THE MYSTERY OF *MALANGA*: POSSIBLE ROLES OF *XANTHOSOMA VIOLACEUM* IN ANCIENT MAYA DIET, CULTURE, AND AGRICULTURE

by

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The Mystery of *Malanga*: Possible Roles of *Xanthosoma violaceum* in Ancient Maya Diet, Culture, and Agriculture

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ABSTRACT

Until the mid-20th century, Ancient Maya agriculture has historically been discussed almost exclusively in terms of maize cultivation and the use of swidden methods. More recent ideas about alternative subsistence strategies and crops that could either supplement swidden or introduce more intensive maize agriculture, however, have led to more questions than answers. While the possibility of root crop utilization by the ancient Maya had been suggested by scholars as early as the 1960s, serious consideration has only occurred since the recent discovery of a Classic period *manioc* (root crop) field near the ancient village of Cerén in El Salvador by Dr. Payson Sheets. The discovery of such intensive *manioc* cultivation, along with the sophistication and extent of *manioc* use, suggests that other root crops may also have been important components of Maya agriculture. The little-known root crop that today is commonly referred to throughout Central America as "malanga" (*Xanthosoma violaceum*) was uncovered in previous investigations (beginning in the 1970s) at the site of Cerén, which included the excavation of a household garden containing *malanga* plants.

Through the use of ethnography, ethnohistory, iconography, and archaeology, I have compiled a summation of *malanga's* possible role(s) in ancient Maya agriculture, as well as how to continue research on the plant. Ethnographic research, for instance, has led to the argument that *malanga* was most likely processed in a similar way to *manioc*, which suggests

that use-wear analyses may provide evidence for *malanga* use when less durable indicators like starch grains are lacking. Ethnohistoric evidence has been instrumental in providing ideas for how root crops like *malanga* may have been used, such as for famine food or as a supplementary crop, while iconography has indicated that *malanga* may have had religious importance as well. Lastly, the use of archaeology, in combination with the above, suggests that *malanga* would most likely have been grown in swampy, inundated soils in a kitchen garden setting. Through my research on *malanga*, I believe I have provided new and important information on the ancient Maya diet and on how to continue searching for a previously unknown crop.

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CHAPTER 1

INTRODUCTION

Ancient Maya agriculture has historically been discussed almost exclusively in terms of maize cultivation and the use of swidden methods. New ideas about alternative subsistence strategies and crops that could either supplement swidden or introduce more intensive maize agriculture, however, have led to more questions than answers. While the possibility of root crop utilization by the ancient Maya had been suggested by scholars as early as the 1960s, serious consideration has only occurred since the recent discovery of Classic period *manioc* (a root crop) field near the ancient village of Cerén in El Salvador by Dr. Payson Sheets. The discovery of such intensive *manioc* cultivation, along with the sophistication and extent of *manioc* agricultural systems and use, suggests that other root crops may also have been important components of Maya agriculture. Another root crop, called *malanga* (*Xanthosoma violaceum*), was found at Cerén as well, but little work has been done with it. In addition, as Cerén is unique in its well-preserved nature, few archaeologists have even found the root crop at other sites – making *malanga* a practically unheard of crop. In the following chapters, I will attempt to address this issue.

In the first chapter, I will discuss the ancient Maya, who are the main focus of my research. A short background on the spatial and temporal contexts in which the ancient Maya lived will be provided, followed by a description of each geographic region within the Maya area. A history of the site of Cerén, where the majority of my study has been focused on, will also be included. This section will be comprised of the history of the general site area as well as pertinent archaeological information. Chapter 2 will focus on a short history of Maya agricultural studies, which spans from Conquest-era up to and including the 1970s, when a paradigm shift occurred regarding ancient Maya population densities occurred. In chapter 3, I will discuss root crops native to the New World in order to gain a better understanding of how, and why, root crops may have been used in a Pre-Columbian diet. At the beginning of the chapter, a spatial, temporal, and environmental overview will be given for the Andes, Amazonia, and the Caribbean; these are the areas where root crops in the New World originated, and where they are still in use today. In the fourth chapter, I will provide ethnographic, ethnohistoric, iconographic, and archaeological evidence for New World root crops. Chapter 5 will be an extension of chapter 4, and will cover research related specifically to *malanga*. Finally, in chapter 6, I will 1) re-examine the information at hand and determine how best to further studies of *malanga*, and 2) re-examine the information at hand to provide a summary of *malanga's* possible use in ancient Maya diet.

A. History of Mesoamerica and the Ancient Maya

Figure 1. Mesoamerica

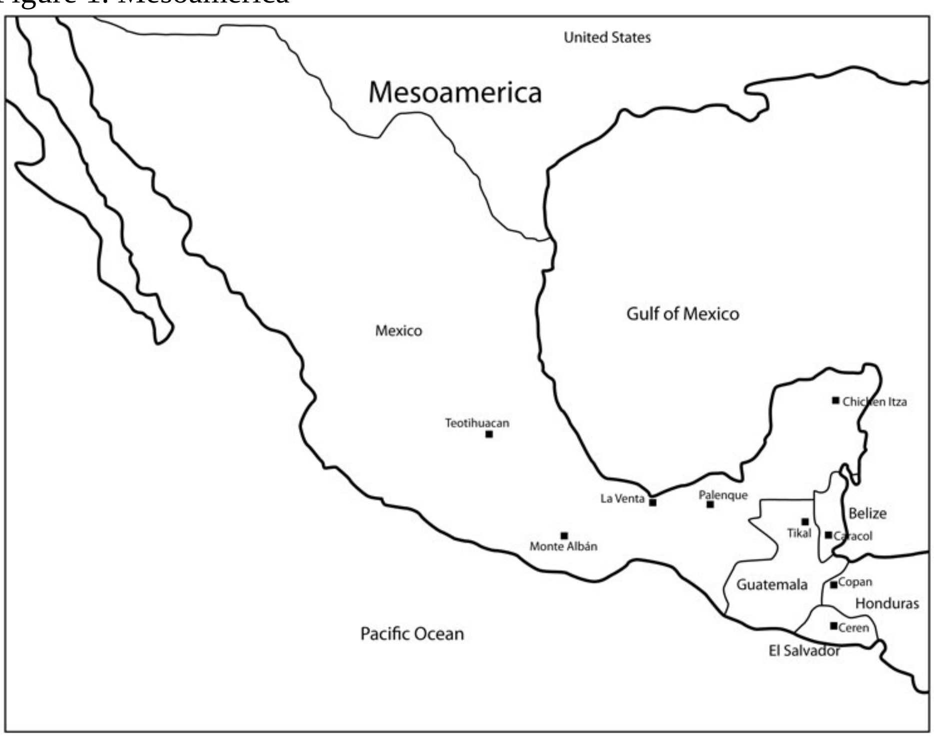
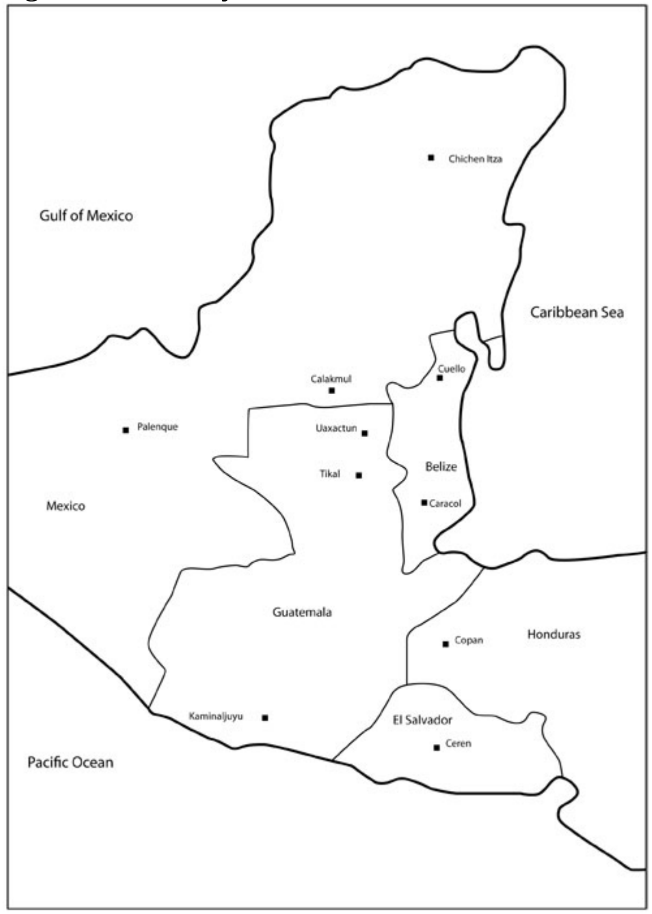


Figure 2. The Maya Area

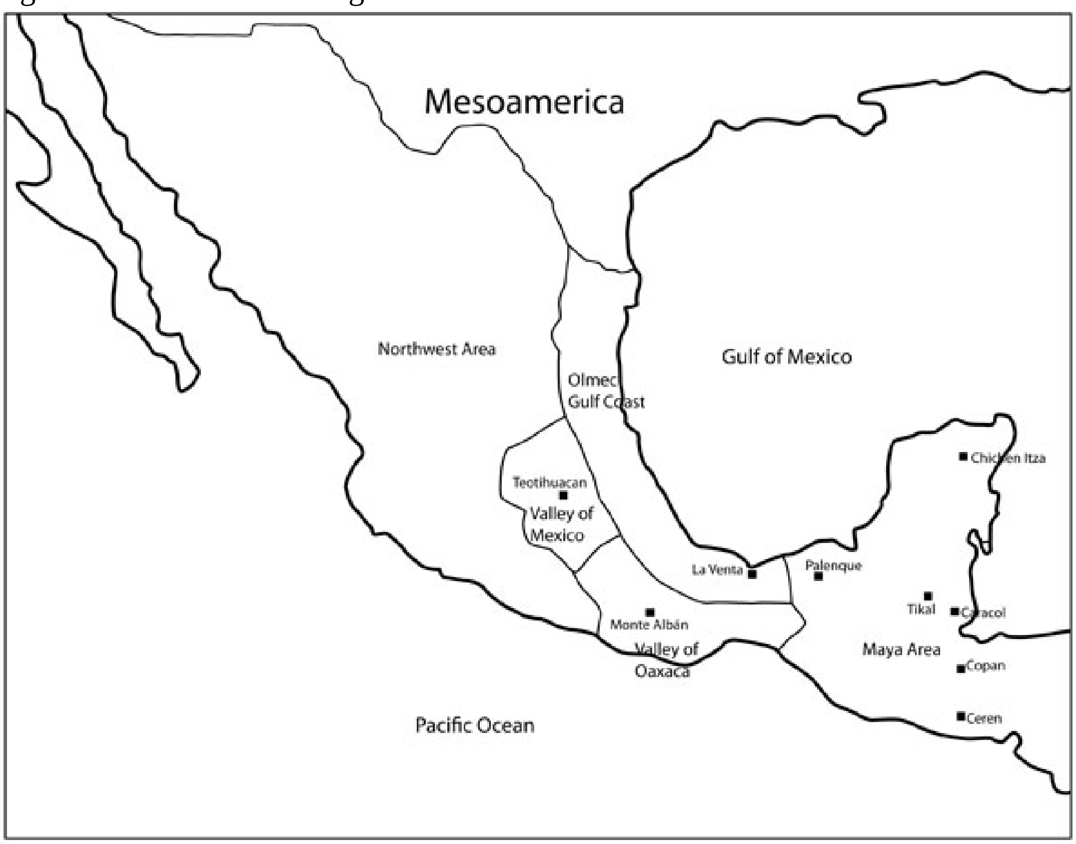


Mesoamerica (consisting of the modern-day countries of Mexico, Guatemala, Belize, Honduras, and El Salvador) has been populated for thousands of years, with the Maya being one of the most enduring civilizations of this area. The development of astronomy, calendrical systems, and hieroglyphic writing during the Maya "fluorescence" in the Classic period has long been seen as an impressive aspect of the Maya civilization, but their history has been marked with important advancements both before and after this time period.

After the earliest movements of nomadic hunting and gathering peoples from Asia into North America during the last Ice Age, referred to as the Paleoindian period (beginning as early as 20,000 or as late as 12,000 (Evans 2004:31; Shurr 2000)), the Archaic period (about 8000-2000 BC) saw the establishment of settled communities and the development of agriculture. The earliest known semi-sedentary settlements emerged along the seacoasts of the Pacific and Caribbean, where copious wild resources could support a long-term settlement (Blake et al. 1995; Brown 1980). The Early Preclassic period (2000-1000 BC) began with the appearance of the first complex societies in Mesoamerica, such as the Olmec in the Gulf Coast lowlands of Mexico (Grove 1968; Rust and Sharer 1988) as well as societies in the Valley of Mexico and the Valley of Oaxaca (A.A. Joyce

1993; Flannery and Marcus 2000). The earliest settled communities were generally located in the highland and coastal Maya areas, while development in most of the interior Maya lowlands lagged during this time. On the Gulf Coast of Mexico, the Olmec rose and fell during the Early and Middle Preclassic periods. Craft specialization, long-distance trade, social ranking, and new ideology all led to the emergence of a ruling elite and a new hierarchy (Clark 1996; Flannery 1968; Grove 1981a, 1981b; Hayden 1995; Hirth 1984). In highland Mexico, complex societies arose in the Valley of Oaxaca, Chalcatzingo, and the Valley of Mexico (A.A. Joyce 1991, 1993; Joyce 1991).

Figure 3. Mesoamerican Regions



The earliest archaeological macrofossil plant remains found in this area date back to 1000 BC (Miksicek et al. 1991), but Paleoecological evidence (Pohl et al. 1996) for early agriculture in the wetlands in northern Belize shows the earliest dates at 2100 BC. It is likely, however, that nomadic hunter-fisher-gatherer farmers were cultivating maize, and probably *manioc*, in the area since at least 3400 BC (Kaufman 1990). Intense deforestation has been documented beginning around 2400 BC, which suggests that maize was converted into a more common crop at this time. Chili peppers and cotton appeared around 1700 BC (Hammond 2001), and squash and bottle gourd around 1500 BC (Colunga-GarcíaMarín and Zizumbo-VillaReal 2004:S102; Lentz 1999; Pohl et al. 1996).

The Middle Preclassic period (1000-400 BC) provides clearer evidence for social divisions within society, as well as for sophisticated religious and economic institutions that supported the authority of dynastic leaders (Fahsen 2010; Rice 1976:441-445; Sanders 1973:354). In addition, as populations increased during this, so too did competition between communities for areas of good land and resources. As some communities edged out others, differential access to resources (both local and those acquired by trade) supported the emergence of social stratification and centralized political control in the Maya area (Sanders 1973, 1977). The Late Preclassic period (400 BC – AD 100) focused on the continuation of the developmental trends that started in the Middle Preclassic period (Freidel and Schele 1988; Kosakowsky et al. 1999; Sidrys 1976).

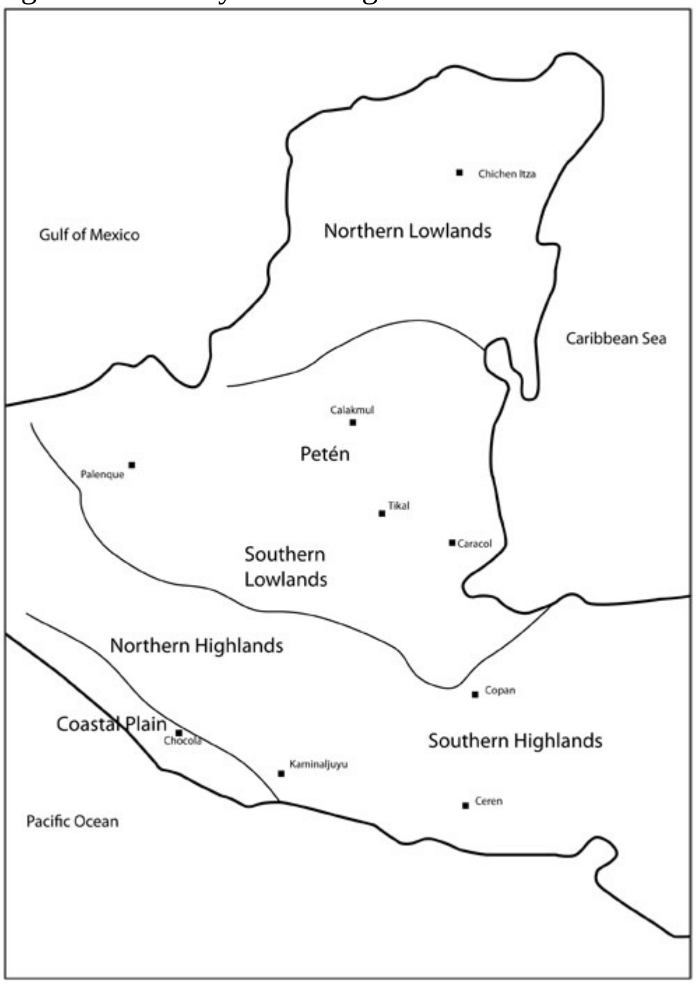
Early Classic (AD 250-600) through Late Classic (AD 600-800) (Ball and Taschek 1991; Chase and Chase 1998) lowland society was characterized by stratification into elite and nonelite and the emergence of divine kings with great economic, religious, and political power (Graña-Behrens 2006:117-120). The emergence of powerful leaders and increased population growth, however, led to competition for land, water, food and other resources and, as a result, an increase in warfare (Borowicz 2003; Coe 2011:92-94; Laporte 2003; Sharer 2006:376).

In the Terminal Classic period (AD 800-900), the overpopulation and diminishing resources that arose at the end of the Classic period led to the eventual breakdown of divine kingship. Those who could not to compete for these resources migrated to the coasts, to the southern highlands, and to the north in the Yucatan Peninsula (Sharer 2006:585). Chichen Itza in the northern lowlands in the Early Postclassic period (AD 900/1100-1200) and Mayapán in the Late Postclassic period (AD 1200-1500), for instance, became large military powers and religious centers (Coe 2011:201; Sharer 2006: 586, 626). In the time shortly before the Spanish Conquest, Maya states were ruled not by divine kings who determined their kingdoms' fate, but by political elites and shared governance among elite families who used new religious cults and pan-Mesoamerican trade to reinforce their authority (Coe 2011:210; Sharer 2006:628).

B. The Maya Environmental Context

Including modern-day eastern Mexico, Belize, Guatemala, and the western portions of Honduras and El Salvador, the Maya area has a highly varied environment. Rugged, almost inaccessible mountains with cool temperate climates drop down to vast level plains characterized by hot tropical conditions. As a result, agricultural opportunities are also highly variable. Areas with deep alluvial or volcanic soils are highly productive, but agriculture is almost impossible in regions with thin, rocky soils. Dry deserts and tropical rainforests dot the landscape, but because of the seasonal rainfall found throughout the area, even the wettest tropical forested areas can be largely dry for several months. In addition, while some areas have water available to them year-round from lakes and rivers, others only have access through caverns found deep beneath the surface (Sharer 2006:30; Sluyter 1994). Due to such variation, the Maya area is often divided into three basic geographic zones: the Pacific coastal plain to the south, the highlands in the center (including both southern and northern highlands), and the lowlands in the north (including both southern and northern lowlands).

Figure 4. The Maya Area Regions



The Pacific Coast

The coastal plain stretches along the Pacific coast from Chiapas in Mexico through southern Guatemala and into El Salvador. Rich volcanic soils, coupled with the soil from silt deposits along the rivers, create a good agricultural environment (Kaplan 2008; Sluyter 1994:565). The climate is tropical, with clearly defined dry and wet seasons. Before agriculture, a large array of flora and fauna meant that early settlers could hunt and gather a variety of wild food without traveling large distances. Being situated on the Pacific coast also meant that both earlier and later settlers were able to prosper through the trading of fish and salt. The large number of natural resources and the fertile soils of the coastal plain led to early settlement dating to the mid-Holocene, and to the beginnings of Maya civilization around 400 BC (Kaplan 2008; Neff et al. 2006).

The Highlands

The highlands, to the north of the coastal plain, have an elevation generally above 800 meters (Sharer 2006:34). Divided into the southern highlands and the northern highlands, the major population centers of the pre-Columbian era were located within the largest and richest valleys. The southern highlands include the elevated terrain starting in Chiapas and extending through southern Guatemala into Honduras and El Salvador, between the belt of volcanic cones parallel to the Pacific coast to the south and the rift-valley system to the north. This zone of active plate tectonics has frequent earthquakes and volcanic eruptions, but has also created fertile volcanic soils in the valleys and basins in addition to multiple obsidian sources (Dull, Southon and Sheets 2001; Hayden and Nelson 1981; Sidrys 1976). The northern highlands are located in the Chiapas highlands of Mexico and in the south-central part of Guatemala. Agriculture in this area can be difficult along the high slopes, but the alluvial soils that accumulated in the numerous valleys and basins in the northern highlands supported intensive farming. Heavy forests and weeds did not pose major problems in terms of competition for resources, but they also left soils along the slopes easy targets for erosion. As a result, irrigation and anti-erosion techniques like terraces were utilized in the highlands (Nations and Nigh 1980).

