminary way. One of the objectives of this project was to determine some of the particular species of lowland food plants that were being used, cultivated and/or domesticated by Early Formative people in the Mazatán area. Characteristics of the local environment and reports of species recovered from archaeological deposits in similar biogeoclimatic zones suggest that some of the following species might be expected to occur: root crops such as manioc or sweet potatoes; tree fruits such as plums, avocados, nance, zapote, coyol, cacao, guava and

papaya; and herbaceous plants such as tomatoes, chili peppers, cucurbits and beans. Domesticated forms of some of these species could also occur. A Mesoamerican domestication has been postulated for avocados, tomatoes, some species of cucurbits, chili peppers and beans, and possibly papaya, manioc and cacao, although the specific areas of origin are still under much debate (Heiser 1990; Stone 1984).

As indicated in Chapter Four, fragments of avocado seeds were identified from the recovered macroremains. The avocado was probably a local arboreal species. It may have been wild, with people simply collecting the fruit as it ripened and/or employing certain cultivation techniques for increased productivity or efficiency, but it may also have achieved domesticated status around this time. Beans were also identified, and comparison of their size ranges with other domesticated (archaeological and modern) examples strongly indicates that at least some domesticated species were being used. While beans are frequently considered to have been domesticated in highland areas (probably because the earliest domesticated specimens in Mesoamerica were recovered from highland areas such as the Tehuacán Valley), there is no evidence for a specific area of origin (Kaplan 1967:210) and we should not reject the possibility that some species may have been locally domesticated. In any case, they were certainly being cultivated by the Locona phase and through the Early Formative period.

How important were these cultigens in the local subsistence economy? It is impossible to provide an answer to this question with the limited data recovered from this study. However, given the consistency through time and space in their archaeological ubiquity, it would not be unreasonable to assume that they were crops of at least some economic significance. At the very least, they provide strong evidence for a mixed economy that included gathering and cultivation of plant foods in addition to previously documented evidence for fishing and hunting.

Do the recovered data provide any indications of why the development of local cultivation practices occurred? In Chapter Two I discussed several possible incentives

relating to nutrition, availability, efficiency or convenience, and storability. Avocados are certainly high in several nutrients, and their oil content would have provided a comparable alternative to animal fats. Their seasonal availability would have been dependent upon the particular races and varieties being cultivated or harvested, as well as on climatic characteristics and bearing patterns. Under certain conditions, ripe fruit may have been available throughout much of the year. The planting or transplanting of avocado trees close to the household would have permitted efficient harvesting of the fruit as it ripened and as required by household needs. Mature avocado trees can produce great quantities of fruit and, while long-term storage is generally poor, a good harvest would produce more than enough for the needs of a single household.

Beans are also highly nutritious, especially in their protein and caloric values. If there was differential access to preferred fishing and hunting areas, beans could have provided an alternate source of protein for people in less fortunate social positions. In terms of seasonal availability, beans would likely have been a wet-season crop. However, planting beans in bajos at the beginning of the dry season, or in kitchen gardens where they could be watered as necessary, would perhaps have permitted a harvest in the dry season as well. One of the unique characteristics of beans is their storability; few tropical fruits preserve for long periods under the hot and humid conditions of the coastal environment. The advantage of having a stored supply of food for future use may well have provided an incentive for their cultivation. If sociopolitical inequities were developing at this time, the creation of food surpluses – possibly involving the use of stored foods such as beans – may have been an important security strategy, as I discussed in Chapter Two.

Adoption of non-local domesticates

Maize was the only species identified from the analyzed samples that was definitely a non-local domesticated cultigen. As noted in Chapter Four, extant evidence indicates

that the center of origin of maize was well outside of the Mazatán area. Its archaeological occurrence here at this time period therefore suggests that the process of its introduction and subsequent adoption into the subsistence economy had taken place by the Barra phase. The stable carbon isotope data from Tlacuachero (Blake et al. 1992b:89) indicate that it may have taken place as early as the Chantuto B phase. If, as the hypothesis implies, the cultivation of indigenous species had begun to be practiced well prior to the adoption of non-local species, we would expect to find earlier evidence of the former. In fact, our first evidence for local cultigens occurs slightly later than for maize. Evidently, the time to look for the first occurrences of cultivation practices – as well as the introduction of non-local domesticates – is not in the Early Formative but in the Late Archaic period.

What role did maize play in the subsistence economy in the early period of its use? Was it used as a dietary staple? It would certainly have provided a good source of carbohydrates for supplementing a diet that was apparently high in animal protein. In the absence of direct evidence for other carbohydrate-rich foods, it would be reasonable to assume that maize may have been valued for this nutritive property. Little is known about its productivity at this time, but the generally small size of the recovered cob fragments suggest that it was significantly less productive than is modern maize. Size, of course, is not always the primary determinant of productivity. The cultivation of more plants could have compensated for the small size of the ears.