The Lowlands

The transition between the mountainous highlands and the relatively flat lowlands tends to be gradual. Extending over northern Guatemala, Belize, and the Yucatan Peninsula of Mexico, the Maya lowlands make up the largest portion of the Maya area. The lowlands are characterized by a large range of resources, including lush tropical forests filled with primates, jaguars, agoutis, deer and other fauna, as well as local limestone for building material and deposits of chert and chalcedony for stone tools (Hester and Shafer 1984). The southern lowlands contain large limestone formations and a lower relief at the coastal margins. Rivers and lakes in the area provide year-round access to water, with deep and fertile soils along riverbanks. The Maya Mountains, the only part of the lowlands above 800 meters in elevation, are also located in the southern lowlands and provide the only sources of basalt, granite, and hematite, among other minerals, in the region (Roberts and Irving 1957). A wide range of soil and forest types are found in the central lowlands, as well as lakes, rivers, and low seasonal swamps. It was here in the interior of the southern lowlands that the earliest centers of lowland Maya civilization, Nakbe and El Mirador, appeared (Sharer 2006:46).

The northern lowlands correspond roughly to the northern half of the Yucatan Peninsula. There are almost no surface streams in this area and only a few lakes, but the climate is optimal for crops like cotton, and the Maya in the northern lowlands were known for being major producers of woven textiles even after the Spanish Conquest (Huntington 1912). Soil quality is uniformly poor, as the soil A-horizon is extremely thin – especially as one travels farther north into the Yucatan peninsula. The porous limestone found throughout the area also causes issues, as it allows any water to soak through the surface rapidly and, in contrast to the southern lowlands, the inhabitants of the Yucatan had to rely largely on the distribution of *cenotes* and waterholes (Huntington 1912; Sapper 1896). The waterholes, or *aguadas*, are found wherever the limestone forms natural valleys that prevent rainwater from seeping away, and are still some of the only sources of water for the inhabitants of the area today. *Cenotes* are generally located further north in the Yucatan, and are formed when the limestone that forms the roofs of underground caves collapse – thus creating a natural sinkhole (Pearse, Creaser and Hall 1936).

C. A History of Cerén and the Surrounding Area

The Climate, Environment and Volcanic History

The site of Cerén (see Figure 1) is located at an elevation of 450 meters alongside the Río Sucio, in the Zapotítan Valley of what is now the country of El Salvador. Situated on the Pacific drainage, El Salvador has a tropical monsoon climate of alternating wet and dry seasons, with 90% of the rainfall occurring in the May-October rainy season. Although the average amount of rainfall during this rainy season is 1700 mm, the average has a standard deviation of +/- 300, suggesting that the amount of rainfall can be quite variable (Sheets 2006:37). As a result, agriculturalists in El Salvador are often plagued by problems with crop growth and erosion (Sheets 1982). The planting of maize at the right time, for instance, is very important since it needs to be planted just before the rains (in order to germinate in a warm, porous soil), but also needs moisture in large amounts right away in order to begin growing.

The Zapotítan Valley, like most of the Mesoamerican highland area, is a volcanic landscape, with the large volcanic complexes of San Salvador volcano on the east and Santa Ana volcano on the west. The major eruption of the Ilopango volcano in particular (most likely dating to AD 536 (personal communication, Sheets [2011])) affected both the Zapotítan Valley and Central America, and possibly had an impact as far away as China. The Ilopango eruption deposited up to a few meters thick volcanic ash over the valley, killing most vegetation, polluting water supplies, and making most fields uncultivable. The Zapotítan Valley was largely abandoned for about half a century, with Cerén being one of the earlier sites colonized as people moved back in. Based on pottery dating, site occupation probably began in the later 500s or early 600s, with radiocarbon dating placing the end of the site's occupation to the mid-600s. By the Late Classic period, however, the Zapotítan Valley had completely recovered demographically from the Ilopango eruption.

After about a half century of occupation, however, the site of Cerén was covered yet again, this time by the nearby Loma Caldera volcano (Sheets 2006:9). The people living at Cerén during the Loma Caldera eruption did not have time to take their important possessions with them: The site therefore provides a great opportunity for archaeologists since these possessions are now covered in 5 meters of volcanic ash, creating an amount of preservation never before seen in Mesoamerica. Plants, for example, can be discovered by pouring dental plaster into cavities created when volcanic ash surrounded the organic material (which then decomposed). By creating these dental plaster plant casts, archaeologists are able to determine the actual appearance of ancient plants and therefore identify the plant type.

After the Ilopango eruption, much of the area around the volcano remained uninhabited until a presumed Chortí Maya immigration into the Zapotítan Valley (Sheets 1982:105). Sheets (2009) provides a particularly convincing argument for Chortí occupation based on housing, storing, and cooking structures. At the site of Cerén, these immigrants began planting their cultigens in soil still developing in the Ilopango tephra, which was somewhat weak for agriculture. This “tierra blanca” tephra that was farmed at Cerén would be defined as a juvenile agricultural soil, and the agricultural practices found at the site are both a reflection of and a response to those soil conditions (Zier 1992:224).

At the point of occupation was an erosional surface from which a significant amount of *tierra blanca* tephra had already been moved, suggesting that the unstable tephra was subject to degradation through sheet washing and planted crops were in danger from heavy or sudden rains. As a result, the villagers at Cerén used crosscutting rows to reduce the rate of flow of rain runoff and slow down soil erosion. Field ridging would also encourage moisture retention during the periodic dry episodes seen during the Salvadorian rainy season (Zier 1992:226). Agricultural features preserved at Cerén also suggest an occasional fallow period system (Wilken's (1971) "high performance *milpa*"), in order to keep soils fertile (Zier 1992:232).

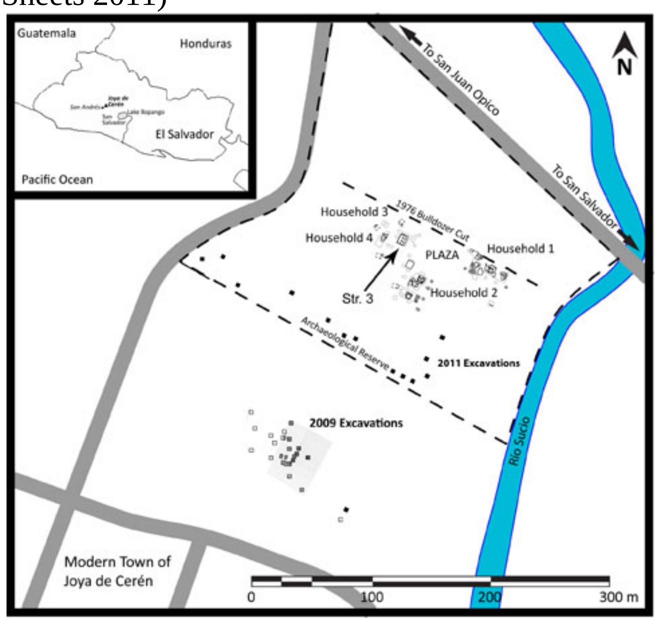
Social and Cultural History

During its occupation in the Late Classic period, the Cerén site was a village of commoners that was located in the Zapotítan Valley area. Black (1983:75) found that there were forty-two sites contemporary with Cerén within the Valley, including: eleven hamlets, fourteen small villages, seven large villages, three isolated ritual precincts, four large villages with ritual construction, two secondary regional centers, and one primary regional center. Black's survey, however, covered only about 15 percent of the valley, and it has been estimated that roughly 280 sites were inhabited at this time (Sheets 2006:11). According to the survey (Black 1983:82), between 40,000 and 100,000 people lived in the Zapotítan Valley during the Late Classic period, which in turn lead to a more nucleated population during the Early Postclassic period. While the area's population was not dramatically reduced during the "collapse" of the Southern Lowlands, more than half of the population seen in the Late Classic was lost during the Late Postclassic.

The primary regional center of the Zapotítan Valley was San Andrés, which is roughly located in the center of the Valley. It can be surmised that San Andrés was the religious, political, and economic center of the area, and people from villages like Cerén would likely go there for special purposes. This probable Cerén-San Andrés connection is strengthened by the fact that the two sites are only 5 kilometers apart from one another (Sheets 2000; 2006:11). The economic importance of San Andrés would likely have been linked to more "prestige goods," including obsidian from Ixtepeque in Guatemala, and jade from the Motagua River Valley (also in Guatemala). San Andrés would also have been much more equipped than the small village of Cerén in terms of providing occupational specialists who could work obsidian into well-made knives and other cutting tools as well as jade beads and axes (Sheets 2000). These types of high-quality goods that required long-distance trade were likely sold at an elite-run market at San Andres or, possibly, at a smaller market located in one of the other bigger regional sites (Sheets 2006:11).

This is not to say, however, that Cerén villagers were not self-sufficient in many domains, or unable to manage their own economy, politics, or religious affairs. According to Sheets (2000:217) "commoner individual and household choice was far greater than would have been anticipated by economic models emphasizing the elite." It was found, for instance, that Household 1 at Cerén contained toolkits for groundstone implement manufacture, which points to a surplus of groundstone artifacts that would have been traded with other households in the village for other goods (Sheets 2000:225). In addition, while San Andrés was the largest center, other secondary centers would have held marketplaces as well. Thus, Cerén households had the opportunity to go to other marketplaces if prices were too high or if they had more loyalty to another site (Sheets 2000:223). A religious structure was also found at the site, suggesting that inhabitants controlled their own community-wide religious

Figure 5. Cerén Archaeological Site (updated from Sheets 2011)

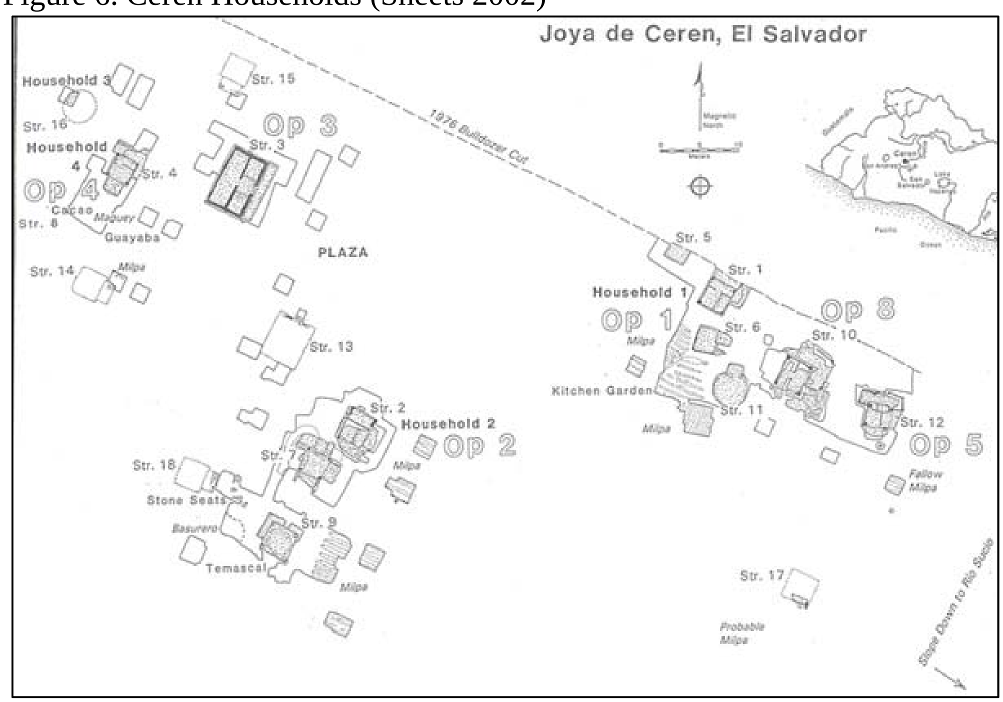


ceremonies. There is also evidence of a possible council house that would have been used for community gatherings and political meetings (Sheets 2000, 2006).

Archaeology

After its re-discovery in 1976, excavations at Cerén from 1989-2000 were focused predominately on unearthing buildings and determining their functions, – although the majority of structures at the site have been left untouched for the sake of preservation. In all, four households, a public building, a sauna, and a religious compound have been identified (Sheets 2006:12-14). Household 1 appears to have manufactured groundstone implements in considerable numbers, as evidenced by its abundance of hammerstones and other groundstone tools compared to other households. Heavily worn *manos* and *metates* found in the home also suggest that Household 1 had a large role in maize grinding. Household 2, on the other hand, contained a large amount of decorated gourds and vessels as well as pigments, and may have been inhabited by decorative specialists (Sheets 2000:226). It would appear, then, that in

Figure 6. Cerén Households (Sheets 2002)



addition to community-level religious and political buildings, Cerén also had a built-in economy based on its households.

In addition to the excavated buildings, a number of maize fields were also discovered at and around the site. Each household was surrounded by a *milpa*, with maize of the Nal-Tel/Chapalote variety (Lentz et al. 1996). Most of the maize plants found at Cerén had matured at the end of the first planting, allowing botanists to date the eruption to the actual month of August, which is the middle of the rainy season (Sheets 2006:37). According to Sheets and Woodward (2002), the average density of maize at Cerén would have roughly been between 4000 and 5000 kilos per hectare – an impressive feat of productivity.

Research conducted during the 2009 and 2011 field seasons were also able to show that individual cultivators seemed to be making their own decisions regarding their own plots of land. Boundaries of individual farmer's plots were visible where they ended in cleared areas, platforms, other cultigens, or in two parallel lines (Sheets 2009b:121). These two lines emanated from the village and acted as a land division mechanism, or "land use lines," thereby effectively separating different kinds of land use such as *manioc* cultivation vs. maize cultivation (Sheets 2009b:122). Evidence of individual decision-making was also found in the amount of field up-keep and the productivity of each field (Lamb and Heindel 2011).

One of the most interesting agricultural discoveries made at Cerén and the area surrounding the site occurred during the 2007 field season. In an effort to understand the process of agricultural intensification, Dr. Sheets and his students drew upon Netting (1993), who argued that intensification among traditional smallholders (as opposed to that seen in state-level societies) was more pronounced near their households. As a result, the main hypothesis of the 2007 season was that agricultural intensification and productivity would decline in the fields found a few hundred meters south of the village (Sheets et al. 2007, 2011:4). The archaeologists instead found that the maize fields encountered south of the village were just as intensive as those found at the site center. Even more surprising, however, was the discovery of an intensive *manioc*-planting field. Dating to the Middle Classic period, and thus buried by the Loma Caldera volcanic ash at the same time as the Cerén village (Miller 2002; Sheets 2002), it became clear that the field was utilized by the inhabitants of Cerén who were there at the time of the eruption.

Before the 2007 field season, only a single *manioc* plant had been found in the kitchen garden of Household 1, which suggested that *manioc* was a minor garden plant. These new excavations demonstrating the formality and extent of the *manioc* beds, however, indicate that *manioc* must have been a staple crop at Cerén (Sheets 2009a:6; Sheets et al. 2007, 2011:6). In addition to maize and *manioc* fields, large handfuls of beans (both common and Lima beans, as well as some wild relatives) were found in Cerén ceramic vessels and other storage units (Lentz and Ramírez-Sosa 2002:34). Carbonized chile pepper seeds, peduncles (stalks), and rinds were also found in large amounts particularly in storage rooms, but also in a kitchen where they were hung from the rafters in large clusters. It is likely that chile peppers were grown as house garden plants, as is still practiced by the modern Kekchi Maya of Guatemala (Lentz and Ramírez-Sosa 2002:35).

Figure 7. Maize Field (left) and Manioc Field (right) (Dixon 2009:53)

In addition to the *manioc* field, another root crop – *Xanthosoma violaceum*, or *malanga* – was found in a household kitchen garden during past excavations of the site of Cerén (Lentz and Ramírez-Sosa 2002; Sheets 2002). As the manioc field had not yet been found at this time, malanga's predominance at the site led researchers to believe that it was the main root crop used by the Maya living at Cerén (see Lentz and Ramírez-Sosa 2002). This view has now changed, but the plant's large presence in the excavated kitchen garden should not be forgotten. While *Xanthosomes* are fairly well-known in lower Central America and South America, they are relatively non-existent in most of the Maya area today. As Cerén's high level of preservation is unique within the Maya area, however, it is possible that *malanga* was grown in areas outside of Cerén as well but there have not been any opportunities to discover it. It is my hope that I will be able to provide more information on this crop and contribute to Maya agricultural studies.

CHAPTER 2

A HISTORY OF MAYA AGRICULTURAL STUDIES

A. Prior to the 1960s

Before the 1960s, the literature on the ancient Maya characterized Maya agriculture as long-fallow, slash-and-burn (swidden) cultivation of maize. Relying on research by early soil scientists, the tropical soils were viewed by Maya scholars as being poor in quality due to oxidation and leaching of nutrients, and as a result it was believed that the land could not be used for anything but swidden agriculture (Fedick 1996; Wiseman 1978). When it was determined that Maya sites held much higher populations than previously imagined, however, it became clear that swidden cultivation alone would have not been sufficient to feed such large populations, and archaeologists began to consider alternative agricultural strategies and cultigens (Bronson 1966; Pohl et al. 1996; Rice 1978).

Diego de Landa and the Relación de las cosas de Yucatán

In 1562, Diego de Landa began to investigate incidents of idolatry among the Maya living in the Yucatán Peninsula. While in the Yucatán, de Landa had grown suspicious of the rather quick acceptance of the Spaniards' religion and believed (rightfully so) that the Maya were adding the Christian god to their own large religious pantheon (de Landa 1975 [1566]:18). As a consequence, the manuscript is largely focused on the ritual practices of the Maya, which often included offerings of maize in various forms. According to de Landa, maize appeared to be the most important crop for the Maya at this time, and he noted that they gave their deities numerous offerings of maize and incense, and that their lords were given a drink of "toasted maize" (de Landa 1975 [1566]:66-67, 101; Staller 2010:30). De Landa's emphasis on maize, both as a source of sustenance and as a crop imbued with religious power, has led subsequent scholars to emphasize maize in ancient Maya diet and religion as well.

John Lloyd Stephens and Frederick Catherwood: Incidents of Travel in Yucatán

In Volume I of their *Incidents of Travel in Yucatán,* John Lloyd Stephens and Frederick Catherwood detailed their exploits in the Yucatán Peninsula during the 1850s. In the documentation of his travels, Stephens' Chapter 11 focused mainly on Maya maize agriculture, and he wrote extensively on maize at the site of Uxmal and its "modern-day" (in 1856) cultivation. Describing the ground-surface appearance, Stephens stated that, "Throughout the ruins circular holes were found at different places in the ground, opening into chambers underneath…" (1856:226; 228-230) Due to the small openings of each chamber and the general homogeneity of their structure, Stephens concluded that: a) these chambers were not meant for people to go in and out of; and b) they were all constructed for the same purpose (1856:231). .

Stephens' main informant in the area was called "Don Simon," who argued that the cement was not hard enough to hold water, and therefore that the chambers were not meant to be cisterns or reservoirs. Instead, it was suggested that the chambers were granaries or store-houses of maize. According to Stephens, this conclusion was logical since, "from earliest knowledge of the aborigines down to the present day, maize has been the staff of life to the inhabitants." (1856:232). When Don Simon argued that the chambers were probably used as granaries as opposed to cisterns, he specifically said that they were maize granaries – even though they could have been used to store other crops as well. Moreover, while both the Yucatec Maya of the 1850s and Europeans like Stephens and Catherwood believed that because maize was the staple crop for current Maya it must have also been so for the ancient Maya, this is certainly not necessarily the case.

During this time period, both Stephens and Catherwood and the Maya living in the Yucatán were likely to be much more acquainted with the less-intensive swidden agriculture, which led to a general leeching of the soil's nutrients. According to Stephens' records, it appears that the farmers were forced to keep fields fallow for an extended period of time, and that they could only use a plot of land to plant maize once due to the plant's harmful nature to the soil. Stephens believed that the planting and cultivation of maize, "probably [differed] little now from the system followed by the Indians before the conquest." (1856:233-234). Stephens, however, had failed to take into account the drastically lower population of modern-day Maya versus the ancient Maya, which, as will be discussed further below, has a large impact on agricultural systems.

Early Archaeologists: Swidden Agriculture

Due in part to the ethnohistoric documents created by de Landa and Stephens (Morley 1946; Thompson 1954) as well as durable artifacts and little understanding of settlement patterns (Rathje 1971; Wellhausen et al. 1957), Mayanists continued to assume that swidden maize cultivation provided the subsistence base for ancient Maya civilization (Meighan et al. 1958:132). Supposedly, one of the biggest issues confronted by farmers in tropical environments is soil erosion. Early Mesoamerican archaeologists addressed this lack of good soil by stating that the only possible way the ancient Maya were able to combat erosion was to practice slash-and-burn agriculture (Morley 1946; Thompson 1954). Population densities were poorly understood at the time but, even if we accept the original low populations that were then believed, the estimated 4-year fallow period needed for swidden agriculture (Cowgill 1961:279; Sanders and Price 1968) would lead to a substantial amount of land in fallow. Based upon the premise that the ancient Maya did not have a good agricultural system and were therefore depleting arable land without envisioning any consequences, it was hypothesized that the collapse of the Classic Maya civilization was the result of exhausted soils and erosion (Cook 1909; Cooke 1931; Meggers 1954; Morley 1920; Ricketson and Ricketson 1937).

B. A New Agricultural Studies Paradigm

When it was determined that Maya sites held much higher populations than had previously been imagined (Bullard 1960; Haviland 1967; Culbert and Rice 1990; Willey et al. 1965) however, it became clear that swidden cultivation alone was insufficient to feed these large populations, and archaeologists began thinking about different agricultural strategies and cultigens (e.g. Bronson 1966; Rice 1978; Pohl et al. 1996; Puleston 1978).

Changing Demographic Estimates

At the beginning of the 1960s, archaeologists began to take a large interest in population estimates for ancient American inhabitants, largely as a result of new techniques that had been created to determine demography. One of the most important changes in demographic estimates occurred during the Tikal survey, initiated by William Haviland in 1961. Based on initial surveying, Haviland gave a population estimate of 10,000 – 11,000 inhabitants during the Late Classic period at the site of Tikal in Guatemala (Haviland 1965:21). Subsequent surveying of settlement at the site, however, led to a new Late Classic population estimate of roughly 49,000 people (Haviland 1969:429, 1972). Investigations that occurred after original surveying (i.e. before 1965) showed the Tikal settlement was much larger than the previous area estimate of 16 square kilometers (Carr and Hazard 1961), with the site including a bigger rural population than had previously been believed.

For instance, after excavations in 1967 and 1968, a marked drop-off in the density of housemounds was apparent as one went further out from the original Tikal settlement area, suggesting that the area was, in fact, a more rural area. In all, the estimated size of Tikal was increased from 16 square kilometers (based on the area of central Tikal) to 63.59 square kilometers for central Tikal and 99.19 for the peripheral area of the site (Haviland 1969:430; Pulseston and Callender 1967). In addition to creating to area and demographic estimates for Tikal, Haviland (1969) also argued that a substantial portion of the Tikal population was not engaged in swidden agriculture. In central Tikal, density estimates showed that there was insufficient space for such agricultural activity to be carried out (Puleston 1978). In contrast, the periphery of Tikal was located in areas much more conducive to potential swidden agriculture. However, the presence of more extensive *bajo* areas was actually associated with a decrease in density in the Tikal periphery, suggesting that the swidden system may not have been the best agricultural technique to use in this environmental context (Haviland 1969:429). *Bajos* would have decreased arable land, and based on the large demographic estimate, other agricultural systems would be necessary to feed such a large population.

While Haviland and others were conducting the Tikal survey, area and demographic investigations were also being done at the site of Barton Ramie in the Belize River Valley (Willey et al. 1965). Gordon Willey and his colleagues pioneered settlement pattern research in the upper Belize Valley from 1954 through 1956. The surveys done at Barton Ramie paralleled that at Tikal, in which evidence showed that most of the houses at the site were occupied simultaneously during the Late Classic period (Willey et al. 1965:30-35). As a result, previous population estimates based on scattered occupation were found to be unfounded, and the Barton Ramie population during the Late Classic was much larger than previously assumed. Willey, however, still argued that primary food production was still dependent on long-fallow, maize-based, swidden cultivation in the surrounding, near-vacant slopes (Ford and Fedick 1992:45). In addition to aiding Willey in his surveys, Bullard (1960) also carried out reconnaissance of the Peten in 1958, recording structures and mounds, and argued for a larger population density than previously believed (like that seen at Barton Ramie).

Different Agricultural Techniques

As noted earlier, unmodified tropical environment generally foster increased soil loss, erosion and sedimentation, and a number of studies have shown that these issues certainly plagued the ancient Maya as well as the modern-day inhabitants (Binford 1983; Binford et al. 1987; Deevey et al. 1979; Rice 1991, 1993; Rice and Rice 1984; Rice et al. 1985). In order to combat such problems, it is likely that the ancient Maya used multiple agricultural techniques to provide themselves with necessary subsistence.

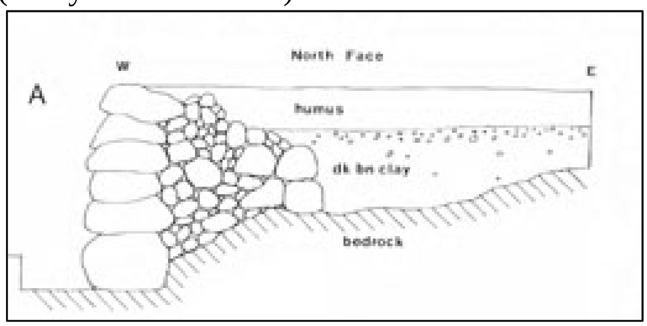
High Performance Milpa

The “high performance *milpa*” (or the intensive inter-planting of multiple species within a field in addition to the field rotation of basic crops) system was one way archaeologists were able to retain the idea of swidden agriculture while making it still feasible given the new, larger population estimate (Wilken 1971:442). The high-performance *milpa* (“field”) uses techniques that allow for multi-cropping with either reduced or no fallow periods. Crop rotation and intercropping are seen as the main fallow-period-reducing mechanisms in which perennial species (such as root crops like *manioc* or *malanga*) were planted annually in order to produce crops during the fallow period, or were planted with maize in order to increase the overall productivity of the *milpa*. Root crops, or crops that grow below ground, can be especially useful in increase the output of cultivated fields. For instance, even after fields are abandoned, below-ground crops can remain and be harvested later on from “fallow” lands (Wiseman 1978:84, 442). This type of agriculture is attested to by colonial documents such as a 1696 report coming from the Petén, from Avendaño y Loyola (cited by Thompson 1970:72; also see Marcus 1982:249), which discussed how the Maya planted maize, beans, chiles, and “other seeds” two or three times a year. Modern-day intercropping, however, appears to have declined in efficiency since the Conquest-era, as ethnographic research also states that these tracts of land rarely have more than two crops on a piece of land (Drucker and Heizer 1960:40; Morley 1946:135).

Terracing

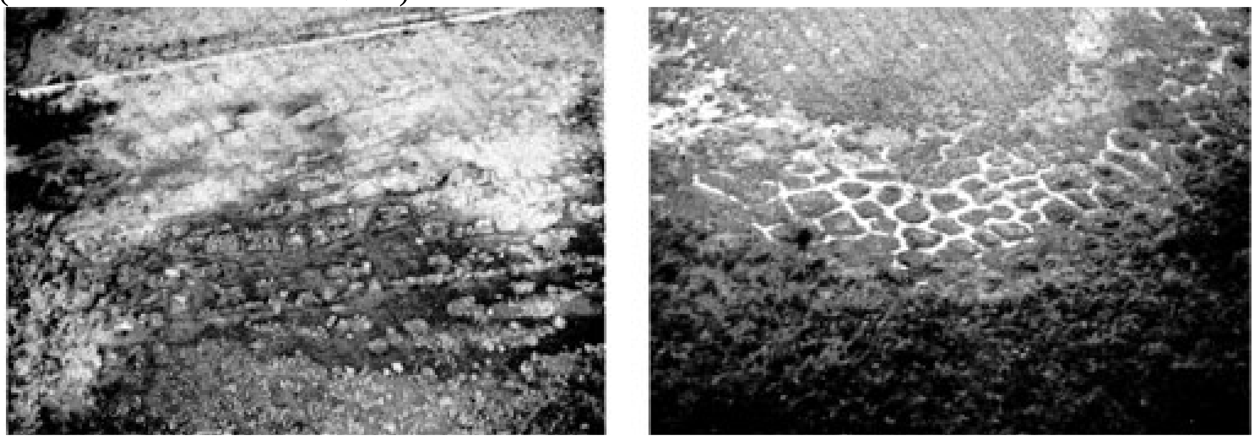
Terracing involves the creation of artificial systems of terraces for irrigation. Agricultural terracing is particularly useful in the tropics because it significantly slows down soil loss. Ethnographic observations have shown that present-day terrace systems are created in an unplanned manner. It is therefore argued that, like the modern terraces created in the region, ancient terrace systems were the natural consequence of the cultivation of slopes where both farmers and erosion pulled rocks and soil downslope to create better water absorption and drainage as well as crop yields (Chase and Chase 1989, 1998:66, 72-73; Wilken 1987; Williams 1990). Population densities and environmental factors have also been used to explain both the presence of terraces in some hilly regions of the Maya area and the apparent absence of terraces in others (Healy et al. 1983; Killion and Dunning 1992; Killion et al. 1991; Turner 1974; see Dunning and Beach 1994:62 for a rebuttal).

Figure 8. Example of a Caracol Terrace Wall (Healy et al. 1983:404)



Raised Fields

Figure 9. Ancient Raised Fields (Left: Long Swamp, Northern Belize; Right: Pulltrouser Swamp) (Turner and Harrison 1981:401)



When discussing raised fields in Mesoamerica, the *chinampa* system used in the Basin of Mexico is most often used as an example. In an effort to understand and describe the wetland agricultural methods employed by the ancient Maya, archaeologists working in the Maya area have often tried to use the *chinampa* system as analog to that of the Maya. According to Siemens (1996), however, the water-control features seen in this system were not the same as those implemented by the ancient Maya. *Chinampas* are dependent on an arrangement of dams and dikes that controls the water level, allowing for year-round cultivation. However, it appears that the ancient Maya left the fields subject to the seasonal fluctuation of water level. Within the lowland floodplain and wetland environments of the Maya area, then, the maintenance of raised fields was based on the scheduled exploitation of microenvironments orchestrated with seasonal flooding (Lucero et al. 2011; Scarborough 1983, 1994; see also Pohl et al. 1996; Harrison 1996). Ethnohistoric accounts suggest that raised fields were used as planting surfaces for maize and cotton (Puleston 1977), and previous cultivation experiments have shown that squash, beans and tomatoes also grow well on raised fields (Bradbury and Puleston 1974; Thompson 1974).

Artificial Rain Forest

An artificial rain forest is a mixture of tree, vine, root, and seed crops that are combined in a specific way so as to favor certain crops while still preserving the normal cycle of the parent forest (including the death and re-growth of the trees). It has been suggested (Wiseman 1978) that this type of agricultural system most likely results from a selective clearing process, which is used by the modern Maya in the Petén today. In this process, the farmer does not completely cut down the forest to create a *milpa*, but rather keeps some culturally useful species while eliminating those plants that are not considered useful. These favored species would then gain light, space, and nutrients due to reduced root and shade competition, while those plants deemed "useless" would be repeatedly cut down, possibly even leading to a regional extinction (Wiseman 1978:85). Selection for shade-tolerant varieties would therefore be crucial, which would in turn explain the extensive use of shade-tolerant root crops. These root crops would also be useful because they take much fewer local nutrients from the forest than seed crops such as maize and cereals, which also means there would be less root competition between the root crops and trees (Wiseman 1978:86).

Kitchen Garden

One of the most common types of agriculture seen in use by modern Maya is the kitchen garden (Wilk 1991; also see Hellmuth 1977 for ethnohistoric documentation). Defined as a small, fenced enclosure, the plants raised in modern gardens are ornamental flowers, medicinal herbs, supplementary crops like chile and *manioc*, and fruit and shade trees (Netting 1977; Wiseman 1978:79). It has also been suggested that they may have provided an alternative source of food during times of famine as well (Marcus 1982). Much of the household activity is carried out in the shade of this garden, and household refuse is easily used for mulching and fertilizer (Killion 1990, 1992; Redfield and Villa Rojas 1971; Wiseman 1978:81).

Archaeologically, remains of Preclassic garden plots have been found throughout the Maya area, including in the Belize River Valley (Ball and Kelsay 1992) and the Petexbatun (Dunning et al. 1997). Indirect evidence for the use of household gardens by the ancient Maya has also been provided by botanical and settlement pattern studies (Sharer 2006:645) as well as chemical testing of soils adjacent to household structures (Killion et al. 1989; Smyth et al. 1995). As will be discussed further, the site of Cerén also shows the presence of kitchen gardens located adjacent to households. Importantly, evidence at the site gives archaeologists an idea of what past kitchen gardens may have looked like – a ridged field containing a variety of different crops, including maize, *manioc* and *malanga* (Sheets 2002).

Arboriculture

Arboriculture is the cultivation of tree crops in extensive stands rather than household gardens. Tree crops (such as *ramón*, cacao, and sapodilla) require much less labor than maize cultivation since weeding is not necessary, and some species of fruits and nuts can simply be collected from the ground. Intercropping could be used in this cultivation system in order to create an “artificial rain forest” system (Sharer 2006:645). Currently, the present-day Maya create and manage forests in which favored arboreal species are selected for and encouraged (Atran 1993; Nations and Nigh 1980). Modern managed forests, or “orchard gardens,” contain a diversity of useful species. Ethnohistoric (de Landa 1975 [1566]) and archaeological research (Lentz 1991; Puleston 1982; Santley 1985; Wiseman 1978) have provided evidence for ancient Maya arboriculture as well.

The Search for Different Crops

In terms of archaeological evidence, maize has been found more often than other crops within the Maya area. Scholars must keep in mind, however, that this predominance of maize in the archaeological record may be the result of misleading differences in preservation (Johnson and MacNeish 1972; MacNeish 1997). For instance, unlike many other crops, maize can be analyzed with pollen, phytolith, and starch grains, and parts of the maize (like their kernels) are hard and thus carbonize easily (Pohl et al. 1996:357). Root crops, however, only leave behind starch grains due to the fact that they are often planted with stem cuttings. As a result, these crops do not have hard parts that carbonize well. In addition, few root crops produce diagnostic seeds and pollen, leading to little archaeological evidence (Sheets et al. 2012:260). Evidence of nutritional and productivity problems associated with dependence on maize (Kennedy 1983; Danforth et al. 1985) has also led some researchers to speculate that the Maya may have also relied on other staple (or at least supplementary) crops as well (Bronson 1966; Harris 1972; Puleston 1978). For example, starting in the late 1960s, Dennis Puleston argued for the importance of ramón nuts in the ancient Maya diet.

The term “root crop” refers to those vegetables grown for their enlarged, edible storage root (such as the tuber portion of a potato). While root crops (such as *manioc*) and grain crops (such as maize and wheat) do produce seeds, they are relatively inefficient at doing so, and as a result root crops are usually planted through vegetative propagation. Latin America, both currently and in the past, is usually most associated most with the root crops *jícama*, *malanga*, *manioc*, and sweet potato. The suggestion that root crops were an important part of the ancient Maya diet was first provided by Bennet Bronson in his 1966 article, “Roots and the Subsistence of the Ancient Maya.” Bronson argued that maize *milpa* agriculture would have provided a weak subsistence base for an urbanized society, and as a result, there must have been other staple crops utilized in pre-Columbian Mesoamerica. In his study, ethnographic, ethnohistoric, and linguistic information on root crops were analyzed in order to provide evidence for how root crops may have been utilized in the past.

For his ethnographic research, Bronson studied different modern-day Maya groups in order to determine current root crop utilization – finding that there was, in fact, a large distribution of utilization (particularly of the sweet potato, or *camote*) (Bronson 1966:257). After examining ethnohistoric documents, it was Bronson's argument that, as root crops were culturally marginal in Europe in the 16th century, Europeans who came to the New World focused largely on what they knew – seed crops. In addition, due to the fact that they were unfamiliar with the root crops they found, these newcomers were unable to name many of the new roots that they found (Bronson 1966:260). As a result, many ethnohistoric accounts regarding root crops are muddled, and it is difficult to get a full understanding of the number of available roots and their distribution in the Maya area. Bronson also used lexical information collected by linguists in order to determine which root crops had specific names in Mayan languages, as well as how often these words were used in native sources (Bronson 1966:263).

While the tropical climate in many areas of Latin America has made it difficult to find traces of crops in the archaeological record, recent starch grain analysis has allowed archaeologists to recover evidence of ancient root crop use. Researchers in South America and the Central American Isthmus have been particularly successful in recovering such starch grains (Dikau et al. 2007; McKey et al. 2010, though Mesoamerican scholars have been utilizing this new technology as well (Hather and Hammond 1994; Piperno 2009; Ranere et al. 2009). The majority of these starch grains have been identified as *manioc*, but possible charred starch grains from *malanga* were also found, which will be discussed in further chapters (Hather and Hammond 1994:334). Further research on starch grains in the Maya area will hopefully be continued, as this is the best way to uncover direct archaeological evidence of ancient root crop use.

CHAPTER 3

NEW WORLD CROPS

The majority of New World root crops originated from, and continue to be grown and utilized in, South America and the Caribbean. While plants like the potato and arrowroot remained outside of Central America in prehistoric times, others were transported to Mesoamerica and into the Maya area, including: *jícama*, sweet potato, *manioc* and *malanga*. The examination of the different morphological attributes and edaphic requirements of these root crops can aid archaeologists with both understanding the agricultural methods used for growing New World root crops in the past as well as their dietary uses.

A. Brief Background on the Andes, Amazonia, and the Caribbean

Figure 10. South America

Within the Andes and Amazonia (Aveni 1990; Burger 1984; Cárdenas 1979; Isbell 2008; Kano 1979; Moore and Mackey 2008; Moseley and Day 1982; Moseley and Mackey 1973, 1974; Pozorski and Pozorski 1988), there are three main contrasting landforms: 1) The arid Pacific coast (Araya-Vergara 1997:249-258; Benfer 1984; Grieder et al. 1988; Moseley 1975; Weir et al. 1988); 2) The Andes mountains or highlands

(Benfer 1984; Burger 1992:12; Grieder et al. 1988; Moseley 1975; Weir et al. 1988); and 3) the Amazonian lowlands or tropical forest (Rebellato et al. 2009:20). While the inhabitants of the coastal areas focused their efforts primarily on the intensive use of maritime resources during this time, some floodplain agriculture was also implemented as well. This cultivation occurred along the banks of the rivers, which allowed the population to take advantage of seasonal inundation. Crops utilized during this time included potatoes, sweet potatoes, *manioc*, *jícama*, peanuts, lima beans, squash, chili peppers, maize, and guava (Brochado 1984; Lathrap 1970). In contrast, in the highlands, there was a larger focus on rainfall agriculture and, because maize grows better on alluvial valley floors, root crops like potatoes, *oca*, and *ullucu* that are better adapted to valley slopes were most likely grown more often in the area (Grobman 1961).

Figure 11. The Andes (with sites) and The Amazon

The Caribbean Islands form an archipelago chain encircling the Caribbean Sea, running east from Cuba to the Leeward Islands, and then south to Trinidad (10 km from the South American mainland), and was first populated by South Americans around 7200 years ago (Higman 2011:1-2; Osgood 1942). Compared to its neighbors, the vegetation of the islands was probably more similar to Central America than South America, but differences in soil, elevation,

Figure 12. The Caribbean Islands (updated from Caribbean Islands Satellite Map, geology.com)

temperature, and rainfall even within the Caribbean islands are substantial (Carbone 1980). In the mountainous regions of Puerto Rico and Jamaica, for example, heavy and regular rain falls throughout the year that allowed for growth of montane forests while other areas of the same islands had prolonged dry periods more suitable for shrubs and cacti (Haggett 2002:474-489). The majority of the islands were populated by about 3000 years ago, with early inhabitants continuing to engage in a hunting, gathering, and fishing lifestyle, with the emergence of forest burning to clear land in Hispaniola and Puerto Rico 5400-5300 years ago (Piperno and Pearsall 1998). By AD 500, however, the larger islands planted crops such as manioc, maize, and agave in kitchen garden settings (Higman 2011: 27, 33). At the time of the Conquest, the Taínos (the largest culture group at that period) did not practice slash-and-burn but, rather, heaped up mounds of earth in more permanent fields (called *conuco*) to cultivate root crops in the alluvial soil. In addition, inhabitants discovered living in southwestern portions of Hispaniola (where the climate was much dryer) apparently constructed extensive irrigation systems in addition to planting root crops (Sauer 1966:51-54; Sturtevant 1961).

B. Common New World Root Crops

Roots and tubers are storage organs that have developed in many families of plants, possibly as a result of selective pressures in those environments with variable amounts of rain (Leon 1977:20). The storage organs permit the accumulation of nutrients, and by growing underground they can maintain these nutrients with minimal loss. Although different storage organs may vary in their structure, the nature of their storage tissues is common to all. Consisting mainly of water and starch grains, storage organs may also contain poisonous, bitter, or acrid substances in the storage tissue as a deterrent to animals.

Storage organs may be either roots or stems. In roots, also called “tuberous roots,” the storage tissues may derive from a normal cambium (e.g. *manioc*), or tertiary cambiums that develop around vascular elements (e.g. the sweet potato). The thickened, tuberous roots develop fibrous roots that are then used for the uptake of water and nutrients. Storage stems include rhizomes, corms, and tubers. A rhizome is defined as a thickened stem growing (either partially or entirely) below ground. The roots of the plant then grow from the underside of the rhizome and send up leaves and flowers above ground. A corm is a swollen, underground stem base that is composed of solid tissue. A tuber is similar to a corm in that it is an enlarged stem base, but, unlike corms (and tuberous roots), roots grow from many different points on the tuber instead of just from the bottom. Due to the fleshy tissues of the storage organs of root crops, they are easily destroyed by fungi, bacteria and insects, and thus difficult to find in the archaeological record. In addition, most grow in wet regions and the materials preserved are very scarce and irregularly distributed.

Vegetative propagation – a form of asexual reproduction by which a piece of the mother plant is taken and re-planted – is necessary in most root crops because of their inefficiency in producing seeds. In modern agriculture, and most likely ancient agriculture, the use of vegetative propagation is particularly important because it permits the multiplication of superior and uniform materials in large monoclonal plantings. Frequently the planting material is the edible part, and in times of scarcity or famine, the "seed" has to be eaten (Leon 1977:24). As a whole, however, vegetative propagation, especially in monoclonal plantings, is an important restriction in increasing variability. By only reproducing through the mother plant, it is difficult to introduce new traits (Abraham et al. 1964).

Potato

Morphological Attributes

Potatoes are one of the most frequently utilized tubers in the world today, and originated in the Andes of South America. While considered one species (*Solanum tuberosum*), potatoes are actually made up of multiple groups and hybrids (Ugent 1970). The potato is known to be drought-resistant and, as a result, it was likely a high commodity in the dryer and colder areas of South America.

Environmental Considerations

The potato is the most common root crop in the Andes, domesticated in the Peruvian-Bolivian *altiplano*. Due to its area of origin, the potato grows best at altitudes over 3000 meters above sea level. The oldest potatoes date to 2000 BP, and are represented in ceramics of the third century BC (Leon 1977:33) continuing into the Nazca, Chimú, and Inca cultural periods. Because of its prevalence in dryer regions as opposed to tropical ones, however, the potato was not grown in Mesoamerica and therefore will not be discussed further.