Stable carbon isotope data (Blake et al. 1992b) suggest that maize was not a significant dietary component during the Early Formative period. The ubiquity data presented in Chapter Four, however, present a somewhat puzzling discrepancy to these conclusions. Maize occurred in 81 of the 133 samples that yielded macroremains, and in each of the chronological phases at all four sites. While the absolute counts must be interpreted with great caution, the 2280 complete and fragmented maize specimens (Table 4.4) indicate a fairly strong presence and suggest that maize was of some economic

importance.

If maize was adopted and used not as a staple food but as a dietary supplement, the discrepancy between the isotope and the ubiquity data might be explained. Occasional or low-volume use of maize would produce relatively low $\delta^{13}\text{C}$ values but, at the same time, it could also produce large numbers of preserved plant remains.

What would have prompted the people in the Mazatán area to begin cultivating maize? The accommodation of this new species to an established cultivation regime would probably have involved little extra cost or effort; at the same time, it would have extended the diversity of the local resource base. In addition to the nutritive properties of maize, it can be successfully stored for extended periods. Perhaps, as suggested above for beans, people valued maize because it could be stockpiled for future use – to fill seasonal gaps in the availability of certain other foods, or possibly to be used in competitive feasting contexts.

In Chapter Two, I discussed the hypothesis that non-local domesticates were adopted by aspiring elites as prestige items to be used in competitive feasting contexts. The identification of maize in Barra deposits supports the implication that the first non-local species should be contemporaneous with the first indications of emerging social complexity. In general, however, the analysis failed to yield data which convincingly support the hypothesis. If maize was not a dietary staple but instead an ingredient to be used in the preparation of special beverages or for consumption in feasting contexts, the archaeological record should display a greater reliance on local food plants. While the ubiquity data indicate that the reverse was the case, it is very difficult to make such direct comparisons between different species. If maize was used primarily by elites, we might expect spatial distributions of maize remains to indicate differential use or consumption of this species. However, while some excavated structures appear to represent high status contexts, too few contexts have been excavated at any one site to provide clear indications of differences in social status. In any case, distribution of special foods or

beverages through the gift-giving or feasting complex would possibly obscure status distinctions in the archaeological record.

If maize was used as an ingredient in a special beverage such as chicha, we might expect to find material evidence for the various stages of production, as outlined in Chapter Two. Recovered maize cobs are possible indicators of the malting stage. Vessels that may have been used for soaking the kernels and stones that may have been used for grinding the jora were also recovered (Clark et al. 1987, 1990). For the cooking stage, we have hearths and charcoal. Obviously, these indicators correspond with common domestic activities and cannot be used to pinpoint a specific activity without corresponding evidence that is more exclusively related to chicha preparation. For the sieving stage, we have maize remains that might represent by-products, although it is questionable whether such by-products would have been preserved. A wet mass of soaked maize would probably have been fed to dogs or dumped in a refuse area where, uncarbonized, it would stand little chance of surviving through millennia.

Summary

The botanical data that were recovered from this study indicate that cultivation of avocados, beans and maize was practiced by Early Formative people in the Mazatán area. We still do not know exactly what contribution these plant foods made to the diet. Other archaeological data indicate that cultivation was just one part of a varied and diverse subsistence economy that emphasized faunal resources. As Lowe (1971:230) points out, the great variety of natural resources in lowland tropical areas may have worked against a greater degree of dependence upon agriculture, since "the forest dweller was always but a step removed from the possibility of a hunting and gathering subsistence, no matter how much corn he was accustomed to planting."

As Ford (1976:268) wrote, "Perhaps undue attention has been given for too long to the trinity of corn, beans, and squash". This common characterization of Mesoamerican

subsistence is derived from studies of highland areas and does not take into account the complexity and diversity of the resource base in the Mazatán area. The tropical forest habitat undoubtedly played an important role in the direction of cultural development in the Mazatán area, just as the arid thorn forest habitat did for development in the highland areas. We cannot expect that all areas would have had similar trajectories or that a single explanation can account for the variation.

Domestication and agriculture should be considered processes, not events (Pearsall 1993). While the presence of domesticated plants does not imply fully developed agriculture, it only takes a few plant remains to signal that the agricultural process is underway. Obviously, it was well underway in the Mazatán area by the beginning of the Early Formative period, and possibly much earlier. We must remember, however, that the process is not necessarily unidirectional or irreversible. There is no reason to presume that a mixed economy based on gathered and/or cultivated plant foods, fishing and hunting, as is indicated for the Early Formative Mokaya, is an intermediate stage on the "pathway to agriculture". This is too reminiscent of the fixed stages implicit in many classificatory evolutionary schemes. Many possibilities for variation and adaptation exist. Our challenge is to interpret and explain such variation, and this can best be accomplished through detailed archaeological analysis at the local level.