Arrowroot

Morphological attributes

Arrowroot (scientific name *Maranta arundinacea)* is a plant with a rhizome (Stutervant 1969). An herbaceous, perennial plant, arrowroot often grows to a height of .9-1.5 m and has rhizomes that are in fact a good source of starch (Ciacco and D'Appolonia 1976; Erdman and Erdman 1984; Lii and Chang 1978; Raymond and Squires 1969). In the modern-day processing of arrowroot to obtain starch, the roots are often crushed and then screened to separate the coarse and fine fibrous residue from the starch. The starch settles by gravity and subsequently air-dried in naturally ventilated buildings (Erdman and Erdman 1984).

Environmental considerations

Arrowroot was first domesticated in the lowlands of northern South America, and is perhaps one of the oldest root crops in the Americas. Archaeologically, arrowroot can be seen by ca. 8600 BP, and was found in the Aguadulce Rock Shelter in Central Pacific Panama. By around 7554-7640 BP, it had traveled to Western Panama, where it was found in the Chiriqui Rock Shelters. Finally, between, between 5260-5000 BP, it was located in Southwestern Ecuador, near the Valdivia Sites in Real Alto (Piperno 2011:S458). Arrowroot has had a long history in Polynesia as well and, today, the island of St. Vincent in the Caribbean produces over 98% of the supply of arrowroot starch for the United States, Canada, Britain, and Europe (Bolt 1962). Beginning around the 1970s, however, areas with similar climates and environments have been used to grow arrowroot as well, including other islands in the Caribbean, Southeast

Asia (Motaldo 1967), South America, the Philippines (Kay 1973), and India (Maury and Barooah 1976).

Sweet Potato (*batata*)

Morphological attributes

The sweet potato (scientific name *Ipomoea batatas*), a tuberous root, is known to have been (and still is) a staple food source for many indigenous populations in Central and South America, Africa, the Caribbean, Hawaii, and Papua New Guinea. In addition to being a good carbohydrate source, sweet potatoes also contain important health-promoting compounds such as beta-carotene and anthocyanins. The roots, leaves, and shoots are all edible, with the dark green leaves having nutritive values comparable to common dark green leafy vegetables (Bovell-Benjamin 2007; Ishida et al. 2000). While often called a yam in the United States, sweet potatoes are different from true yams in that the edible storage organ of the sweet potato is a true root, while for the yam it is a tuber. As a result, the appearance and shape of sweet potatoes and yams are different: the sweet potato is usually smaller, short, and blocky with tapered ends, while yams are usually long and cylindrical (Bovell-Benjamin 2007:4). The sweet potato is particularly useful due to the fact that it can reproduce by three means: asexually, vines that can be planted to produce daughter plants, and sexually through its seeds (Woolfe 1992:24).

Environmental considerations

The first appearance of the sweet potato is in coastal Peru, where tubers have been dated to as far back as 10,000 BP (Engel 1970). A long history of sweet potatoes in coastal Peru has also been demonstrated through starch grain analysis conducted by Piperno and Holst (1998). In addition to growing throughout Central and South America and the Caribbean, the sweet potato was one of the first crops to be introduced to Spain from the New World. From Spain, the sweet potato was taken to China in 1594 and; after a famine in Fukien, later became an important crop in that region as well. It was also introduced early on to Japan, and has grown well in the southern region (up to 35 degrees N). Today, the crop has spread to most of the world's tropical, sub-tropical and warmer temperate regions, and among the world's root crops, the sweet potato ranks second only to the potato in economic importance (Horton 1998:10; Woolfe 1992:19).

Jícama

Morphological attributes

The plants of this tuberous root species (scientific name *Pachyrrizus erosus*) offer such variability in size, shape of leaves, and tuberous roots that the specific limits are difficult to recognize. *Jícama*, however, can still often be identified by its very long and large tuberous roots that can reach 6 to 8 feet long and weigh up to 50 pounds. The roots are often round and beet-shaped with a distinctive taproot and can be eaten raw or cooked. This root is a good source of ascorbic acid, thiamin, riboflavin, niacin, and other important minerals (Fernandez et al. 1997:279). The vining tops can reach up to 10 to 20 feet in length, and have compound leaves with pointed edges, white flowers, and green lima bean-shaped pods (Fernandez et al. 1997:284).

Environmental considerations

Jícama is one of the most successful New World root crops in modern times. While domesticated in Central America and grown from Mexico to South America, it is also able to grow in Asia and Oceania (Piperno 2011:S458). *Jícama* does best in warm climates with moderate rainfall and, today, *jícama* is produced commercially in tropical regions like Puerto Rico, Hawaii and Mexico (Stephens 2011). *Jícama* roots are, however, particularly susceptible to chilling injury, and storage at 10 degrees Celsius or below often results in chill damage within 2 weeks (Cantwell et al. 1992; Mercado-Silva et al. 1998; Mercado-Silva and Cantwell 1998).

***Manioc* (*cassava*)**

Morphological attributes

Manioc, also known as *cassava* (scientifically, *Manihot esculenta*), is a plant with a tuberous root and has a wide morphological diversity, with clusters of closely-related species in both North and South America (Rogers and Fleming 1973). *Manioc* is a perennial plant that is often handled as an annual but, due to its hardiness, can also offer harvesting flexibility to the farmer. *Manioc* simply grows when conditions are favorable and, when they are not, the plant drops its leaves and assumes dormancy until favorable conditions return (Ceballos et al. 2010:54). In terms of processing methods, the most important *manioc* trait for its use as food is the HCN content of the root's cortex. The amount of HCN can range widely, from high ("bitter" *manioc*) to very low ("sweet" *manioc*). "Sweet" *manioc* tends to occur in the western side of South America as well as in Central America. "Bitter" *manioc* is better known in the eastern side of South America and the Antilles (Dufour 1993; Renvoize 1972).

Environmental considerations

Due to its preference for dryer areas, *manioc* tends to grow better in South America than in the Yucatán and Petén, and the prevailing hypothesis is that cultivated *manioc* originated in South America (Allem 1994, 2002; Olsen and Schaal 2001). A large proportion of *manioc* varieties is drought tolerant and can produce in degraded soils as it is naturally tolerant to acidic soils. Though domesticated in the New World, *manioc* was introduced in the 16th century to Africa by Portuguese explorers. The crop continued to spread further in Africa, and was adopted first as a vegetable and later as a flour source (Jones 1959). *Manioc* was also introduced to India and Southeast Asia in the 19th century.

***Malanga* (*Xanthosoma violaceum*)**

Morphological attributes

Cultivated for its corms, the genus *Xanthosoma* is found from Mexico to Brazil, but most of the cultivated species are now generally centered in the Caribbean. The plants rarely flower, but the leaves of Xanthosomes can grow fairly large and are often used ornamentally (Ray and Renner 1990:59-60 [Engler 1877]). In modern-day countries like Nicaragua, the corms are used for propagation and animal feeding while the cormels are used for eating. (ReyesCastro, Nyman and Ronnberg-Wastljung 2005:267).

Most members of the Araceae family (to which *Xanthosomes* belongs) contain minute, needle-like crystals of calcium exalate scattered through their tissues. These crystals can be found in all parts of the plant, including roots, tubers, rhizomes, stems, leaves and fruits. In *Xanthosoma* varieties, the tuber contains the largest amount of calcium exalate. The crystals are often accredited with an acrid, burning sensation in the mouth where parts of the plants are chewed. This sensation is the result of the crystals piercing the mucous membranes which elicits a stinging sensation, which in turn has been likened to the feeling of eating radishes. The crystals, or “raphides,” of calcium oxalate are easily destroyed and their burning properties dissipated through sun drying or heating. For *Xanthosomes* and other Araceae genera with edible tubers, the cortex of the tuber can also be removed in order to get rid of the calcium oxalate (Plowman 1969:97).

The tubers are eaten boiled, sometimes with salt and large quantities of peppers, but it can also be eaten baked. *Malanga* can also be ground down and used as flour and, in the Philippines, is used to make pastries with coconut (Plowman 1969:119). In addition to being a good source of starch, *malanga* also contains chemical compounds such as alkaloids, glycosides, saponins, essential oils, resins, several sugars, and organic acids (Plowman 1969:98). By containing essential carbohydrates, proteins, fat and vitamins, *malanga* has the ability to be an important food source (Tambong et al. 1997; Torres et al. 1994; Wilson 1984).

While the tuber portion of *malanga* provides a good source of carbohydrates, the leaves of the plant have also been demonstrated to contain antioxidant and free-radical scavenging properties. Using powdered, air-dried leaves from *malanga* plants collected near Riobamba Ecuador, Picerno et al. identified high levels of phenolic compounds – especially flavones – that have been proved to be effective as antioxidant agents (2003:6424). More specifically, it was shown that the leaves contained a series of C-glycosyl flavones and apigenin derivates – glycosidation has been reported to decrease the radical scavenging of the host molecules. The structures of the C-glycosyl flavones that were isolated in the leaf extracts seemed to be correlated to these free-radical scavenging properties. The presence of polyphenols in the leaves also contributes to cardioprotection and anticarcinogenation, which makes *malanga* even more appealing for usage (Picerno et al. 2003:6427).

Environmental and edaphic considerations

The genus *Xanthosoma* was introduced to Africa by the 1850s, and since then, has slowly become a replacement for taro – which has a lower yield and more resistance to disease (Léon 1977:34). It is currently known in Portuguese Africa as "*batata de taxola*." Today known as "cocoyam" in modern-day Nicaragua, *malanga* has become the third most important starch food crop in the country after the potato and *manioc* (ReyesCastro, Nyman and Ronnberg-Wastljung 2005:265). The major producing areas for *malanga* in Nicaragua are located in humid zones, and production relies on small farmers having .5-2.0 ha in production. Due to large demand, however, farmers in non-traditional *malanga*-producing areas have begun to establish small commercial areas to expand production. While growing *malanga* in the dry zones of Northwest Nicaragua is not as effective, the use of small plots of land in the area has been successful enough to ensure continued farming (ReyesCastro, Nyman and Ronnberg-Wastljung 2005:266).

In order to determine how well *malanga* grew in different climatic locations, ReyesCastro, Nyman and Ronnberg-Wastljung (2005) conducted field experiments in four different location during the rain season in 1999 and 2000 in Nicaragua: Masaya (hot and very dry), Nueva Guinea (cool and very humid), Nueva Segovia (cool and humid, in a high altitude), and Managua (hot and dry). Previous studies (Caesar 1980; Goenaga 1994; Onwueme 1978; Onwueme and Charles 1994; Torres et al. 1994, 2000) determined that one of the main features of *malanga* is its high water requirement during its initial stages of growth. According to Onwueme and Charles (1994), rainfall between 1400-2000 mm/year is required to obtain optimal growth and development. Any water stress during this growing period can retard general growth and reduce the yield, which ReyesCastro and his colleagues observed in Masaya.

A temporal drought was reported early in the growing season in Masaya in 1999, which then resulted in the production of secondary shoots (ReyesCastro, Nyman and Ronnberg-Wastljung 2005:270). In addition, as previous studies examining water supply in the end of the growing season (e.g. Goenaga and Chardón 1993; Onwueme and Charles 1994), Reyes Castro et al. found that any water supplied after the time when the cormels (the part of the tuber that is eaten) have reached maturity results in the growth of the root and shoot meristems of the cormels (2005:271). In all, the production of *malanga* in the rainforest area of Nueva Guinea, where the climate is stable and humid, was generally higher than in other areas. The unpredictable and variable climate of Masaya and the water stress conditions in Managua favored the production of secondary shoots from the corms.

C. A Note on Taro

Figure 13. *Taro* Leaf

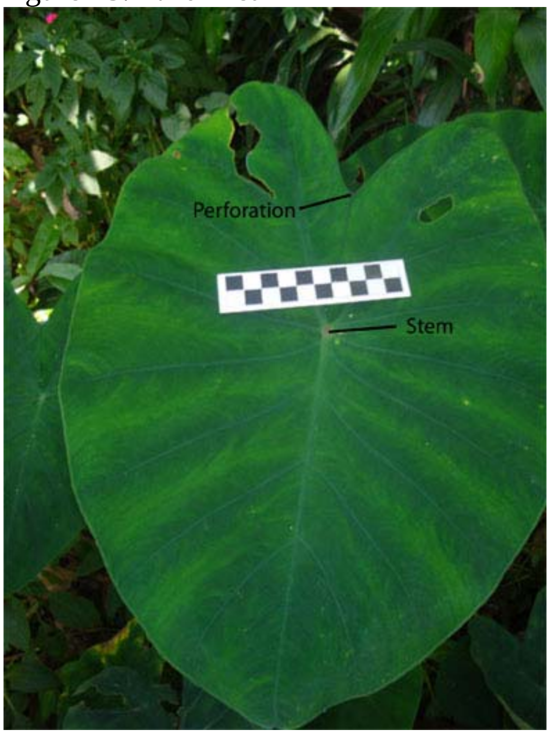


Figure 14. *Malanga* Leaf

Taro, or *Colocasia esculenta*, is a tropical root crop grown for its edible corms. Closely related to *Xanthosomes*, *taro* corms are almost unrecognizable when compared to those of *malanga*. As a result, in Central America, what is actually *taro* is often believed to be *malanga*, though *taro* is not indigenous to the New World. *Taro* is most likely native to the lowland wetlands of Malaysia, and evidence suggests that it was cultivated in wet tropical India by 4300 BC (Rao 1974). Taro was introduced to the Americas from western Africa in the early 1500s and, by the 18th century, it had spread from the Caribbean to Brazil (Leon 1977:28). The most effective way to tell *taro* and *malanga* apart from one another is to examine their leaves. In Taro, the stem hits right in the middle of the leaf and creates a perfoliate leaf, while in *malanga*, the stem hits the actual vein of the leaf, creating a sagittate leaf form (David Lentz, personal communication 2011). Due to the confusion surrounding *taro* and *malanga*, “cultural malanga” – named *malanga* that is actually *taro* – will be referred to as “malanga” instead of *malanga*.

CHAPTER 4

STUDIES ON NEW WORLD ROOT CROPS

In his attempt to show that some root crops could be staple crops important enough to rival maize Bennet Bronson (1966) relied on ethnographic, linguistic, and some limited ethnohistorical evidence. Moreover, in calling for more attention to be paid to the role of root crops in ancient Maya subsistence, Bronson focused on four different root crops seen in the Maya area today: *camote* (sweet potato), *jicama* (yam), *yuca* (*manioc* or *cassava*), and *yautia* (*Xanthosoma violaceum*). Drawing on ethnographic data from modern distributions of Maya peoples (focusing predominantly on the Lacandon), Bronson found that three of the four “most unacculturated” groups utilize a variety of roots (1966:257). Bronson also stated that lexical evidence shows that words for *camote* and *yuca* in particular are held in common by all major branches of the Mayan linguistic stock, which suggests that these words and the objects to which they refer have great time-depth among the Maya. *Jicama* and *malanga* lack this linguistic prominence, with *jicama* (“*xicam*” in Mayan) first appearing at the end of the 16th century. No Maya word for *malanga* appears in the early literature except “*macal*,” which is used in the *Book of Chilam Balam* (Bronson 1966:263).

In order to add to Bronson’s research, I have also compiled ethnographic, ethnohistoric, and iconographic data on New World root crops and, where applicable, have tried to provide as much information on *Xanthosoma violaceum* as possible.

A. Ethnography

South America

Due to its large use in Amazonia, *manioc* has been the main root crop studied ethnographically in South America. The difference usage of “bitter” vs. “sweet” *manioc* in has been a particular source of interest, and the “bitter” cultivars appear to have been the staple crop in the Amazon Basin, northeastern South America, and the Antilles (Nordenskiold 1924; Renvoize 1972; Steward and Faron 1959:293). “Bitter” *manioc* has a higher level of cyanide and cyanogenic glucosides than “sweet” *manioc*, leading to questions as to why there is a preference for a potentially more toxic cultivar. Using data on the characteristics of the *manioc* cultivars used by Tukanoan Indians in northwestern Amazonia, Darna Dufour (1989; 1993; 1995) was able to understand this preference, as well as how the Tukanoan Indians grew and processed their crops. Living in a village setting, modern-day Tukanoans practice swidden agriculture with *manioc* as the principal crop. Secondary crops, however, also include *taro* (not native to the area), sweet potato, and arrowroot (Dufour 1993). In her study, Dufour found that Tukanoan Indians preferred the “bitter” *manioc* due to cultural preferences, since “bitter” cultivars become sweet when glucose is released from the cyanogenic glucosides through processing. Since Tukanoans used manioc to create breads like *casabe*, the “bitter” *manioc* made better quality bread because it ferments better (Dufour 1993:586).

Ethnographic research of semi-sedentary lowland South America has been particularly useful in determining the use of manioc as a staple crop, as opposed to other well-known crops such as maize. According to Brochado (1977:57), manioc was the caloric staple of most of these lowland South American Indians. In addition, of the 533 indigenous peoples he studied that cultivate manioc, 86.4% employed it as a primary food source and only 13.6% used it only as a supplementary resource. Shorr (2005:85) also found manioc to be the staple crop among the Tikuna, who live on high ground above the floodplain of Amazonia. While this area is comprised mainly of infertile upland soils, the Tikuna are able to sustain themselves through farming due to the ability of manioc to grow in nutrient-deficient soils (Neves and Petersen 2006:301). Several Caboclo settlements on Ituqui Island also used manioc as the largest source of calories (Murrieta and Dufour 2004), which shows that manioc is capable of being a staple crop in a number of different environments.

Central America

The Lacandon Maya of Chiapas, Mexico have been some of the most well-studied peoples through ethnographic research. Through the inferred continuation of their traditional system of agriculture and food extraction, many archaeologists have – falsely - used the Lacandon lifestyle as an analogy for ancient Maya agricultural strategies. Lacandon subsistence strategy centers around a multipurpose land-use system that takes advantage of a number of food-producing resource areas, including: primary forest, *milpa*, secondary forest growth, marshes, and rivers, lakes, and streams (Nations and Nigh 1980:8). The Lacandon practice swidden agriculture, plant maize *milpas*, and allow secondary forest growth on *milpa* land during fallow periods in order to maintain a sustainable system. While this is their main source of food, however, the Lacandon also plant a wide variety of other root, tree, grain, and vegetable crops during the rainy season (May through October). Known cultivated root crops include the sweet potato, *manioc*, *jícama*, and *malanga* (Nations and Nigh 1980:10). According to ethnographic research (Nations and Nigh 1980), the Lacandon put the leaves of sweet potatoes and *jícama* on the ground between the hills of maize on the *milpa*. In addition, root crops are planted at varying depths below the *milpa* surface, with *malanga* and sweet potatoes a few inches beneath the soil, and *manioc* below them. In this way, both maize and other crops are able to utilize available space, water, and soil nutrients in a highly efficient manner. For the Lacandon, maize is a staple crop, but many other crops (such as root crops) are planted along with maize and eaten as well.

Recent ethnographic research on the Ch'orti' Maya, the culture that probably originally inhabited Cerén at the time of the Loma Caldera eruption (Sheets 2009), has presented important information on how the Ch'orti' see their own relationship to their environment. According to Johanna Kufer, Ch'orti' speakers refer to themselves as *ajk'opot gente* or *ajk'opot pak'ab*, which means "people of the countryside or hamlet" (Kufer 2009: 198). By creating the distinction between themselves and the city-dwelling Ladinos who don't farm their own land, the Ch'orti' appear to differentiate through settlement pattern. The modern-day Ch'orti' lifestyle can also provide archaeologists with a template for how agriculture may have been divided up within the household. According to Kufer, the production of maize, beans, and squash in the *milpa* is traditionally a male activity while women procure a wide diversity of local vegetables. Women often tend to patio gardens that contain non-staple crops such as manioc (Kufer 2009:204). Thus, the ethnographic work here shows that present-day Ch'orti' do not use root crops as staple crops but, instead, focused on the Mesoamerican triad of maize, beans and squash.

Some ethnographic accounts do indicate that *malanga* has been grown in many parts of Mesoamerica, which may account for the numerous names in different places. According to these accounts, the roots are poisonous when raw, but the poisonous properties (attributed to the presence of "irritating crystals") are destroyed by cooking (Standley and Steyermark 1958:362). However, determining what type of *Xanthosome* is being used, or even if a particular plant is *Xanthosoma* can be difficult. Since there is not common name, with different places referring to the plant as "*yautia*," "*malanga*," "*munul,*" "*tiquisqui,*" etc., confusion is inevitable. In addition, modern Maya call malanga "*macal*," which is the same word used for the true yam that was introduced by the Spanish during the 16th century (Bronson 1966:258). It has been suggested that the new plant was give the name of the older *Xanthosoma*, after which both plants continued to exist side by side as plants cultivated by the Maya. Without this distinction, what is actually *malanga* may be mixed up with what are being called yams and, as a result, *malanga* may have a more extensive distribution than appears from the literature (Bronson 1966:259).

B. Ethnohistory

Due to the preoccupation of archaeologists with maize agriculture, ethnohistorical evidence for the widespread use of root crops in Mesoamerica at the time of the Conquest has not been fully examined. Most ethnohistorical sources available today come from highland Central Mexico, and while we cannot make a direct comparison between 16th century Central Mexico and 6th century El Salvador, these sources can help us gain a better understanding of how root crops may have been used (Acuña 1982-1987; D'Anghiera 1990; Barros 2007; Feldman 1993; Sahagún 1590).