CONTRIBUTIONS OF THIS STUDY

This project has not provided final answers to many of the questions that it attempted to address, but the botanical data that it brings together make an important contribution to the limited knowledge of Early Formative subsistence in the Mazatán area. This is the first substantive body of archaeobotanical data to be generated for this area and time period. In fact, it is one of very few studies which document and describe plant remains from Early Formative lowland sites throughout Mesoamerica.

Elsewhere on the Pacific Coast of southeastern Mesoamerica, excavations at Salinas

La Blanca on the coast of Guatemala (see Figure 1.1) yielded mineralized maize cob fragments which date to the Cuadros phase (Coe and Flannery 1967; Mangelsdorf 1967:127). These appear to be somewhat larger than the cobs from the Mazatán area, but a larger sample from the latter is necessary before detailed comparisons can be made. Seeds from hogplum, avocado, and matasano fruits were also recovered. At nearby La Victoria, no plant remains were recovered from Early Formative deposits, although grinding tools indirectly suggest that maize agriculture was practiced (Coe 1961). Conflicting reports of recovered plant remains from El Mesak on the Guatemala coast (Pye and Demerest 1989:1; Pye 1992:37) are unclear about whether maize was present in Locona/Ocós deposits. In the Tecojate region of coastal Guatemala, ceramics decorated with maize cob impressions from the Early Formative deposits excavated at Medina indicate that maize was being cultivated, but no recovered plant remains have been identified (Arroyo 1991:11-12). At El Carmen, on the coast of El Salvador, carbonized plant remains were recovered but have not been identified (Demerest et al. 1989:5).

Across the Isthmus of Tehuantepec on the Gulf Coast, very little botanical material dating to the Early Formative period has been recovered. At the major Olmec center of La Venta, charred palm nuts were recovered from Early Preclassic deposits at Río Bari (Rust and Sharer 1988:103). At San Lorenzo Tenochtitlán, indirect evidence suggests that cultivation of maize and root crops may have occurred, but no physical remains of food plants were recovered (Coe and Diehl 1980:144). The paucity of archaeological plant remains from this area is unfortunate, given the significant role that subsistence strategies must have had in the formation of the Olmec cultural complex.

Excavations at Cuello in the tropical lowlands of northern Belize (Hammond 1991) yielded a good sample of carbonized plant remains, including maize, squash, beans, chili peppers, hogplum, nance, mamey, avocado, guava, cashew, and cacao (Miksicek 1991:72, 76). These were from Swasey phase deposits, which were originally thought to

date to the Early Formative period. However, new radiocarbon dates falling between 1100 and 400 B.C. place this phase in the Middle Formative period (Andrews and Hammond 1990:573), somewhat later than the period of primary interest here.

Outside of these tropical lowland areas, the arid conditions in the Valley of Oaxaca and the Tehuacán Valley resulted in much better preservation of plant remains. Excavations at the Archaic period site of Guilá Naquitz produced remains of piñon nuts, agave, beans, mesquite, nance, prickly pear, cucurbits, acorns, hackberry, and possibly avocado and chili peppers (Smith 1986:266). At Tierras Largas, maize and avocado were identified from Early Formative deposits (Winter 1976:31 and Fig.2.8), and excavations at Santo Domingo Tomaltepec yielded maize, teosinte, avocado, bean, chenopod, amaranth, portulaca, and mollugo from Early Formative contexts (Smith 1981:188-192). At Fábrica San José, a Middle Formative site, maize, teosinte, avocado, bean, chipil, and zapote were recovered (Ford 1976:261-266). In the Tehuacán Valley, a great variety of taxa were recovered from Archaic and Early Formative deposits, including maize, coyol, amaranth, avocado, wild and domesticated bean, mesquite, plum, prickly pear, chili pepper, cucurbit, bottle gourd, agave and cotton (Smith 1967:Table 26).

It is clear that environmental factors play a major role in the degree of preservation of plant remains, and, by extension, in our ability to address questions about subsistence and the development of agriculture. In the tropical lowland environment, where conditions generally result in poor plant preservation, our task is much more difficult. Precisely for this reason, it is imperative that archaeological projects in lowland areas include carefully designed programs for the collection and analysis of botanical data.

RECOMMENDATIONS FOR FUTURE RESEARCH

The information recovered from this project provides some insights into the plant component of the subsistence economy and has potential application to the wider research goals of the Mazatán project. This must, nevertheless, be considered a

preliminary study. More data have since been recovered that were not included in the analysis (Blake et al. 1993c; Clark and Lesure 1992) and some of the analyzed material, including the wood charcoal, remains unidentified. It is hoped that this will be the first of many such studies directed toward a better understanding of the nature and development of subsistence strategies in the Mazatán area.

All research projects are learning experiences, and this was no exception. Certain problems related to the collection and analysis of the data limit the effectiveness of the study results. In retrospect, the oversights are obvious, but then hindsight usually is much sharper than foresight.

The primary problem that I faced is a common one: the analysis of data collected by other people, for a project of someone else's design. In this case, I was working with data collected by various workers over multiple field seasons, using recovery techniques that varied from one season to another. While this presented several small problems in designing methods for analyzing the data, they were generally surmountable. One of the more serious problems concerns the preliminary processing of the data.

Where possible, standard-sized samples are generally collected for flotation. This is done to facilitate comparability of recovered remains (Pearsall 1989:98), although the various unknown factors of preservation and deposition limit the comparisons that can be made. In the sample collection stage of this project, different sizes of samples were collected because of the various natures of their contexts. Normally, this would not preclude comparisons, because density ratios (ie. the number of seeds per liter of processed soil) could still be computed. However, such ratios require that we know the volume of soil that was processed for each sample, and, as noted in Chapter Four, this was not recorded. A consistent measure of the number of maize kernels per liter of floated soil, for example, might have provided more specific information than the fact that maize is present – or, it might not. The point is that, by neglecting to record the volume of processed soil, we narrowed our available options for data quantification.

The other major problem that I faced was the lack of adequate comparative material for identification of the recovered plant remains. It is imperative that the identification strategy be planned well in advance. Ideally, the researcher should attempt to develop her/his own comparative material from plants collected in the specific research area. In my case, I lacked the time required for such a project, but the collection of seeds from common fruits in the local markets would have required little time and would have constituted a beginning. As I found out, established comparative collections are limited in their applicability to areas other than the ones for which they were established. Much time and money can be spent locating and travelling to institutions with suitable collections. There also appears to be some reluctance to make such collections available to other scholars; the general consensus seems to be that we should all develop our own.

As a final observation, I consider this to be a "paleoethnobotanical" study in the strict sense of the term – that is, the analysis of archaeological plant remains for the purpose of interpreting past human/plant relationships – but the "ethno-" aspect is admittedly rather limited. More attention to modern patterns of food production, preparation, consumption and discard is essential for drawing analogies between modern and ancient practices. Relying on ethnographic analogy presents its own problems, but it is one of our only means of interpreting the recovered data in terms of past human behavior and of generating testable hypotheses about such behavior. As I discussed in the previous chapter, recovered botanical remains provide an indirect reflection of plant use. Post-depositional processes and differential rates of preservation certainly have a great effect on how plant remains are represented in the archaeological record, but the ways in which plants are prepared, consumed and discarded are of at least equal importance in determining the amounts and types of material that will be preserved. Ethnographic observations have the potential to provide valuable insights and should probably be a standard part of any paleoethnobotanical study.

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APPENDIX ONE
FLORAL AND FAUNAL SPECIES IN THE MAZATAN AREA

LITTORAL ZONE

FLORA:

<u>Latin name</u>	<u>Spanish name</u>	<u>English name</u>	<u>Reference*</u>
<u>Achatocarpus nigricans</u>	limoncillo		P:5
<u>Avicenia nitida</u>	madresal	black mangrove	C&F:14,V:21
<u>Batis maritima</u>	saladilla		B:20
<u>Bromelia pinguin</u>	piñuela		C&F:14
<u>Bursera excelsa</u>	copal	copal	P:5
<u>Canavalia maritima</u>	frijolón		B:24
<u>Capparis indica</u>	clavelina		B:24
<u>Conocarpus erecta</u>	botoncillo		B:20,P:5
<u>Ipomoea pes-caprae</u>	pata de vaca		B:24
<u>Laguncularia racemosa</u>	mangle blanco	white mangrove	V:20,B:20
<u>Prosopis juliflora</u>	mezquite	mesquite	B:24,P:5
<u>Rhizophora mangle</u>	mangle colorado	red mangrove	V:20,B:20
<u>Salpianthus arenarius</u>	pie de paloma		B:24
<u>Swietenia humilis</u>	cóbano, zopilote	mahogany	P:5
<u>Ximenia parviflora</u>	ciruelillo		B:24

FAUNA:

<u>Agaronia testacea</u>		snail	C&F:11,P:6
<u>Ajaia ajaja</u>	espatula	(waterbird)	E&A:151
<u>Anadara reinharti</u>	pata de mula	clam	P:6
<u>Butorides virescens</u>	garcita verde	green heron	E&A:149
<u>Cardisoma crassum</u>	cangrejo azul	mouthless crab	C&F:12
<u>Caiman crocodilus</u>	caimán	cayman	E&A:148
<u>Centropomus nigrescens</u>	robalo	snook	C&F:11
<u>Chelonia mydas</u>	parlama	green sea turtle	C&F:11
<u>Chione oblitterata</u>		clam	P:6
<u>Coendou mexicanus</u>	puercoespín	porcupine	C&F:12,E&A:155
<u>Crocodylus acutus</u>	cocodrilo de río	river crocodile	C&F:11;E&A:132
<u>Ctenosaura similis</u>	iguana rayada	black iguana	C&F:11
<u>Dasypus novemcinctus</u>	armadillo	armadillo	C&F:11
<u>Eudocimus albus</u>	ibis blanco	(waterbird)	E&A:151
<u>Felis pardalis</u>	ocelote	ocelot	E&A:156
<u>Goniopsis pulchra</u>	brujo	small crab	C&F:12
<u>Lepisosteus tropicus</u>	armado	gar	C&F:129,V:23
<u>Lutjanus colorado</u>	pargo	red snapper	C&F:11
<u>Mycteria americana</u>	cigüeñón	stork	E&A:150

<u>Mytella falcata</u>	mejillón	mussel	C&F:11
<u>Ocybode occidentalis</u>	chichimeco	beach crab	C&F:11
<u>Ostrea columbiensis</u>	ostrea	oyster	C&F:11
<u>Otus cooperi</u>	tecote manglero	(owl)	E&A:153
<u>Pandion haliaetus</u>	águila pescadora	eagle	E&A:152
<u>Pelicanus occidentalis</u>	pelicano gris	grey pelican	E&A:149
<u>Polymesoda radiata</u>		marsh clam	C&F:11
<u>Procyon lotor</u>	mapache	raccoon	C&F:12,E&A:156
<u>Sciades troschelli</u>	tacazonte	marine catfish	C&F:11
<u>Sesarma sulcatum</u>	pinto	small crab	C&F:12
<u>Strombus galeatus</u>		snail	C&F:11
<u>Tamandua tetradactyla</u>	hormiguero	collared anteater	C&F:12,E&A:155

SHORT-TREE SAVANNA ZONE

FLORA:

<u>Acacia pennatula</u>	espinillo blanco		B:16
<u>Acrocomia mexicana</u>	coyol	coyol palm	B:16
<u>Alvaradoa amorphoides</u>	palo de hormiga		B:16
<u>Bursera simaruba</u>	palo mulato		E&A:111
<u>Byrsonima crassifolia</u>	nanche	nance	B:16
<u>Cordia dodecandra</u>	cupapé		B:16
<u>Crescentia cujete</u>	jícara	calabash	B:16
<u>Curatella americana</u>	cacahito		B:16
<u>Enterolobium cyclocarpum</u>	guanacaste		E&A:113
<u>Hymenoclea courbaril</u>	guapinol		E&A:110
<u>Piscidia piscipula</u>	matapiojo		B:16
<u>Quercus oleoides</u>	roble	oak	B:16
<u>Sabal mexicana</u>	palma real	fan palm	H:59
<u>Scheelea preussi</u>	corozo, manaca	corozo palm	H:59
<u>Tetracera volubilis</u>	bejuco		B:16

FAUNA:

<u>Agkistrodon bilineatus</u>	cantil	(snake)	E&A:116
<u>Burhinus bistriatus</u>	alcaraván	(waterbird)	E&A:119
<u>Ceryle torquata</u>	pescador gigante	kingfisher	E&A:121
<u>Dasyprocta punctata</u>	guateque alazán	(rodent)	E&A:125
<u>Lepus flavigularis</u>	liebre	hare	E&A:124
<u>Nasua narica</u>	tejón	coati	C&F:15
<u>Ortalis spp.</u>	chachalaca	(bird)	E&A:118
<u>Sylvilagus floridanus</u>	conejo	cottontail	C&F:15
<u>Urocyon cinereoargenteus</u>	zorra	grey fox	C&F:15

CANTILEÑA SWAMP

FLORA:

<u>Eichhornia crassipes</u>	jacinto de agua	water hyacinth	B:20
<u>Pachira aquatica</u>	zapote de agua	water zapote	B:20
<u>Pontedaria sagiata</u>	lirio de agua	water lily	P:6

FAUNA:

<u>Ajaja ajaja</u>	garza espatual	(waterbird)	P:6
<u>Anas discors</u>	cerceta	widgeon	P:6
<u>Ateles geoffroyo</u>	mono araña	spider monkey	Ab:314,E&A:140
<u>Caiman crocodilus</u>	caimán	cayman	Ab:331
<u>Centropomus sp.</u>	robalo	snook	V:23
<u>Cairina moschata</u>	patón	duck	P:6
<u>Cichlasoma timaculatum</u>	mojarra	bass	V:23
<u>Constrictor constrictor</u>	boa; mazacuata	boa	Ab:331,E&A:133
<u>Cuniculus paca</u>	tepezcuintle	spotted cavy	Aa:36,E&A:141
<u>Dasypus novemcinctus</u>	armadillo	armadillo	Ab:302,E&A:124
<u>Dendrocignas autumnalis</u>	pijiji	(waterbird)	P:6
Eleotridae (Fam.)	sambuco	(small fish)	V:23
<u>Felis pardalis</u>	ocelote	ocelot	E&A:143
<u>Fulica americana</u>	gallereta	coot	P:6
<u>Iguana iguana</u>	iguana de ribera	water iguana	E&A:133
<u>Kinosternon cruentatum</u>	casquito amarillo	soup turtle	Aa:39,V:23
<u>Lepisosteus tropicus</u>	armado	gar	V:23
<u>Nasua narica</u>	tejón	coati	Aa:36;E&A:142
<u>Odocoileus virginianus</u>	venado de campo	deer	Ab:302;E&A:127
<u>Panthera onca</u>	jaguar	jaguar	Ab:321,E&A:143
<u>Pseudemys scripta</u>	jicotea	black turtle	Ab:332,A:43
<u>Staurotypus salvinii</u>	cruzalluchi	snapping turtle	Aa:41

COASTAL PLAIN: TROPICAL DECIDUOUS AND EVERGREEN SEASONAL FORESTS

FLORA:

<u>Achras zapota</u>	chicozapote	sapodilla	C&F:14,E&A:58
<u>Annona cherimoya</u>	cherimoya	custard apple	B:16
<u>A. reticulata</u>	anona		B:16
<u>A. muricata</u>	guanábana		B:16
<u>Astronium graveolens</u>	jocotillo		B:12
<u>Brosimum alicastrum</u>	ramón	breadnut	B:12
<u>Bursera simaruba</u>	palo mulato		B:16
<u>Calycophyllum candidissimum</u>	camerón		B:16
<u>Calytranthes chiapensis</u>	pimienta		B:14

<u>Carica papaya</u>	papaya	papaya	C:49
<u>Castilla elastica</u>	hule	rubber tree	E&A:59
<u>Cedrela oaxacensis</u>	cedro	cedar	B:16
<u>Ceiba aesculifolia</u>	ceiba, pochote	ceiba	B:16
<u>Ceiba pentandra</u>	ceiba, pochote	ceiba	B:16
<u>Cordia alliodora</u>	laurel		B:16
<u>Enterolobium cyclocarpum</u>	guanacaste		B:14
<u>Eugenia acapulcensis</u>	capulín		B:14
<u>Ficus glaucescens</u>	amate prieto	black fig	B:14
<u>Godmania aesculifolia</u>	roble cachudo		B:16
<u>Hymenaea courbaril</u>	guapinol		B:14,E&A:110
<u>Ipomoea murucoides</u>	palo bobo		B:16
<u>Lafoensia puniceaefolia</u>	campana, granadillo		B:14
<u>Leucaena esculenta</u>	guaje		R&E:50
<u>Licania arborea</u>	toposte		B:14
<u>Luehea candida</u>	algodoncillo		B:16
<u>Lysiloma auritum</u>	chicharrón		B:16
<u>Persea americana</u>	aguacate	avocado	C:49
<u>Platymiscium dimorphandrum</u>	hormiguillo		B:14
<u>Psidium guayaba</u>	guayaba	guava	C:49
<u>Rheedia edulis</u>	zapotillo, limoncillo		B:14
<u>Sapium macrocarpum</u>	amatillo		B:14
<u>Spondias mombin</u>	ciruela	hog plum	B:16
<u>Sterculia mexicana</u>	castaño	chestnut	B:14
<u>Styrax argenteus</u>	capulín		B:14
<u>Swietenia humilis</u>	cóbano	mahogany	B:16
<u>Swietenia macrophylla</u>	caoba	mahogany	E&A:57
<u>Tabebuia chrysantha</u>	lombricillo		B:16
<u>T. rosea</u>	roble colorado		B:16
<u>Theobroma cacao</u>	cacao	cacao	C:49
<u>Vatairea Lundelli</u>	sacacera		B:14

FAUNA:

<u>Agriocharis ocellata</u>	pavo ocelado	wild turkey	E&A:68
<u>Agkistrodon bilineatus</u>	cantil	(snake)	E&A:116
<u>Alouatta villosa</u>	mono saraguato	howler monkey	E&A:73
<u>Ara macao</u>	guacamayo	macaw	E&A:69
<u>Aratinga canicularis</u>	cotorra	parrot	E&A:120
<u>Ateles geoffroyi</u>	mono araña	spider monkey	E&A:73
<u>Bothrops spp.</u>	nauyaca	(snake)	E&A:65
<u>Caluromys derbianus</u>	tlacuachillo	(marsupial)	E&A:70
<u>Canis latrans</u>	coyote	coyote	E&A:125
<u>Chironectes minimus</u>	tlacuachillo	(marsupial)	E&A:70
<u>Coendou mexicanus</u>	puercoespin	porcupine	E&A:75
<u>Constrictor constrictor</u>	boa, mazacuata	boa	E&A:64
<u>Crax rubra</u>	hocofaisán	pheasant	E&A:67

<u>Cuniculus paca</u>	tepezcuintle	spotted cavy	E&A:76;F:14
<u>Dasypus novemcinctus</u>	armadillo	armadillo	E&A:75
<u>Desmodus rotundus</u>	vampiro	vampire bat	E&A:71
<u>Felis pardalis</u>	ocelote	ocelot	E&A:80
<u>Felis yagouaroundi</u>	leoncillo	jaguarundi	E&A:127
<u>Galictis allamandi</u>	grisón	grison	E&A:79
<u>Harpia harpyja</u>	águila arpía	eagle	E&A:67
<u>Iguana iguana</u>	iguana de ribera	river iguana	E&A:63
<u>Lepus flavigularis</u>	liebre	hare	E&A:124
<u>Lutra annectens</u>	nutria	river otter	E&A:79
<u>Mephitis macroura</u>	zorrito rayado	hooded skunk	E&A:126
<u>Nasua narica</u>	tejón	coati	E&A:77
<u>Odocoileus virginianus</u>	venado de campo	white-tail deer	E&A:127
<u>Panthera onca</u>	jaguar	jaguar	E&A:81
<u>Potos flavus</u>	mico de noche	kinkajou	E&A:78,F:14
<u>Procyon lotor</u>	mapache	raccoon	E&A:77
<u>Ramphastos sulfuratus</u>	tucán	toucan	E&A:69
<u>Tamandua tetradactyla</u>	hormiguero	anteater	E&A:74
<u>Tapirus bairdii</u>	tapir	tapir	E&A:82
<u>Tayassu tajacu</u>	jabalí de collar	collared peccary	E&A:82
<u>Tayra barbara</u>	viejo de monte	tayra	E&A:78
<u>Urocyon cinereoargenteus</u>	zorra gris	grey fox	E&A:126

THE PIEDMONT: LOWER MONTANE RAIN FOREST

FLORA:

<u>Achras zapota</u>	chicozapote	sapodilla	L:62
<u>Annona cherimoya</u>	chiramoya	custard apple	L:62
<u>A. diversifolia</u>	papaya		L:62
<u>A. muricata</u>	guanábana		L:63
<u>A. reticulata</u>	anona		L:62
<u>Artocarpus altilis</u>	palo de pan	breadfruit	L:62
<u>Belotia mexicana</u>	capulín		B:10
<u>Brosimum alicastrum</u>	ramón	breadnut	B:8
<u>Calocaroum zapota</u>	zapote colorado	mamey	L:62
<u>Calophyllum brasiliense</u>	cedro cimarrón	brown cedar	B:10
<u>Cassia grandis</u>	caña fístula		B:8
<u>Cedrela mexicana</u>	cedro		L:62
<u>Chrysophyllum mexicanum</u>	zapote		B:10
<u>Cordia alliadora</u>	laurel	laurel	L:62
<u>Crescentia cujete</u>	jícara, morro	calabash	L:63
<u>Cymbopetalum penduliflorum</u>	orejuela		B:10
<u>Dialium guianense</u>	guach	wild tamarind	B:8
<u>Dracaena americana</u>	campanillo		B:8
<u>Erblichia xylocarpa</u>	asta blanca		B:8