The different types of cultivated *Xanthosomes* (*Xanthosoma saggitifolium, X. violaceum, X. yucatanense,* etc.) are botanically similar and are generally not differentiated in historic literature. Thus, while we can conclude archaeologically that *X. violaceum* was found at Cerén, as identified by David Lentz et al. (1996), there is not much that can be said about varietal distribution around Mesoamerica. *X. yucatanense*, however, is known specifically for its edible roots and can be identified as one of the wild *Xanthosomes* eaten in the Petén and the Yucatán (Leone 1968). With all the confusion around *Xanthosoma*, however, it is difficult to know, based on solely historical sources, whether the Maya used several varieties, or even how much of an emphasis was placed on that crop. By studying Contact- and Colonial-era documents for references to root crops, I hope to determine the ways in which roots were used in order to provide ideas for how the ancient Maya may have used roots as well. To make this research transparent and replicable, I will also discuss the methods I used to search these documents.

The Relaciones Geográficas del Siglo XVI

The primary source used in my own ethnohistoric research was the *Relaciones Geográficas del Siglo XVI*, of which I used ten volumes relating to Central Mexico. These volumes included the areas of Guatemala, Antequera, Tlaxcala, Mexico, Michoacan, and Nueva Galicia, which are the names given to the different territories of New Spain in the Colonial period. The *Relaciones Geográficas* were created on the order of King Philip II of Spain. As Spanish imperialism continued to grow throughout Central and South America, and into the Philippines, the government found it necessary to have a systematic way of learning about their newly conquered territories. This system became a series of fifty questions that were to be used both in Spain as well as Spanish colonies overseas (Cline 1964:341). Instructions were included with each questionnaire, addressed to the governors, mayors, or *alcaldes* mayors of specific areas, that explained exactly how to report on the Spanish and native people living within their jurisdiction. When all the questionnaires had been distributed to the various villages and filled out, they were to be "sent to His Majesty and the Council of the Indies." (Acuña 1982:25) The people in charge of each village (i.e. those that

Figure 15. Map of provinces mentioned in the *Relaciones Geográficas*

gained a high position based on good relations with the Spanish government) were given the duty of filling out each report, in a very specific way. First, they were supposed to write down the exact date, the name of the people who completed the report, and the name of the governor or mayor that sent them the instructions and questionnaire. They then had to report on each chapter, or question regarding their own village (Acuña 1982:26).

Figure 16. Map of provinces (with names labeled) mentioned in the *Relaciones Geográficas*

Going through each volume, I looked for certain key words that would help me find all references to root crops. The first words that I searched for were *raíz* and *raíces*, which are the Spanish words for root and roots (as the *Relaciones* were all in Spanish). This allowed me to find any mention of the use of general roots, as well as any plant described as a root. I also used the words *batata*, *camote*, *yuca*, *jicama*, which were the main root crops referred to in other ethnohistoric sources. Unfortunately there were no instances of any of the names used for any

Xanthosome. After recording each root reference in a database, I was able to create a set of tables characterizing the references to different root crops. The information compiled in these tables include the *Relacion* from which they came from, the provincial location and the specific town, if given, from which the report was recorded. Next, I included the name of the root found in the report (if there was no name, the cell was simply labeled "general roots") as well as the different names attributed to it, and which languages they were from. The uses were written down as well (if given), in addition to the passage from the report and the chapter number that it was taken from.

Since many of the *Relaciones* included root names in multiple languages, I also chose to use some linguistics in my research. I first examined how many roots were given names in multiple languages and surmised that this may be an indication of its importance. If more language groups recognized the root, this could be because it was used more widely. I used Nahuatl, Mixtec, and Zapotec dictionaries to determine whether root names were translated correctly, though none of the Zapotec root names found in the *Relaciones* were in the Zapotec dictionary. With the exception of one Mixtec name, all the translations (or, at least, all those that were in both the dictionaries and the *Relaciones*) seemed to be correct. It was also interesting to note the exact translations of certain roots, as this led to more information pertaining to important root crops, such as *camote*, which will discussed later on. However, as I have no background in either the Nahuatl or Mixtec languages, I relied heavily on what the dictionaries said, which is not the most advantageous method since different translators will create different dictionaries.

Camote (Nahuatl) / *Batata* (Spanish) / *Ñami* (Mixteca) / *Chayotes*

Before examining specific types of root crops, the term "*camote*" should first be discussed. *Camote (*known in Spanish as *batata)* is a general term used for all edible root crops.

In the provinces of Guatemala, Antequera, Tlaxcala, Mexico, Michoacan, and Nueva Galicia in particular, all root crops are referred as both *camote* and *batata* (Acuña 1982:145-146; 1984a:170, 190, 191, 195, 200, 205; 1984b:60, etc.). In addition to the Nahuatl and Spanish names for the root crop, there is also mention of the Mixtec word for *camote,* which is *"ñami."* (Acuña 1984a:322; Morales 2008:264). The presence of Nahuatl, Mixtec, and Spanish words for root crops indicates that, in addition to the high frequency of references to edible root crops in the *Relaciones*, there is also linguistic evidence for the predominance of root crops.

Figure 17: Map of provinces (with names labeled) mentioned in the *Relaciones Geográficas* as having *camote*

<u>*Guaucamote* (Nahuatl) / *Yuca* (Island of Hispaniola) / *Yuca Boniata*</u>

Yuca, called *cassava* or *manioc* in English, is the second most predominant root crop reported in the *Relaciónes*. Like *camote*, *yuca* is found in Guatemala, Antequera, Tlaxcala, Mexico, and Michoacan, though it was not reported in Nueva Galicia. *Yuca* is often discussed alongside maize, beans, and squash, and is usually mentioned with *camotes* in the same sentence (e.g. Acuña 1982:95-96, 109, 132). Y*uca* is specifically the name used for *manioc* on the Island of Hispaniola, which today consists of the countries of the Dominican Republic and Haiti. In this Caribbean area, much of the *yuca* grown was poisonous, but the so-called "*yuca boniata*" contained little to no poison, and was the only type of *yuca* found on the New World mainland. As a result, *yuca* and *yuca boniata* are both used to mean *manioc* due to the fact that the *Relaciones* only pertain to the mainland, and thus all *yuca* discussed is actually *yuca boniata*. In Tlaxcala, *yuca* is referred to as "*quaucamotl*," which is also the word used in Siméon's Nahuatl dictionary (Acuña 1985b:247, 273). Spelled "*quauhcamotli*," which I believe is similar enough to *quaucamotl* to be seen as the same word, the definition is said to be, "a plant of the family of convolvulaceae; has roots that have the taste of a *camote*, and are good to eat." (Siméon 1997:408).

Figure 18: Map of provinces (with names labeled) mentioned in the *Relaciones Geográficas* as having *yuca*

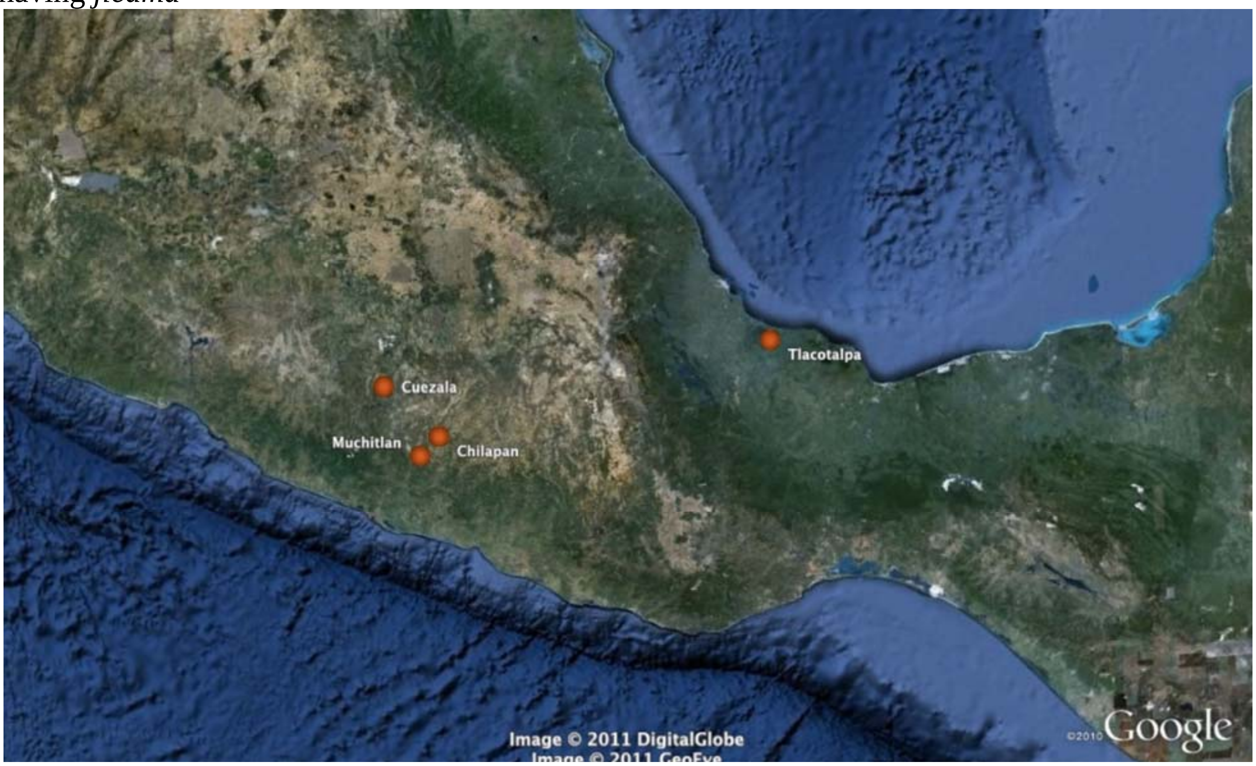
As previously stated, *yuca* can be seen in most of the general areas covered by the *Relaciones*. It does not, however, appear to have a name besides the one in Nahuatl, and the Spaniards on the Island of Hispaniola (or, rather, the *Relaciones* reporters) did not include its name in any other languages. In either case, the *Relaciones* reporters did not find *yuca* in another language other than Nahuatl, or, they did not think it was significant enough to write down the root's name in other languages. In both cases, the *yuca* plant is recognized as note-worthy root, but is not so influential as to garner its own special name within the different languages.

<u>*Xicama(tl)* (Nahuatl) / *Ña'mi kuiji* (Mixtec) / *Jicama* (Spanish)</u>

Unlike *yuca*, *jicama* is found in a much more restricted geography in the *Relaciones*, being mentioned only in Tlaxcala and Mexico. Like the other roots, however, it is described as a food, and is included with foods such as beans, squash, maize, and *camotes* (or *batatas*). In all four references to *jicama*, the root is described as being similar to a turnip, or a round turnip, which gives hints as to how the recorders connected indigenous foods to the foods known in Spain (Acuña 1985a:116, 273, 293; 1985b:319). Based on these *Relaciones,* however, it is unclear how *jicamas* were similar to turnips, since they could be alike in shape, color, taste, smell, or a number of other characteristics.

Siméon's Nahuatl dictionary contains the words "*xicama*" and "*xicamatl*," which both describe a root whose leaves are edible, and whose root is, "very sweet when eaten raw." (Siméon 1997:764). Even though *jicama* is not mentioned very often in the *Relaciones*, it is important to note that there is, in fact, a Mixtec word for *jicama* as well (which is not mentioned in the *Relaciones*). As mentioned previously, many different root crops in the Mixtec language are named as a certain type of *camote*, and *jicama* is treated in a very similar way. There are multiple synonyms in the Mixtec language for jicama which already sound and look very similar to the Nahuatl word, such as "*xikama*," "*tikama*," "*tyikama*," and "*sikama*" (Morales 2008:519). The main Mixtec word, however, is "*ña'mi kuiji*," which means white *camote* (Morales 2008:787).

Figure 19: Map of provinces (with names labeled) mentioned in the *Relaciones Geográficas* as having *jícama*



Specific Root Crops Used as Food

One of the main uses for roots, as laid out in the *Relaciones* is, of course, food (see Table 1 below). As can be seen in the previous sections *yuca*, *jicamas* and generic *camotes* are the most prevalent type of root crop used as food within the *Relaciones*. In fact, of all of the references to specific root crop names as food, only three are not named as *camote*, *yuca*, or *jicama*. The first, from Chinantla, is called *puscuaucamote*, and explicitly states that the root is a type of *camote*. The *puscuaucamote* is used to make tortillas, which is unique in that there is no other reference to this type of root or to any root crop being used for tortillas (Acuña 1984a:103, 106). Another root is called *mexcale*, used to make a "sweet food," though it is unclear as to whether *mexcale* actually refers to the name of the root, or if it is the name of the food that is created (Acuña 1986b:131, 148). It is also unclear as to what "food" is supposed to mean, but there is a very short passage on how the food is made. According to the Tecpatepec *Relacion*, the root is cooked underground and then used as the so-called sweet food (Acuña 1986b:148). Unfortunately, I was unable to find any other reference to *mexcale* in my other sources. There is also a specific type of bread that is made from *yuca*, called *cazabe*, which is only mentioned in the *Relacion* of Chinantla (Acuña 1984a:103, 106). It will, however, be discussed in further length later on.

The other root, from Huexutla, is called *quequexquitl*. According to the reporters of the *Relacion*, there is not a Spanish name for it, which could either mean that the Spaniards were not particularly interested in this root, or that the root was uncommon enough that they found no reason to name it. Interestingly, the *Relacion* also reports that *quequexquitl* "sustains [the natives] when they do not have maize." (Acuña 1985b:247) It has been proposed in the past that the Maya may have used root crops as a back-up for when they had a bad year when harvesting their main subsistence crops (i.e. maize, beans, and squash) **(**Bronson 1966, Rice 1978**)**. In this instance, at least, the *Relaciones* give evidence for root crops being eaten during tough times.

Other reports hint of this situation as well, though they do not give specific names for these roots. For example, in Atlatlauhacan, the natives of the area were forced to "sustain themselves, in their time of disloyalty," by eating "herbs and roots, and wild birds." (Acuña 1985b:49) This passage contains quite a bit of Spanish biases, particularly when referring to the time before they were finally conquered by the Spaniards as their "time of disloyalty." It is possible that the Spanish in this area had a general distaste for the herbs and roots that the natives ate and, as a result, believed they must have been eating these awful foods when they were warring with the Spaniards. I do not see much of an advantage in doing this, or an advantage for the indigenous peoples of the area to lie about what they were eating, so I do believe this necessary resourcefulness did occur.

Within the *Relacion* reports pertaining to root crops as food, however, there are some conflicting stories about whether or not it was desirable to eat root crops. Along with the general "they eat…" passages, there are multiple references to what the natives ate before the Conquest. The tone of each of these reports greatly relates to the views of the reporters of the *Relaciones*, and, in particular, how reliable the transcribers were when writing down what the Indians had to say. For instance, in the province of Coatzacualco, before the Spaniards arrived, the Indians ate *yuca*, and "they lived more than now," (i.e. lived longer before the Spaniards arrived) (Acuña 1984a:119). A similar example comes from Cozauhtepec, which states that the natives used to eat tortillas and *camotes*, "but now they eat less healthy." (Acuña 1984b:186) Clearly, these quotes insinuate that roots like *yuca*, and *camote* in general, were seen as healthy foods that the Indians ate in the past. In other places, however, the reporters assert that the Indians eat the same things today as they did in the past (1984b:172, 1986b:148). In Tzicaputzalco, they even go so far as to say that *camotes*, *huacamotes* (*yuca*), and *jicamas* were "healthy in the past *as well as now*." (1985b:273; emphasis added). Thus, while there are hints that in dire times roots would become a staple food source, it also appears that *camotes*, *yuca* and *jicama* were simply seen as healthy supplements to the maize, beans, and squash diet, both in pre-Conquest and Conquest times.

Another interesting use for the consumption of roots is during festivals, which, in Zapotitlán, require men to abstain from eating meat and drinking cacao. Instead, they eat "maize and chilies, fruits and herbs and roots." (Acuña 1982:40) Not only does this passage provide a better understanding of the times when roots were eaten, it also shows us which foods were the most important to the people of Zapotitlán. Cacao was seen as more of a prestige good, or at least more luxurious, throughout Mesoamerica. Meat would also have been seen as an important commodity, as there are few large animals in Mesoamerica and meat was rarely part of everyday meals. Meat and cacao, then, would have been considered more of a delicacy, whereas the other foods mentioned were seen more as a way to get much needed sustenance. In this respect, we can view roots in this area as a common food that was appropriate for "purging," or fasting from prized foods like meat and cacao, during festivals.

Table 1: Roots mentioned as food in the *Relaciones Geográficas*
*Note – table divided by Relación book, then further divided up by Province/City, the Town/Village located within that Province or City, and the different names given to each mentioned root.   Comments included where necessary.

Relacion	Province/City	Town/Village	Root Crop	Nahuatl	Mixtec	Spanish	Other Names	Use	Comments	References
Guatemala	Zapotitlán		*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#4: This land is abundant with fruits and other foods, like cacao and corn, beans, camotes (whose other name is batatas) #23: In low, wet areas, there are many types of roots	I (1982:36); I (1982:45)
			General roots					Food (for festivals)	#14 and 25: During festivals, the Indian men were not allowed to eat meat or drink cacao, but they ate corn and chilies, fruits and herbs and roots	I (1982:40)
	Santiago Atitlán	The Capital of Atitlán	*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat corn, beans and squash, batatas, yuca boniata	I (1982:95-96)
			Yuca Boniata	*Guacamote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food	#24: They eat corn, beans and squash, batatas, yuca boniata	I (1982:95-96)
		San Bartolomé	*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat corn, beans and squash, batatas, yuca boniata	I (1982:109)
			Yuca Boniata	*Guacamote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food	#24: They eat corn, beans and squash, batatas, yuca boniata	I (1982:109)
		San Andrés	*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat a large amount of batatas and yuca boniata	I (1982:132)
			Yuca Boniata	*Guacamote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food	#24: They eat corn, beans and squash, batatas, yuca boniata	I (1982:132)
		San Francisco	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#23: The Indians eat avocados, guavas, camotes, and yucas boniatas	I (1982:145-146)
			Yuca Boniata	*Guaucamote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food	#23: The Indians eat avocados, guavas, camotes, and yucas boniatas	I (1982:145-146)
	La Verapaz		*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	1: They have good beans and batatas 2: The natives here eat roots (that we call batatas), yuca, and squash	I (1982:209); I (1982:245)

Table 1, cont.: Roots mentioned as food in the *Relaciones Geográficas*

Relacion	Province/City	Town/Village	Root Crop	Nahuatl	Mixtec	Spanish	Other Names	Use	Comments	References
Antequera	Chinantla		*Guaucamote*	*Camote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food (bread)	#15 and 24: They eat a bread from a type of camote called guaucamote (called yuca on the island of Espaniola) from which they make cazabe	II (1984a:103);RII (1984a:106)
			Puscuaucamote	*Puscuaucamote*				Food (tortillas)	#15 and 24: They use a type of camote, called puscuaucamote, to make tortillas	II (1984a:103); II (1984a:106)
	Cuahuitlan		*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#26: They eat beans, chilies, camotes	II (1984a:170)
	The Province of Coatzacualco		*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#23: There is much corn, squash, beans, batatas, and yuca to eat	II (1984a:121)
			Yuca	*Guacamote*			*Yuca Boniata; Quaucamotl, Huacamote, Cuauhcamote*	Food	#23: There is much corn, squash, beans, batatas, and yuca to eat #14: They ate corn, beans, squash, yuca; they lived more than now	II (1984a:121); II (1984a:119)
	Justlahuaca	Xicayan	*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#23: They eat batatas, which are sweet roots	II (1984a:310)
		Zacatepec	*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#16: They used to eat maize, beans, batatas, deer, rabbits #23: They eat bananas, batatas	II (1984a:321); II (1984a:322)
		Ayusuchiquilazala	*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#23-25: They eat batatas, called ñami in their language and camotes in mexicano	II (1984a:303)
	Guatulco	The port of Guatulco	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#15: They used to eat iguanas and drink clear water; now they eat squash and camotes (which is a root that tastes like chestnuts)	II (1984a:190)
			Camote	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat maize, chilies, squash, and camotes, if they plant them	II (1984a:191)
		Pochutla	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat maize, beans, chian, camotes	II (1984a:195)
		Tonameca	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat maize, beans, chia, camotes	II (1984a:200)
		The Village of Guatulco	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They eat maize, beans, chia, camotes	II (1984a:205)
	Teguantepec		*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#4: The natives pick bananas, batatas #15: The natives used to eat maize, beans, batatas, deer, fish	III (1984b:109); III (1984b:116)
	Tetiquipa and Cozauhtepec		*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They pick beans, cotton, camotes #15: They ate tortillas, camotes (which are like turnips); but now they eat less healthy #24: They used to eat beans, camotes (which are like turnips)	III (1984b:182); (1984b:186); (1984b:187)
	Teticpac		General roots					Food	#15: The macehuales didn't eat anything but herbs and roots	III (1984b:172)
	Ucila		*Guaucamote*	*Guaucamote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food	#15: The natives ate what they eat now, like maize, guaucamotes, chilies #24: In this land they eat maize, guaucamotes, chilies	III (1984b:273); (1984b:274)

Table 1, cont.: Roots mentioned as food in the *Relaciones Geográficas*

Relacion	Province/City	Town/Village	Root Crop	Nahuatl	Mixtec	Spanish	Other Names	Use	Comments	References
Tlaxcala	Tlacotalpa	The Town of Tuztla	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: They have a lot of maize, camotes, jicamas (which are roots, like turnips), and many other roots that they eat	V (1985a:293)
			Jicama	*Xicama(tl)*	*Ña'mi kuiji, Xikama*	*Jicama*	White *Camote*	Food	#24: They have a lot of maize, camotes, jicamas (which are roots, like turnips), and many other roots that they eat	V (1985a:293)
Mexico	Atlatlauhacan		*General roots*					Food	#15: To sustain themselves, in their time of disloyalty, they ate herbs and roots, and wild birds	VI (1985b:49)
	Huexutla		*Quequexquitl*	*Quequexquitl*				Food	#4: They have a root that does not have a Spanish name; it sustains them when they do not have maize	VI (1985b:247)
	Ichcateupan	Tzicaputzalco	*Camote*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: The food they have, that was healthy in the past as well as now, are corn, beans, onions, camotes, huacamotes, jicamas	VI (1985b:273)
			Huacamote	*Guaucamote*			*Yuca; Quaucamotl, Huacamote, Cuauhcamote*	Food	#24: The food they have, that was healthy in the past as well as now, are corn, beans, onions, camotes, huacamotes, jicamas	VI (1985b:273)
			Jicama	*Xicama(tl)*	*Ña'mi kuiji, Xikama*		White *Camote*	Food	#24: The food they have, that was healthy in the past as well as now, are corn, beans, onions, camotes, huacamotes, jicamas	VI (1985b:273)
	Tequizquiac	The Village of Citlaltepec	General roots					Food	#15: They ate maize, herbs, roots, rabbits #21: They have many diverse types of herbs and roots to eat	VII (1986a:199); (1986a:202)
	Tolnacuchtla	The Village of Axocopan	*Mexcale*					Food	#22: There is a root is used to make a sweet food called mexcale	VIII (1986b:131)
			General roots					Food	#24: They have maize, beans, squash, and many roots to eat here	VIII (1986b:131)
		Tolnacuchtla	General roots					Food	#22: They use pencas and roots to make a sweet food	VIII (1986b:136)
		Hueypuchtla	General roots					Food	#15: They ate deer, beans, and roots that are the same as the ones they eat now	VIII (1986b:144)
		Tecpatepec	General roots					Food	#15: They ate the same foods they eat now, like maize, beans, roots; they did not have diseases	VIII (1986b:148)
			Mexcale					Food	#22: There is a root, cooked underground, that they use as a sweet food, and it is called mexcale	VIII (1986b:148)
	The Mines of Zumpango		*Batata*	*Camote*	*Ñami*	*Batata*	*Chayotes*	Food	#24: The natives eat beans, squash, tomatoes, batatas	VIII (1986b:199)
Nueva Galicia	The Villa of Purificación	The Village of Tuito	General roots					Food	#15: They have many roots that they eat	X (1988:229)
		The Village of Malabaco	General roots					Food	#15: There are many common foods, like maize, beans, fish, chickens, and roots	X (1988:232)
	San Martín and Llerena		General roots					Food	#5: The Indians that live in Sierras de San Andrés eat herbs and roots	X (1988:249)

Sumario de la Natural Historia de las Indias

In his book, *Sumario de la Natural Historia de las Indias,* Gonzalo Fernández de Oviedo describes the different types of types of flora and fauna found throughout New Spain. Born in Madrid in 1478, Oviedo provides one of the earliest examinations of North and Central America's natural history (Miranda 1996:7). He stayed in Spain, and Italy, working first as the page to a son of Ferdinand and Isabella, then as a secretary to Gonzalo Fernández de Córdoba (Miranda 1996:12-143). Oviedo's first trip to the Americas was in 1514, where he was appointed supervisor of gold smelting in Santo Domingo. Before traveling to the New World, Oviedo had been a prominent fixture at court. The culture shock must have been especially intense for him as, not only was he accustomed to a certain lifestyle, but he was also a part of the earlier expeditions to the Americas (Miranda 1996:16). As more and more conquistadors and *encomenderos* came to fight for land and goods, Oviedo, and others, became angry at the injustices and atrocities committed by the Spaniards against the natives. Disenchanted with his government, Oviedo began to focus his time on learning about the practices of the natives he encountered (Miranda 1996:23).

In 1523, Oviedo was appointed by the monarchy to become the historiographer of the Americas, and he wrote the *Historia General y Natural* with staying in New Spain. The *Sumario de la Natural Historia de las Indias*, however, was written while he was in Spain. His notes on the natural history of New Spain were resting comfortably in Santo Domingo (Miranda 1996:49). The context of where the *Sumario* was written is particularly important, as Oviedo's memory of the Americas may have faded. For such a long historiography, it can be assumed that quite a few mistakes were made. In addition, Oviedo relied on his own observations, as well as the words of his translator, as opposed to actual reports of the natives. As a result, he could easily misunderstand, or fails to see the meanings, of what he was observing. This issue, however, is slightly downsized when discussing the production of food, such as the creation of *cazabe*, as all that was necessary was to see how the bread was made. The reasons for making the bread, or the meanings behind it, however, are lost in Oviedo's report.

According to Oviedo, the natives make two different types of bread; the first is made out of maize, while the other (called *cazabe*) is made from the *yuca* root. One way of growing *yuca* is by creating tracts of land, similar to those used in Toledo vineyards, and place five or more sticks of the plant in the ground. Other people cut down and burn forests before simply placing the plants on ground level, which is similar to how maize is planted. There is one type of *yuca* that is not eaten by the animals of the area, due to the fact that it is poisonous if not cooked correctly. There is another type, however, which does not kill (called *yuca boniata* in the *Relaciones*) and has a rough, brown cortex and a very white on the inside (Oviedo 1996 [1535]:96). After being peeled, the root is grated and mashed to remove the juice. The mashed up root is then put in a pan and placed over a fire until it curdles and makes a cake. After putting it in the sun for a while, the natives eat the bread, which Oviedo praises as "buen pan." (Oviedo 1996 [1535]:97)

Oviedo's descriptions are important not only because it allows us to see how indigenous peoples sustained themselves on root crops, but it also shows the kinds of interactions he had with the natives he observed. Saying that *yuca* made a good bread implies that he had tried the bread, suggesting he was not afraid of trying native customs. If this is true, it can be surmised that such interactions between natives and Spaniards did occur early on in the Conquest, and we must take this into account when studying later Colonial documents. For instance, in the *Relaciones*, natives and Spaniards had been interacting and affecting each other for quite some time, and the activities practiced by the indigenous informants are not completely indicative of pre-Columbian practices. In addition, the officials in charge of collecting the information were not completely unaware of indigenous practices, and may have inserted their own opinions of the meanings and reasons for these practices.

Treatise on the Heathen Superstitions that Today Live Among the Indians Native to this New Spain, 1629

Hernando Ruiz de Alarcón created the *Treatise on the Heathen Superstitions*, published in 1629, to describe the rituals and incantations done by the Indians of pre-Columbian Mexico. Alarcón was born in Taxco (Tasco) in modern-day Guerrero, Mexico towards the end of the 1500s, though not much else is known about him. Collecting information from various male and female informants (many of them anonymous) throughout the states of Guerrero, Morelos, and Puebla, Alarcón went on a mission to root out the evils of paganism (Andrews and Hassig 1984:3). He was greatly influenced by the Spanish Catholic church of the early 17th century, which was entrenched in fighting natives who were "sliding back" into their old rituals. As a result, Alarcón believed that, by writing down the pagan religious spells, he could help the church see what they were up against. His *Treatise*, therefore, is particularly biased in that he was already judgmental of the rituals being practiced, and chose to include what he saw to be the most damning practices (Andrews and Hassig 1984:8). Nevertheless, while there is no doubt that he played up certain aspects of rituals that the church would not approve of, we can get a general feeling of how the rituals were performed, and what they may have meant to the people initiating them.

Importantly for this study, Alarcón collected a number of incantations describing the necessary steps of planting practiced by indigenous farmers. The longest incantation is for planting maguey, an agave plant native to Mexico, though this length appears to be partly the result of Alarcón describing the ritual in particularly great detail. There are also two specific incantations dedicated to maize, as well as one that is used for sowing both maize and other seeds. An incantation for the sowing of squash is also included as well (1984:121-128), as well as a short, though important, incantation for the sowing of *camotes*.

The incantation for the sowing of maguey has a jubilant mood to it; an excitement that is seen with the very first line "let it be sown!" (Alarcón 1984:122) Rather than praying to the deity of the earth in the hopes that she will allow the maguey to grow, the farmer instead makes more of a recommendation to her that she should aid the farmer (Alarcón 1984:124). Similarly, the first incantation for maize also includes phrases like "let it be soon!" and asks the deity to take over where the farmer left off (Alarcón 1984:125). The three other incantations for maize, for maize and other seeds, and for squash, contain even less praise for a deity, with the farmer telling the seed he is planting, "You will not bring shame upon yourself." (Alarcón 1984: 127, 128, 129)

In striking contrast to the other incantations, however, the incantation for the sowing of *camotes* contains a much different focal point. According to Alarcón, after cutting the parts of the root that they plan to sow, the famer humbly begins the incantation by speaking to the sun. The farmer first shows his obedience and humility by calling himself an orphan, describing the sun as "the one or only God," and "my uncle." The ritual continues with the farmer holding out the root to the sun, proclaiming that he will plant it with the help of his "sister," the earth. By planting this crop, with aid from the earth, he states that he will be able to rest easy and "remedy all [his] needs." As a result of planting *camotes,* the farmer will survive (Alarcón 1984:129). The first difference that can be seen in this incantation in contrast to the others is how submissive and reverent the farmer is when praying to the sun and earth deities. He cannot plant the root without the help of the earth. As a result, he is not making a strong recommendation to the earth, which can often have a threatening connotation to it, nor is he berating his crop to ensure it will grow. Rather, he is showing the sun what he is doing, so as to not make the sun deity angry by excluding him, as well acknowledging that he cannot plant his crop without the earth's compliance.

The tone of the *camote* incantation is much different from the others. In general, the previous planting incantations are joyful and carefree, with an air of excitement for the upcoming planting. The sowing of *camote*, however, seems much more solemn. There are no exclamations such as "let it be soon!" to start out the incantation, and there appears to be more confidence in the harvest (as can be evidenced in the in the previous sowing incantations). As discussed previously, it is possible that, in some places, root crops were used when other crops had bad harvests. This incantation could be seen as ethnohistorical evidence for this assertion due to the fact that it appears as though the farmer desperately needs the *camote* to grow, or he will not survive. It is possible that this incantation occurred when other crops did not survive, and the farmer had to resort to planting *camote*.

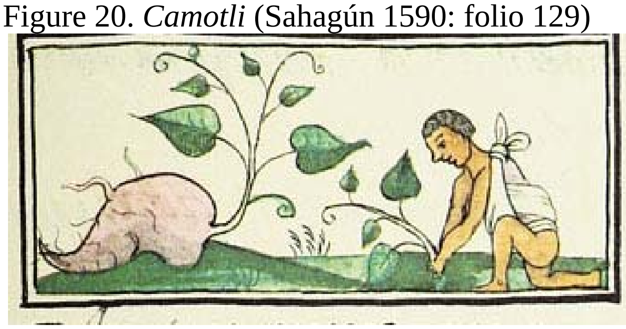
Historia General de las Cosas de la Nueva España, **or The "Florentine Codex"**

Written between 1545 and 1590 by the Franciscan friar Bernadino de Sahagún, the Florentine Codex documents the culture and practices of the Aztec people through Sahagún's own Conquest-era research and illustrations drawn by native artists. In Book 11, Chapter 6, the Ninth Paragraph, the "edible fruits which are within the earth" are discussed. The *quauhcamotli* was described as a tree root that is fine-textured and cylindrical and could be cooked in an *olla* (and presumably eaten after being cooked). The *camotli* (referred to as *camoxalli* if especially small) was said to be cylindrical as well, though more ball-like than the *quauahcamotli*. It too could be cooked in an *olla*, but is also eaten raw; Sahagún mentioned that he prefers to eat it raw but the Aztec usually cooked or baked them. In order to be propagated, the vine or foliage of the *camotli* had to be planted. Sahagún also wrote about *xicamoxiuitl*, which had a lot of foliage and an edible root called *xicama* that was described as round, fat, and soft. The cortex of the edible was thin and its flesh was very white and juicy and, again, could be eaten uncooked. The *cimatl*, however, needed to be cooked as it caused vomiting if eaten raw. Sahagún appears to have found this out the hard way as he wrote, "I take the *cimatl*. I vomit. I get diarrhea. I am purged." (Dibble and Anderson 1963:125; [Sahagún 1590: fo.127]).

Tolcimatl was cylindrical and fine-textured, and could be eaten raw or cooked. It one of the rare times Sahagún discusses the leaves of the plants, he noted that the foliage was "cord-like" and had "chili-red" flower blossoms. Sahagún only briefly mentioned the *cacapxon*, which was said to be round and small and resemble the xicama. *Cacomitl* was usually eaten after being cooked in an *olla* and was fine-textured and sweet. Another fine-textured root, which could be eaten cooked or raw, was *acaxilotl*. Interestingly, however, Sahagún wrote that it grew in the water, but did not elaborate on the agricultural technique used to grow *acaxilotl*. The *atzatzamolli* is the only root that is described as rough, like a volcanic rock, with a tough, black cortex. The plant's leaves were said to be wide and round, the blossoms white, and the stalk slender and hollow. Like *acaxilotl*, *atzatzamolli* was grown in the water (Sahagún 1590: fo. 128). *Cacateztli* was very small and cylindrical root, and, after being cooked, tasted good and savory (Dibble and Anderson 1963:126). Its blossoms were white and the stalk was reed-like, cylindcrical and hollow. Also grown in the water, *cacateztli* was apparently dug out of the mud. *Quequexqui* (also referred to as *quequexquic*) was said to grow in the east and was thick, white, and cooked. *Xaltomatl* was edible uncooked but was also cooked in an *olla* or baked on a griddle. Described by Sahagún as very sweet, it was also "harsh to the throat." *Uitzocuitlapilli*, a cylindrical root, also burned the throat, but was stilled baked on a griddle and eaten (Dibble and Anderson 1963:127 [Sahagún 1590: fo.129]).

Numerous illustrations, made by native artists, were also included in the Florentine Codex. One root in particular, labeled as *camotli*, looks very similar to *malanga*. The edible root portion resembles that of *malanga*, and the arrow-shaped leaves that are indicative of *malanga* are also present (Figure 20) (Sahagún 1590: fo.129). In addition, according to Sahagún's description of the planting method for *camotli*, in which the foliage is transplanted, is comparable to that of *malanga* propagation. Unfortunately, *camotli* is another Nahuatl tranlation for *camote* (Alonso 1997:94) which, as stated above in the *Relaciones* section, is often used as a catch-all term for edible root. As a result, at this time, the Nahuatl (as well as other language) term for *malanga* and its specific uses remains unknown.

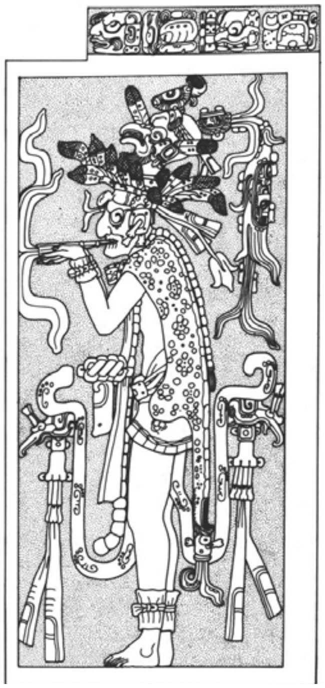
Figure 20. *Camotli* (Sahagún 1590: folio 129)



C. Iconography

Iconographic representations of crops and agriculture are pervasive throughout Maya history, and no doubt later Maya iconographers will find even more examples. The most well-known Maya crop, due in large part to its many instances in iconography, is maize. The Maize God, whose mythical story was recorded in the Popol Vuh in the mid-16th century, exemplified the cycle of wet and dry seasons and the annual planting, sprouting, ripening, and harvesting of

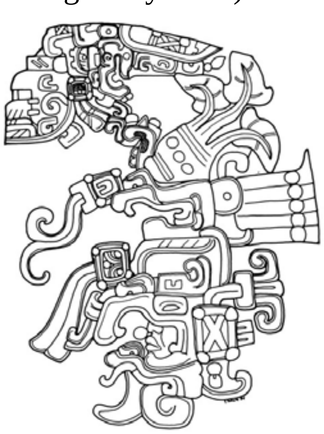
Figure 21. God L (Schele #176)

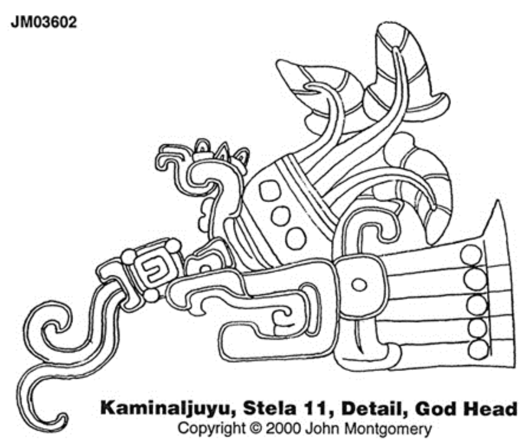


maize – a metaphor for ancient Maya life. Iconographically, maize can be identified through a stalk and leaves, an ear of maize, or just a maize kernel. Maize, however, is not the only crop associated with a god. God L – the precursor to either the One or Seven Death of the Popol Vuh (and thus the Underworld enemy of the Maize God) – was the wealthy god of trade and tribute, but also tobacco (Miller and Martin 2004:58). God L is often depicted smoking a cigar and carrying a merchant's pack on his back, which shows that the Maya connect trade and tobacco.

Due to the immense presence of crop images in ancient Maya iconography, it is logical that, if root crops played an important part in ancient Maya subsistence, they should be included in the iconographic record as well. According to Pohl and her colleagues (2000), *malanga* in particular may have specifically been integrated into Maya iconography as well. At the Maya site of Kaminaljuyu, Guatemala, Stela 11 (ca. AD 200-250) has been particularly interesting in reference to this subject matter. *Malanga* has a very distinct leaf pattern compared to other

Figure 22. Kaminaljuyu Stela 11 (Montgomery 2000)





similar root crops, with the stem is located in the middle of the plant, at the indentation, and with lighter green veins emanating from the middle of the leaf. As can be seen in the top of the God headdress on Kaminaljuyu's Stela 11, the leaves are of the plant are very similar to the unique *malanga* leaves. In addition, a Maya inscription, made on an Olmec jade pendant, (Pohl et al. 2000; Schele and Miller 1986) has also shown a similar type of headdress.

Figure 23. Jade Inscription (Montgomery 2000)

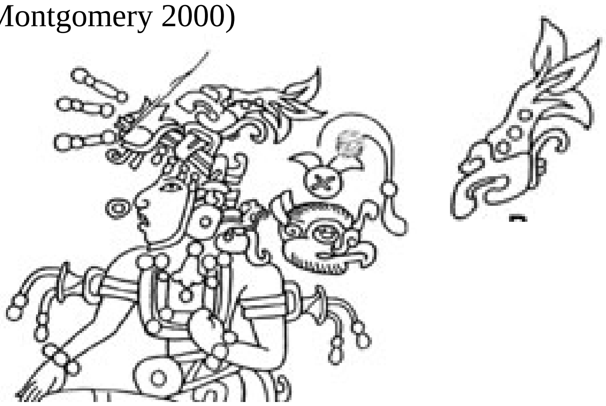


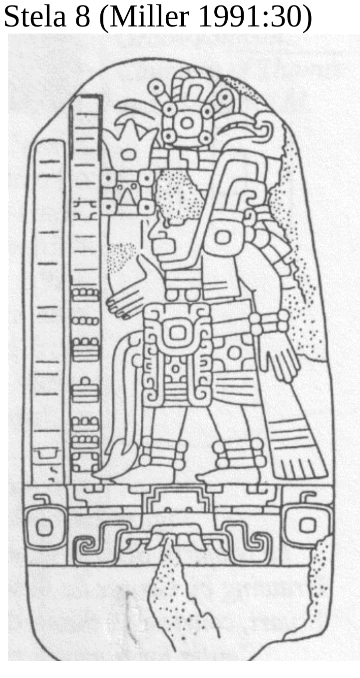
Figure 24. Izapa Stela 25 (Montgomery 2000)

In these images, the fact that the leaves are part of a God's headdress is of particular importance. Unlike the images of crops like the avocado and *nanze*, *malanga* is actually an essential part of the God's costume. It may be inferred then, that *malanga* was important not just as a crop, but also possibly in a mythological capacity. Unfortunately, there have not been any other instances of malanga found in Maya art. As of yet, the only other leaf images I have found are those of trees, like that seen at Izapa (in Chiapas, Mexico), Stela 25. The stem placement on the leaf is similar, but the leaves are not perforated like those of *malanga*, do not show veins, and are clearly associated with a tree in the image.

Outside of the Maya area, however, stelae from the site of Cerro de las Mesas in Veracruz, Mexico dating to the Early Classic period often show a leaf of unknown origin hanging down with an attached stem. Long Count dates are found on both stelae, suggesting a strong connection between Cerro de las Mesas and the Maya at this time (Miller 1991:30). As can be seen on Stela 6 and Stela 8 (Figures 25 and 26), a ruler appears with an open, outstretched hand and a stem coming out of his skirt, ending in an arrow-shaped leaf bearing a striking resemblance to a *malanga* leaf. In addition, unlike in the stelae mentioned above, the long, dangling stem in Stela 6 and Stela 8 argues against the leaf belonging to a tree. Thus, while a tuber is not shown in these stone carvings, the leaf and stem depicted on multiple Cerro de las Mesas stelae provide possible evidence for the importance of *malanga* at the site.