<u>Ficus spp.</u>	amate	fig	B:8
<u>Hirtella racemosa</u>	icaquillo		B:8
<u>Inga laurina</u>	caspirol		L:62
<u>Inga peterno</u>	paterna		L:62
<u>Inga micheliana</u>	cashniquil		L:62
<u>Licania playtpus</u>	zapote amarillo	yellow zapote	B:10
<u>Licaria peckii</u>	pimientillo		B:8
<u>Manilkara achras</u>	zapote	zapote	B:10
<u>Nectandra sinuata</u>	aguacatillo		B:10
<u>Ochroma lagopus</u>	corcho	balsa	L:62
<u>Ocotea rubriflora</u>	laurel	laurel	B:10
<u>Persea americana</u>	aguacate	avocado	L:62
<u>Pithecellobium arboreum</u>	aguacillo		B:8
<u>Platimiscium dimorphandrum</u>	hormiguillo		L:62
<u>Poulsenia armata</u>	mazamorro		B:8
<u>Protium copal</u>	copal	copal	B:8
<u>Quercus oleoides</u>	roble	oak	B:10
<u>Quercus Skinneri</u>	roble	oak	B:10
<u>Rinorea guatemalensis</u>	frutillo		B:10
<u>Scheelea preusii</u>	manaca, corozo		L:63
<u>Stemmadenia Donnell-Smithii</u>	chapona		B:10
<u>Swietenia macrophylla</u>	caoba	mahogany	B:8
<u>Talauma mexicana</u>	flor del corazón		B:8
<u>Terminalia amazonia</u>	almendro, cashán		B:8
<u>Theobroma cacao</u>	cacao	cacao	L:63
<u>Trema floridana</u>	capulín cimarrón		L:63
<u>Trophis racemosa</u>	tulipán		B:10
<u>Vatairea Lundellii</u>	sacacera		B:8
<u>Wimmeria bartletti</u>	lombricillo		B:8

FAUNA:

<u>Agriocharis ocellata</u>	pavo ocelado	ocellated turkey	L:69
<u>Allouatta villosa</u>	mono saraguato	howler monkey	L:69
<u>Ara spp.</u>	guacamayo	macaw	L:69
<u>Artibeus jamaicensis</u>	murciélago	bat	L:69
<u>Ateles geoffroyi</u>	mono araña	spider monkey	L:69
<u>Buteo nitidus</u>	gavilán	grey hawk	L:69
<u>Coendou mexicanus</u>	puercoespín	porcupine	L:69
<u>Constrictor constrictor</u>	boa, mazacuata	boa	L:69
<u>Crotalus durissus</u>	cascabel tropical	rattlesnake	L:69
<u>Ctenosaura pectinata</u>	iguana	iguana	L:69
<u>Cuniculus paca</u>	tepezcuintle	spotted cavy	L:69
<u>Dasyprocta punctata</u>	guaqueque	agouti	L:69
<u>Dasypus novemcinctus</u>	armadillo	armadillo	L:69
<u>Desmodus rotundus</u>	vampiro	vampire bat	L:69
<u>Felis onca</u>	jaguar	jaguar	L:69

<u>Felis pardalis</u>	ocelote	ocelot	L:69
<u>Felis yagouaroundi</u>	leoncillo	jaguarundi	L:69
<u>Harpia harpyja</u>	águila arpía	harpy eagle	L:69
<u>Hetrogeomys hispidus</u>		pocket gopher	L:69
<u>Leptophis ahetulla</u>		green snake	L:69
<u>Lutra annectens</u>	nutria	river otter	L:69
<u>Mazama americana</u>	venado cabrito	brocket deer	L:69
<u>Mephitis macroura</u>	zorriño rayado	hooded skunk	L:69
<u>Nasua narica</u>	tejón	coati	L:69
<u>Odocoileus virginianus</u>	venado de campo	white-tailed deer	L:69
<u>Pharomachrus mocino</u>	quetzal	quetzal	L:69
<u>Potos flavus</u>	mico de noche	kinkajou	L:69
<u>Procyon lotor</u>	mapache	raccoon	L:69
<u>Ramphastos sulfuratus</u>	tucán	toucan	L:69
<u>Rhinoptynx clamator</u>		striped owl	L:69
<u>Sarcoramphus papa</u>	zopilote rey	king vulture	L:69
<u>Sylvilagus brasiliensis</u>	conejo	forest rabbit	L:69
<u>Tamandua tetradactyla</u>	hormiguero	anteater	L:69
<u>Tapiris bairdii</u>	tapir	tapir	L:69
<u>Tayassu tajacu</u>	jabalí de collar	collared peccary	L:69
<u>Urocyon cinereoargenteus</u>	zorra	grey fox	L:69

*References

Aa	Alvarez del Toro (1982)	E&A	Eccardi and Alvarez del Toro
Ab	Alvarez del Toro (1990)	H	Helbig (1964)
B	Breedlove (1981)	L	Lowe et al. (1982)
C	Clark (n.d.)	P	Pailles (1980)
C&F	Coe and Flannery (1967)	V	Voorhies (1976)