Figure 25. Cerro de Las Mesas Stela 6 (Miller 1991:30)

Figure 26. Cerro de Las Mesas Stela 8 (Miller 1991:30)



D. Archaeology

South America

Within Amazonia, fossil remains and phytolith analyses have been highly useful in determining cultivation of *manioc* in the archaeological record. For instance, fossil remains found in paleo-environmental records (Piperno and Pearsall 1998) and archaeological sediments (Mora et al. 1991) that date back to the mid-Holocene, provided evidence for a long history of *manioc* use in the Amazon. In the dry savannas to the north and south of the rainforest, a preserved root fragment was recovered at Januária in eastern Brazil and identified by starch grain analysis as *manioc* dating to about 8600 BP. Along the Pacific coast, the oldest direct evidence of *manioc* cultivation was found at the site of Quebrada de las Pircas (along the northern Peruvian coast) (Rossen et al. 1996). Excavations yielded a fragment of a tuber skin that was identified as domesticated *manioc* by starch grain analysis, and dated to around 7000 BC by association with radiocarbon-dated wood charcoal (Piperno and Pearsall 1998:207-208; Rossen et al. 1996:395, 400).

The earliest dated *manioc* pollen recovered is from the Abeja site, located on the Araracuara Plateau by the Caquetá River in the Colombian Amazon – a wet lowland tropical forest environment (Mora et al. 1991). Radiocarbon dated to between 4700 and 4600 BP (Mora et al. 1991; Piperno and Pearsall 1998:263), this sample suggests that *manioc* cultivation in the South American lowlands dates back to at least the mid fourth millennium BC. Lathrap (1970) and Brochado (1984) have also argued for Central Amazon settlement by *manioc* agriculturalists around 3000 BC.

New analyses of phytolith and starch grain samples have been particularly useful in determining pre-historic use of root crops (Darch 1983; Denevan and Paddoch 1987; Roosevelt 1980). At the Real Alto site in Ecuador, both *manioc* and arrowroot were found, dating to 2800-2400 BC. Chandler-Ezell et al. (2006) hypothesized that the best way to find root crops in phytolith samples would be to focus on the epidermis of the storage organ as opposed to the leaves and fruits, which are normally the portions studied in phytolith analyses (Pearsall 2000; Piperno 1988). The leaves and fruits of many plants tend to have high silica concentrations, which make them easier to identify, but it is unlikely these parts are generally not used in the consumption of root crops. Thus, by studying the composition of the subterranean tissues of root crops as opposed to their leaves, Chandler-Ezell et al. were able to create a new corpus of diagnostic types with which to compare to phytolith samples collected at archaeological sites.

Starch residues extracted from stone pounding tools have also been important in understanding the presence of different crops in the archaeological record (Barton et al. 1998; Fullagar and Field 1997; Fullagar et al. 1996; Kealhofer et al. 1999; Lentfer et al. 2002; Loy 1994; Loy et al. 1992; Perry 2002; Piperno and Holst 1998; Piperno et al. 2000; Therin et al. 1999). In order to create a good diagnostic comparison for starch grains found in the archaeological record, fresh *manioc* roots were cut and pealed, and subsequently pounded with a *mano* and *metate* (for about five minutes). The pounded *manioc* roots were then processed by soaking, fermenting, toasting on a griddle, oven-roasting, and boiling (Chandler-Ezell et al. 2006:109). By utilizing the diagnostic phytolith and starch grain samples created for root crops, Chandler-Ezell et al. were able to find the earliest record use of *manioc* and arrowroot in coastal Ecuador (2800-2400 BC). Artifacts found at archaeological sites with raised fields in French Guiana also indicated a high consumption of cultivated plants. Grinding stones (*manos* and *metates*), present at most sites in the area, were most likely used to prepare maize while graters made on rough granite slabs were probably used for *manioc* processing. Ceramic griddles were also very common at archaeological sites in French Guiana, which may have been used to cook both maize and *manioc* (Rostain 2010:345).

The Intermediate Area

The analysis of starch grains on lithics has been useful in the Intermediate Area as well. At the site of La Mula – the earliest sedentary village on the central Pacific coast of Panama – *manioc* starch grains were found on a grinding stone in a context radiocarbon-dated to the fourth century BC (Piperno and Holst 1998:772; Piperno and Pearsall 1998:296). At the early ceramic site of Monagrillo, located along the Pacific coast of Panama as well, starch grains of *manioc* were identified on the grinding edge of ground cobble that have been dated to the third or fourth millennium BC (Piperno and Holst 1998:772). During an excavation at the Casita de Piedra rockshelter in western Pacific Panama, Dickau et al. (2007:3652) analyzed a flake chopper dating to about 3650 BC, finding *manioc* starch grain residue along the edges. *Manioc* starch grains were also identified on a grinding stone at the same site, and dated to 1650 BC. Pollen grains – where available – have been used in this area as well. *Manioc* pollen, for instance, was identified in a lake sediment core record at Gatun Basin on the Caribbean coast, dating to the early first millennium AD (Piperno 1988:297).

Mesoamerica

The earliest Mesoamerican evidence for *manioc* is earlier than that from the Intermediate Area – suggesting that *manioc* came from its origin of domestication (South America) to Mesoamerica via the Intermediate Area. As stated earlier, the site of San Andrés, along the southern coast of the Gulf of Mexico, produced a pollen grain of a *Manihot* species that may be domesticated *manioc,* which was dated to about 4600 BC (Pope et al. 2001). In addition, on the Yucatán Peninsula, in the wetlands of northern Belize, pollen of domesticated *manioc* also appears in soil sediments at Cob and Cobweb Swamps (Pohl et al. 1996). The earliest of these pollen grains, at Cob Swamp, dates to about 3400 BC. At Cobweb Swamp, located near the Maya site of Colha, *manioc* pollen first appears around 2500 BC.

The Maya site of Cerén in El Salvador, however, has been arguably the most instrumental site in determining the presence of *manioc* in Mesoamerica, and, more importantly, the extent to which it was included in the Maya diet. Previous excavations at the site first documented the presence of *manioc* in a kitchen garden context – specifically on the northernmost ridge of the Household 1 kitchen garden (Sheets 2006; Sheets and Woodward 2002:189). Due to its relatively low abundance in the archaeological record (including the low abundance in the actual kitchen garden), it was hypothesized that *manioc* was only a small portion of the ancient Maya diet – supplementary to the maize staple crop (Sheets 2002, 2006). During 2007 excavations conducted just south of the site, two 2 x 3 meter test pits showed evidence of large constructed ridges (ten times larger than those used in maize fields at Cerén) that were later confirmed to be *manioc* beds. Based on the number of ridges and ridge height and width, it was estimated that such ridges ranged from seven to ten times the volume of the maize fields previously documented at the Cerén site (Lentz and Ramírez-Sosa 2002; Sheets and Woodward 2002). Subsequent research conducted near these *manioc* fields has yielded more evidence of large-scale *manioc* cultivation at the site as well (Dixon 2011). Thus, while the majority of the archaeological evidence for root crops (and *manioc* in particular) gives scant information on the use of root crops in ancient Maya diet, the data collected at Cerén show that *manioc* was actually intensively cultivated in fields as a staple crop.

CHAPTER 5

ARCHAEOLOGICAL AND ETHNOGRAPHIC INVESTIGATIONS OF *MALANGA*

While few Mesoamerican archaeologists are even aware of the malanga plant, excavations conducted the sites of Cuello, Belize and Cerén, El Salvador have shown that the ancient Maya did utilized the root crop. At Cerén in particular, prior archaeological research as well as my own examination of plant casts have been instrumental in providing important information regarding how the plant was grown and used. Ethnographic work conducted at a village near the Cerén site proved to be fruitful as well.

A. Cuello, Belize

Site Context

The Maya site of Cuello is located between the Río Hondo and Río Nuevo in northern Belize. Excavations since 1975 have yielded a cultural sequence covering the Early Preclassic to the Late Classic, with original occupation beginning around 1200 BC (Hammond 1991:Table 3.1; Housley et al. 1991; Law et al. 1991) and even some post-abandonment inhabitants still living in the area until AD 1350. As a lowland Preclassic Maya village, Cuello demonstrated the emergence of a ranked society between 900 and 600 BC, based on an increase in certain goods as well and differences in human burials (Hammond 2005:56). Between 600 and 400 BC, Cuello mirrored other sites in the area with a move towards social complexity, seen in areas such as public architecture and rulership symbolism (Hammond and Miksicek 1981). After 400 BC, Cuello remained a modest community for many more centuries, but the focus of political and economic development moved to other sites in northern Guatemala and southern Yucatan.

Northern Belize is home to Late Cretaceous-Eocene limestone, which creates hard, relatively coarse-grained cherts. As a result, the inhabitants of Cuello had easy access to stone tool materials (Hammond and Miksicek 1981:261). Similar to the rest of the Maya lowlands, northern Belize has a dry season from January to May as well as a summer rainy season. Multiple environments in and around Cuello would have allowed for a large variation of vegetation (Lundell 1937). The “High Marsh Forest” for instance, is an area found on low, poorly-drained ground and along *bajos* and rivers. Due to the high water content inherent in the soils of the marsh forest, this environment probably would have been a suitable and likely location for the construction of channeled and raised fields (Hammond and Miksicek 1981:263). Hammond and Miksicek (1981:263) have argued that this environment would be fairly difficult to use for subsistence but, based on calculations from Wright et al. (1959), the High Marsh Forest makes up the majority of natural vegetation around Cuello.

Malanga

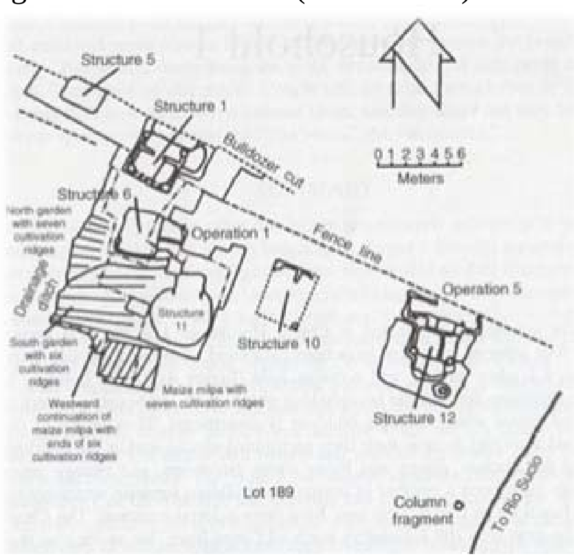
There has been a preliminary identification of *malanga* at Cuello, Belize by Hather and Hammond (1994). During the original investigations of Cuello in the 1970s and early 1980s, a *chultun* – an artificial storage chamber cut into bedrock (see Puleston 1971) - was found that dated to the Late Preclassic (400 BC – AD 100). As the chamber was sealed, a deposit of carbonized plant remains was found untouched, including a root fragment. Hammond and Mikisicek (1981) argued that this was suggestive of *manioc*, sweet potato, *malanga*, and/or *jícama* use. As no root crops were found in any areas excavated in Cuello dating to the Middle Preclassic period (1000 BC – 400 AD) or earlier, it was also believed that root crops were added to ancient Maya diet during the Late Preclassic (Hammond and Mikisicek 1981). Later archaeological and isotopic evidence has indicated that while the people at Cuello made substantial use of maize, they were not dependent on it like later Maya populations (Clutton-Brock and Hammond 1994; Hammond 2005:50).

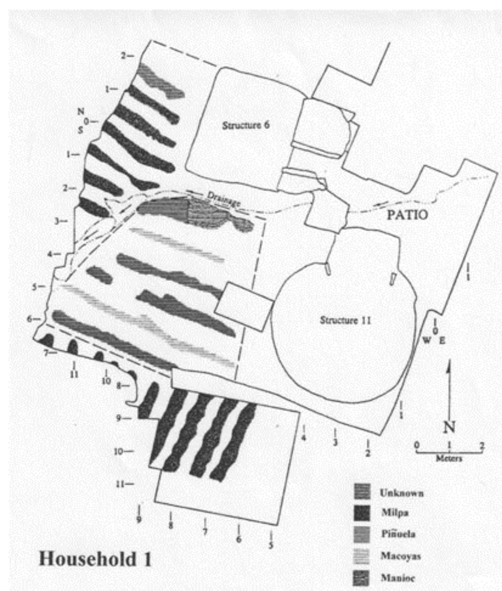
Further excavations in the 1980s led to the discovery of more charred remains, some of which could specifically be identified as *manioc*. It is also believed that some of the carbonized root crop remains were *malanga*, though, due to the fact that *malanga* is not as well known, it could not be definitively identified (Hather and Hammond 1994).

B. Cerén, El Salvador

Archaeological Context

Figure 27. Household 1 (Sheets 2002)





Multiple casts of *malanga* stems were found in Operations 1 and 7, which represents the first time this crop has been described from a Mesoamerican archaeological site (Lentz and Ramírez-Sosa 2002:35). Interestingly, an abundance of *malanga* was found in the Household 1 kitchen garden (Sheets 2002:204). The kitchen garden associated with Household 1, south of Structure 6 and west of Structure 11 in Operation 1, is bordered by a 1 m walkway separating the structures from the garden. Four crop species were planted on top of short ridges running east- west, with ridges spaced about 70 cm apart along the ridgetops. This garden in particular is evidence of a model for zoned biodiversity seen throughout Cerén (Sheets and Woodward 2002). The Household 1 kitchen garden contained six of ridges, and each ridge was devoted largely to a single species. The northern ridge contained *manioc* on the eastern half and *piñuela* on the western half (Sheets and Woodward 2002:189). The next two rows were devoted almost entirely to *malanga*, with one *piñuela* plant at the west end of the third row. The fourth and sixth rows contained only *piñuela*, while the fifth row was divided evenly into *piñuela* on the west and *malanga* on the east (Sheets and Woodward 2002:188-190).

C. Current *Malanga* Research

During the 2011 field season, I was able to create a more detailed description of the *malanga* plant casts found at Cerén and collect ethnographic comparative data to discuss the uses of *malanga* in the region today. Standardized research methods were utilized in order to record stalk width and length. The width was measured in the middle of the stalk, unless there was a significant change in width between the top of the stalk and the bottom (see stalks 2, 8 and 9 in Table 1). Length was measured at the point of juncture between the stalk and the base of the plant cast. In addition, the majority of the stalks contained two crescent-shaped cross-sections at the top of the stalk (each at either side of the stalk). A stalk diameter was measured crescent to crescent at the top of the stalk. If there were no crescents available, the diameter was simply measured at the top of the stalk. The crescents paralleled each other in length so that, for each stalk that had crescents, I was able to take crescent length as well. This crescent shape is one of the traits that is indicative of *malanga*. As stated before, the stem of the plant intersects the leaf at the beginning of the middle vein of the leaf (i.e. at the perforation, as opposed to toward the middle of the leaf).

Table 2. Plant 1.508 RA21-179 Measurements

Stalk	Width (cm)	Diameter (cm)	Length (cm)	Crescent (cm)
1	0.69	0.55	1.95	0.12
2	0.73	N/A	0.57	N/A
2	0.63	0.56	3.88	N/A
3	0.97	0.94	6.24	0.34
4	0.95	1	7.85	N/A
5	0.93	0.84	7.47	0.32
6	0.74	0.81	4.31	0.39
7	0.9	0.65	2.74	0.22
8	1.21	1.2	8.9	N/A
8	0.72	0.68	8.9	N/A
9	.55-1.45	0.68	8.41	0.34
10	0.79	0.87	4.13	0.34
11	1.11	1.52	4.12	0.33
12	0.43	0.53	5.42	0.27
13	1.07	1.42	6.17	N/A
14	1.15	1.1	4.27	N/A
15	1.3	1.1	3.12	0.37
16	0.59	0.78	6.82	0.13
17	0.79	0.95	6.68	0.39
18	0.48	0.64	6.54	0.19
19	0.64	0.9	4.92	N/A
20	1.02	1.2	7.59	0.46
21	0.3	0.27	1.85	N/A
22	0.21	0.2	0.5	0.3
23	0.35	0.45	1.47	N/A
24	0.29	0.49	1.2	0.15
25	0.34	0.15	1.69	N/A
26	0.11	0.36	2.34	N/A
27	0.72	0.8	4.42	0.34
28	0.54	0.84	2.91	N/A

A total of five *malanga* plants were located and studied in the *Museo Nacional David J.Guzman*. The first *malanga* plant cast studied is currently on exhibition at the *Museo Nacional David J. Guzman*, and labeled 1.508 RA21-179. This *malanga* plant cast contained 28 stalks coming out of the base, with no visible roots or corms. Stalk widths of 1.508 RA 21-179 ranged from .11 cm to 1.45 cm, with an average width of approximately .76 cm. The average stalk diameter of this plant was .78 cm. Stalk length varied greatly, ranging from .5 cm to 8.9 cm. Seventeen stalks have visible crescents that could be measured, creating a crescent length average of .29 cm. In general, the width, diameter, and crescent length of all the stalks had little variation. This low variability indicates the *malanga* plant from which the cast was made was in good health. Similar stalks result from the same amount of nutrients and water coursing through the entire plant, which would not occur in a starving or stressed plant (Agbede 2008). Variability in stalk length, however, is to be expected in a healthy plant since leaves located at the same height would constantly be competing for the same sunlight.

Figure 28. Side View of *Malanga* Plant Cast 1.508 RA21-179

Figure 29. *Malanga* Plant Cast 295-1.224 RA21-793

In addition to studying the plant casts from Cerén, I also interviewed local residents of Joya de Cerén about the uses of present-day “malanga” plants. Initially, my research met a challenging obstacle in that many of the people had not heard of the plant and, those who had, did not regularly eat the root. The larger supermarket located in the city of Lourdes sold other root crops, including potatoes, *manioc* and *jícama*, but it was difficult to locate “malanga.” With the help of a local worker I was able to finally find the plant in the supermarket under a pile of *manioc*. There were three *malanga* roots, and all three were already rotting. This revealed the first interesting aspect of my 2011 research, that “malanga” did not appear to be a widely eaten, or even widely known, root crop in El Salvador today.

In addition, the plant presented to me by the residents of Joya de Cerén as “malanga” was identified by paleobotanical specialist Dr. David Lentz as not being *Xanthosoma* (personal communication, 2011). Dr. Lentz identified the plant “malanga” as actually *taro* (*Alocasia esculenta*), a different type of root crop that has similar storage organs. Taro is a root crop introduced from Asia, and has a perfoliate leaf. *Xanthosoma*, on the other hand, has a sagittate leaf. This means that, in order to clearly distinguish taro from *malanga*, a close examination of the leaves (and not just the roots) is needed. A perfoliate leaf is characterized by a stem that enters at the center of the leaf. A sagittate leaf, however, has an arrowhead shape, with the stem entering the leaf at the juncture. In addition, Lentz said that the modern plants identified by the villagers of Cerén as “malanga” (though were actually taro) should be described ornamental. Thus, based on my limited ethnographic research, I was unable to find edible *malanga* corms, or even the *malanga* plant.

Fortunately, some residents of Joya de Cerén were familiar with “malanga,” including where it was grown and sold in the area. Jesus Franco, one of the local excavators, took me to a small nursery just outside the town, which contained three small plants that he identified as “malanga” with supposedly edible roots. Salvador Quintanilla also showed me a similar (though larger) plant growing at the Joya de Cerén Museum which he called “malanga” as well. As a result, contradictory accounts of what the visual differences between ornamental and edible “malanga” plants led to much confusion. For instance, two people insisted that main difference between the two plants was that the leaf veins of edible plants were purple, as opposed to green. When asked the same question, two other people said it was that the leaves of ornamental “malanga” were larger than those of edible “malanga.” The lack of consensus for the types of “malanga” in the area further highlighted that this root crop is a lesser known and used part of community life in Joya de Cerén.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

A. Edaphic Requirements

Maize and Manioc

Maize grows best in warm weather, and requires considerable moisture and warmth from germination to flowering. Extremely high temperatures and low temperatures during flowering damage the foliage, desiccate the pollen, and interfere with proper pollination resulting in poor growth formation (Sheets 2002). Maize can grow in a wide range of rainfall, but is highly sensitive to standing water, particularly during its early growth stage. As a result, proper drainage is a must. Maize can be grown in most types of soil, except sandy and heavy clay soils; well-drained fertile sandy loamy soil seems to provide the best environment (Sharer 2006:156). Due to its very specific rainfall and drainage necessities, maize can be difficult to manage in years with variable climate. Maize agriculture needs proper drainage, and thus is difficult to grow in wetland areas.

Although *manioc* can be cultivated up to 2,000 m above sea level near the equator (Cock 1982), the lower temperatures at such a height in the Maya area mean that it cannot be grown quite that high above sea level. *Manioc* is much more tolerant of poor and acidic soils than maize, beans and squash, but it does not grow well in waterlogged soils (Cock 1982). The optimal precipitation range for manioc productivity is 1,000 to 2,000 mm, but precipitation can be as low as 500 mm in cooler subtropical climates. *Manioc* grows best when under direct sunlight and in aerated soils (Rehm and Espig 1991).

Malanga Cultivation

In a study conducted by Agbede (2008), different tillage strategies were implemented in order to understand how *Xanthosoma sagittifolium* (highly similar to *malanga*) could best be grown. He found that *X. sagittifolium* grew best under zero-tilled/mulched, zero-tilled/unmulched, manually mounded, or ridged soils. (This finding is consistent with Enyi (1967, cited by Onwueme 1978) who reported that *malanga* yields are higher when planted on ridges, where better-shaped corms are obtained). "Growing best" was defined as those plants that had the highest values for the yield components of the plant, including plant height, leaf area, and corm yields. With manual mounding and ridging, corms weigh about 9.5 mg ha^{-1} (Agbede 2008: Table 7). Plant height was around 38.3, leaves per plant were 7.33, and leaf area per plant (in square meters) was between 2.6 and 2.7 (Agbede 2008: Table 6). In terms of density, dry bulk density measured around 1.24 mg m^{-3}. In addition, it was found that those plants with the highest yields had the highest water content, and were grown in temperatures round 30.5 degrees Celsius (about 87 degrees Farenheit) (Agbede 2008: Table 3).

The root crop *taro*, as has been discussed earlier, grows corms that are nearly identical to those of malanga. In a study conducted by Plucknett et al. (1973) that examined how taro was planted in Hawaii, it was determined that taro grown in puddled, flooded soils results in the highest yields. Puddling may not be necessary, however, as long as the flooding condition can be maintained. As a result, soils in Hawaii are often prepared and planted in dry land, and then fields are flooded after planting. Based on studies conducted by both Agbede (2008) and Plucknett et al. (1973), then, crops that have the same edaphic requirements as *malanga* grow best in wetland environments.

B. Ancient Malanga Cultivation in the Archaeological Record

The Petén and Alluvial Watercourses

The terrain of much of the Maya lowlands ranges from a broken karst topography (composed mostly of Mesozoic and Cenozic limestone formations) to the lower relief of its coastal margins. The vast central lowlands region of northern Guatemala is the Petén, and was one of the earlier places to be settled in Maya prehistory. Here, in comparison to other areas in the Lowlands, rainfall begins to diminish and the landscape becomes less rugged, although it is still characterized by low, generally east-west ridges of folded and faulted Cenozoic limestone. Within this region is a diverse range of soil and forest types, of lakes and low seasonal swamps (seasonal wetlands, or *bajos*) (Sluyter 1994).

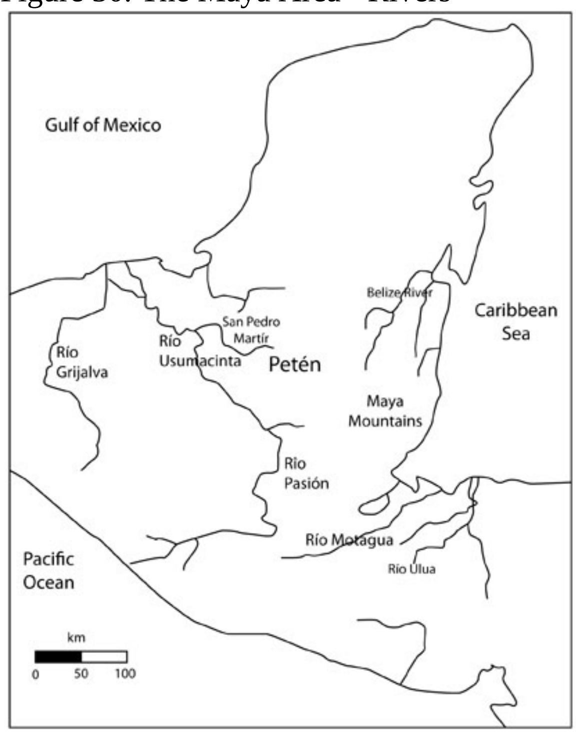
Many of the largest and earliest centers of Lowland Maya civilization developed along the margins of large karst depressions known as *bajos*. During the Preclassic period, colonization generally followed rivers, lakes, and wetlands (bajos) that provided stable sources of water and routes of communication (Dunning et al. 2002). The Middle Preclassic villagers continued to colonize new areas by following the rivers inland, expanding the occupation of the Maya lowlands. As the number of farming communities increased, settlements grew beyond the confines of riverine environments and into the interior regions of forest and marshy *bajos*. This expansion was dependent on several innovations, including new agricultural techniques to cope with both forests and marshes. Many settlements that would later grow to become great cities were situated adjacent to stable sources of water such as lakes or large *bajos*, but even some of these eventually required reservoir construction to support burgeoning populations (Scarborough 1983; 1994).

Most of the rain in the Petén falls from May through January, with the dry season from February to May. Less rainfall combined with porous limestone bedrock means there is less surface drainage, and *bajos* are often covered with low scrub and thorn growth due to the seasonal saturation of soils. The *bajos* of the most interior portion of the Petén contain a variety of vegetation communities, depending on the relative degree of inundation and desiccation characteristic of any given area (Culbert et al. 1996; Lundell 1937; Pope and Dahlin 1989; Siemens 1978). Some interior *bajos* today include small pockets of perennial wetlands with generally herbaceous vegetation, known locally as *civales* (Jacob 1995; Lundell 1937). Soils in the interior *bajos* range from the peats found in *civales*, to a fine clay (Beach 1998; Simmons, Tarano, and Pinto 1959). Both types of soils pose difficulties for agriculture. They are both often very fertile, but are subject to significant drainage limitations or shrink-swell problems, and the clay especially can produce severe cracking during seasonal water deficits. Today, virtually all of these *bajos* contain seasonal wetlands – ecosystems that have been perceived to be deficient in resources (Sluyter 1994). In order to explain the connection between *bajos* and the ancient Maya, several scholars hypothesized that many of these basins were once lakes or perennial wetlands (see Turner 1993), but most have dismissed this idea because of insufficient supporting evidence. *Bajos* and other wetlands are a common feature across much of the southern and central Maya Lowlands, variably covering between 40 and 50 percent of land across the region (Dunning et al. 2002:268).

Due largely to the poor drainage within the Petén region, the populations of the area would have needed multiple forms of agricultural techniques to sustain larger populations. The *bajos,* while providing fresh water during the wet season, could also overflow and cause soggy soils. While this type of environment can create difficulties with growing many crops, *malanga* could have grown quite well in these swampy regions since it thrives in high moisture areas. Most root crops – especially those that have been known to be cultivated in the Maya region, like manioc – are much better adapted to dryer areas. In addition, while *malanga* grows best in wetland environments, its appearance in the archaeological record at the sites of Cuello and Cerén indicate that it can also be grown in areas dryer than the Petén. Thus, even in the dry season, when the area was not as swampy, growing *malanga* would also have been possible.

Since *malanga* thrives in wetter areas, the alluvial watercourses of the Maya area would also be good regions in which to examine the archaeological record for traces of the root crop. The Río de la Pasión lowlands of southwestern Petén, for example, would provide *malanga* with a consistent source of water in which to grow. As the Río de la Pasión flows down into the Caribbean, off-shooting streams continue to create a larger wetland region – an area perfect for *malanga* growth and cultivation. Figure 30 shows a few of these rivers and the Río de la Pasión region.

Figure 30. The Maya Area - Rivers



Durable Indicators

It is important to understand where the most likely places *malanga* would be grown are (e.g. the wetlands of the Petén and the alluvial watercourses present in the Maya Area), but knowing how to find evidence of ancient *malanga* use is a daunting next step. As stated earlier, it is often difficult to find traces of plant remains in the archaeological record of tropical areas. While starch grain and phytolith analyses are becoming more common, finding surviving microscopic evidence of root crops in a particularly swampy area could prove difficult. Thus, more durable indicators of root crops are needed. While to date no experiments have been done to create use-wear patterns for *malanga* processing on obsidian and chert scrapers, I have been able to use experimental archaeological methods to create diagnostic use-wear patterns that are consistent with *manioc* processing. I believe that the experiment I conducted will be extremely useful in finding durable indicators of other root crops whose remains may be difficult to identify.

In 2009, two dacite artifacts were found in the Operation P midden at Ceren. The artifact that I examined is a dacite scraper, which has extensive use-wear, as well as evidence of resharpening (Dixon 2009:76, Sheets 2009c:83). Use-wear on the scraper from Cerén had formed from motions perpendicular to its edge, which, with a slant light with a 10x hand lens and a 40x power binocular microscope, can be seen as small striations. As stated earlier, both bitter and sweet *manioc* have hydrogen cyanide in the cortex, so a knife or a scraper would be needed to remove it, and ethnographic research has shown that modern-day indigenous Amazonian peoples continue use such a removal process (see Dufour 1993).

For my experimental scraper, I used fine-grained chert. The scraper was made from a nodule taken off a large percussion flake, so that the ventral face was completely flat. The edge angle between the flat ventral side and the dorsal side was created as

Figure 31. Scraper Before Use. Scale in mm (Photograph taken by Payson Sheets)

close to 45 degrees as possible. I chose my workable edge early on in the knapping process and, as a result, I did not take unnecessary time to remove cortex beyond that found on the working edge, or attempt to create any other workable edges. Figure 31 shows the scraper before use, with the ventral side facing upward. The edges are jagged and unrounded. It should be noted that the material in this light appears to already have a slight sheen. This observation is important to note so that regular material sheen is not confused with use-wear polish.

In his discussion on experimental and analytical procedures, Hayden, as along with other contributors to his 1979 lithic analysis book, attempted to find a middle ground of agreement for experimental use-wear analysis. For experimental design, it was decided that it is important to look at sequential stage modifications when performing experiments. Also, a distinction should be made before the actual experiment is conducted as to whether the researcher is attempting to replicate the use of a tool, or, if they are controlling certain variables to examine the effect of one specific variable on another (Hayden 1979:365). In my experiments, I chose to do the former, focusing on tool use replication.

To begin experimentation, *manioc* tuberous roots were covered in a thin layer of Ilopango volcanic ash. This was done in order to recreate the Cerén environment in which the *manioc* was grown. A similar process could be used when comparing use-wear of tools found at sites in a different environmental context. In order to obtain as much use-wear as possible from each tuber, the manioc was scraped (but not scraping off the entire cortex). When the ash was completely removed (but cortex remained), the tuber was covered in volcanic ash again. Eventually, the entire cortex was scraped off. In terms of sampling and recording, Hayden and others discussed recording use in minutes and hours. I, on the other hand, found it much more useful to determine extent of use-wear in number of scraping strokes. The variability that results when similar experiments are done by different researchers may be large if just elapsed time and not the pace of scraping is recorded. Also, simply counting the number of processed tubers can lead to large variations and discrepancies since tuber size varies considerably. Each stroke consisted of one long movement extending across the whole length of the tuber. Scraping was done in the same direction each time, always towards me. Only one edge was used in the scraping process, and I held the scraper in the same way for each stroke, as can be seen in Figure 32.

I used multiple sources to determine the type of analysis I wanted to conduct on the experimental scraper, specifically Stanley Ahler's 1979 chapter in Hayden's lithic analysis book, and Patrick Vaughan's 1986 book on use-wear analysis. Ahler talks about the specific use-wear types that can be seen on worked stone tools. Discussing specific use-wear types, he includes the category of flaking wear types, which occur on tool edges and flake ridges. Flaking wear is described by Vaughan as "microchipping," or microflaking, which includes all the flake scars produced along the edge of a tool (Vaughan 1985:10). Another wear type that Ahler includes, which I looked at carefully, is striations. Striations are defined as any linear patterning, which can occur as either individual or groupings of scratches or striae (Ahler 1979:314). Visible striations often depend on the inclusion of foreign particles or abrasion created by microchips located in the worked material after initial tool use. Material type may also be a factor, as can be seen in the differences between obsidian use-wear and chert and harder stones that exhibit use-wear. Obsidian is scratched much more easily, and, due to its glassy and translucent nature, exhibits striations more readily than harder stones.

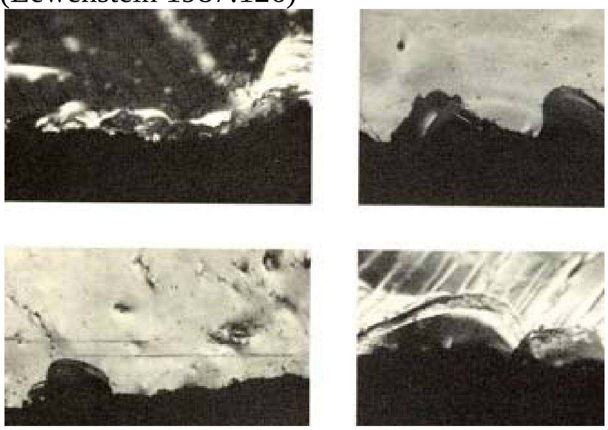
Vaughan discusses the rounding and smoothing of edges, ridges, and surface areas, which are often the more observable category of use-wear in terms of looking at an artifact with the naked eye (1985:12). This rounding and smoothing would be put under Ahler's abrasive wear category, which also includes grinding, blunting, and polishing (1979:305). Smoothing is a finer form of abrasive wear than grinding and blunting and creates a less coarse surface or edge compared to an unused surface or edge. Smoothing is different from polishing in that polishing results in a highly reflective surface (Ahler 1979:308). Taking these studies together, I used their definitions for microflaking, smoothing and rounding, striations, and polish to document the types of use-wear found on my experimental scraper.

Figure 32. Scraping process

After 8,955 strokes, I began to see macroscopic use-wear. Some rounding was visible shortly after the first use of the scraper, but it was not enough to be seen as considerable rounding. Looking at the edge from the ventral surface, there is a stark difference compared to the before use picture. You start to see the beginnings of the edge rounding seen on the dacite scraper, which makes sense since that is the most noticeable type of use-wear when seen macroscopically. The image (Figure 36, below) of the scraper after 30,000 strokes demonstrates how rounded the worked edge had become. More microflaking is also evident along the edge on the dorsal side, but the rounding is more pronounced than flaking wear. Microflaking is much more evident in this photograph, occurring along the edge on both the dorsal and ventral sides of the scraper. There also appears to be a slight polish appearing on the edge that was not present in

Figure 33. After 8,955 strokes
(Photograph taken by Payson Sheets)

Figure 34. Manioc use-wear on obsidian blade (Lewenstein 1987:126)



the previous photo, which suggests sheen associated with use-wear as opposed to the natural condition of the stone. Also, a few faint striations, located perpendicular to the edge, have begun to appear close to where the microflaking can be seen.

Suzanne Lewenstein's 1987 book about stone tool use at Cerros provides a great comparison for my experiment with manioc peeling, since she looked specifically at root crop processing and did her own experimental archaeology on the subject. However, she focused on obsidian rather than on harder stone material. For root crop processing, Lewenstein observed light edge rounding, but little to no surface abrasion or polish. Striations were both parallel and perpendicular, long, and intermittent. Microflaking was symmetrical on both the dorsal and ventral sides of the blades, with flake scars either appearing as deep scalar or half-moon formations, and arranged in small clusters along the edge (Lewenstein 1987:123).

For the *manioc* peeling specifically, the used surface showed light edge abrasion and scar symmetry. Striations were orientated parallel, perpendicular, and diagonal to the tool edge, and appeared as long, narrow, and faint striations located far back from the edge. On the ventral side, however, there were also long, narrow, and deep striations as well as wide and shallow striations. The ventral side also exhibited evidence of polish (Lewenstein 1987:124). For root processing in general, Lewenstein observed that soft materials such as roots did not cause extreme edge rounding or large, deep scars along the edges (1987:126). Lewenstein also found a little polish, which was slightly visible on my scraper after 30,000 strokes. She does not, however, report as much edge abrasion as I recorded in my experiments as only a few strokes were made in her study.

Figure 35. Dacite Scraper (Photograph taken by Payson Sheets)

In comparison, it is clear that the dacite scraper from Cerén had been used much longer than my experimental scraper – based on my qualitative observations, possibly up to five times longer (150,000 strokes). The edge is even more rounded, and microflaking is more apparent. The fact that there are multiple areas on the dacite scraper where resharepening took place also lends support for its extended use. Based on the progressive images taken throughout the peeling process, it makes sense that the experimental scraper would continue to accumulate more and more microflakes. In addition, the striations, which are very faint on the experimental scraper, occur in the same direction as those on the dacite scraper. While not conclusive by any means, this experimental analysis emphasizes the possible connection between the dacite scraper found at Cerén and my scraper used for processing a root crop like *manioc*.

Figure 36. Experimental Scraper after 30.000 strokes (Photograph taken by Payson Sheets)

This connection, however, does not mean that the dacite scraper was used specifically for *manioc* processing. Lewenstein's experiments were focused on obsidian knives used to peel the cortex off of *manioc* and, as Payson Sheets' research has shown, an obsidian blade could be used fairly easily to peel *manioc* cortex (Sheets 2011). Due to the oxalate crystals present in the tuberous roots of both *manioc* and *malanga*, both plants require processing before consumption (i.e. cortex removal), but *manioc* has a thicker cortex than *malanga* and, presumably, would thus require a slightly different processing method. A thinner cortex would make it more difficult to "peel" off the cortex (after an initial incision with an obsidian blade like that used by Lewenstein and Sheets), and a scraper could prove to be a better instrument in this type of cortex removal. As a result, it is likely that the dacite scraper was actually used to process *malanga* as opposed to *manioc*.

C. Malanga as a Crop

Staple Crop

There does not appear to be any evidence that *malanga* was used as a staple crop by the ancient Maya. No ethnographic or ethnohistoric sources discuss *malanga* in this kind of capacity, and the archaeological data available is from a kitchen garden. However, if archaeological research was to be conducted in an area more conducive to growing *malanga* (in comparison to Cerén), higher yields of *malanga* may be observed.

Supplemental Crop

Ethnographic and archaeological evidence suggest that the Maya may have used *malanga* as a supplemental crop. Modern-day Maya use of kitchen gardens has been well-documented by ethnographers, and it appears that the main purpose of such gardens is to provide foods that supplement those grown in the fields.

Famine Food

Similar to manioc, *malanga* is cultivated as a perennial – it can be stored and grown in the ground for several years and, once mature, the corms can be harvested at any time during the rainy or dry season. During a long dry season or a drought the plant ceases to grow, but the tubers remain edible and available and resume growing after the rain reappears. *Malanga*, then, could provide a good source of carbohydrates when other sources fail. However, unlike other root crops (and most crops in general), *malanga* grows exceptionally well in saturated and flooded areas. Flooding can be just as damaging as drought, and *malanga* is unique in that it can be used as famine food when flooding destroys other crops.

D. Conclusions

When Europeans first arrived in the New World, they were met by Maya peoples who mainly practiced swidden agriculture and focused the majority of their attention on maize cultivation. As a result, Conquest-era visitors like Diego de Landa and 19th Century explorers like Stephens and Catherwood, wrote predominately about maize in their discussions of Maya agriculture. Subsequent Maya scholars and archaeologists chose to use culture historical methods in order to argue that the agriculture practice by Colonial-period Maya must have been the same as that practiced by the ancient Maya. When demographic studies conducted in the 1960s indicated purely swidden agriculture could not sustain the population densities recently estimated for the ancient Maya, however, thoughts on agricultural strategies had to be amended. Including new ideas for agricultural techniques and crops used for cultivation, the paradigm shift in ancient Maya agricultural studies found a voice for root crop use in Bennet Bronson (1966). While highly influential at the beginning, Bronson's ideas began to lose consideration until recent excavations conducted at the site of Cerén in El Salvador provided evidence for Bronson's assertions. In addition to a large manioc field that rivaled that maize field found at the site, *malanga* was found in a kitchen garden as well; the cavity produced by the lost organic material of the *malanga* was filled with dental plaster in order to create *malanga* plant casts.

Recovery and subsequent analyses of these plant casts in the summer of 2011 have resulted a new understanding of how root crops may have been utilized by the ancient Maya. Through the use of ethnography, ethnohistory, iconography, and archaeology, I have compiled summation of *malanga's* possible role(s) in ancient Maya agriculture, as well as how to continue research on the plant. Ethnographic research from South American and Central America has shown how different peoples living in different environments use root crops. In South America, for instance, it was found that many of the Amazonian inhabitants ate manioc as a staple crop (as opposed to maize). In Central America, studies of the Ch'orti' and the Lacandon have indicated that root crops were grown in a more supplementary capacity – often with other crops in kitchen gardens.

Ethnohistoric sources have been instrumental in understanding the extent of root crop use and the ways in which they were used. The *Relaciónes Geográficas*, for instance, was able to demonstrate that numerous culture groups and provinces within the Basin of Mexico used the same root crops (though they had different names for them). Other ethnohistoric sources, such as the *Treatise on the Heathen Superstitions*, provide accounts of religious ceremonies that suggest some root crops may have been viewed as famine food when maize yields were down. Some interpretations of ancient Maya iconography, however, argue for the presence of *malanga* leaves in the headdresses of Gods portrayed in images from the Preclassic period. Thus, while Conquest- and Colonial-era documents portray root crops as, at best, supplementary crops, it is possible that *malanga* may have had a much larger role in Mesoamerica during the Preclassic.

Unfortunately, only the sites of Cuello in Belize and Cerén in El Salvador have provided archaeological evidence for the use of *malanga* in ancient Maya agriculture. While the technologies used for starch grain and pollen analyses are becoming more and more sophisticated, *malanga* is difficult to observe in the archaeological record even when utilizing these techniques. As a result, I propose that archaeologists should look towards more durable indicators of *malanga* use, such as use-wear patterns on stone scrapers and knives. Due to the same poisonous oxalate crystals that manioc contains, *malanga* would have to be processed through a method of cortex removal from the corm, which would require a scraper or knife. As I have already shown, use-wear analyses based on *manioc* processing have been highly successful, and I believe similar analyses would be just as useful in the identification of *malanga*. In addition, it would benefit archaeologists to know where the best areas are to look for *malanga* use within the Maya region as well. Based on the plant's edpahic requirements, as well as evidence for its use in gardens, I believe that *malanga* would most likely have been grown in swampy, inundated soils in a kitchen garden setting or along watercourses. Through my research on *malanga*, I believe I have provided new and important information on the ancient Maya diet and on how to continue searching for a previously unknown crop

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