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A PALEOETHNOBOTANICAL PERSPECTIVE ON LATE CLASSIC MAYA CAVE
RITUAL AT THE SITE OF PACBITUN, BELIZE

by

MEGAN D. PARKER

Under the Direction of Jeffrey B. Glover, Ph.D.

ABSTRACT

This thesis presents the results of paleoethnobotanical investigations conducted at nine karst sites associated with the Maya site of Pacbitun in western Belize. The archaeobotanical remains were deposited during the Late Classic period and the site was abandoned at some point during this same time (c. A.D. 900). Paleoenvironmental data from the Maya Lowlands indicates that human activity contributed to regional climate change during the Late/Terminal Classic period. However, site-specific research has demonstrated a variety of responses to these social and ecological changes. The archaeobotanical data from this study is used as a proxy for understanding how people at Pacbitun ritually responded to macro-regional environmental stress. Ritual plant use at the cave sites does not conform to behavioral ecology models that predict biological, cost-fitness related responses to resource scarcity. Instead, the data supports a model of behavior based on culturally motivated ritual practices.

INDEX WORDS: Environmental archaeology, Paleoethnobotany, Maya Archaeology, Ritual,
Cave and karst studies, Mesoamerica, Belize Valley

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RITUAL AT THE SITE OF PACBITUN, BELIZE

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MEGAN D. PARKER

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Masters in Arts

in the College of Arts and Sciences

Georgia State University

2014

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Megan D. Parker
2014

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RITUAL AT THE SITE OF PACBITUN, BELIZE

by

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August 2014

Dedicated to my family.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the generous contributions and guidance provided to me from numerous people. First, I would like to say thank you to each member of my thesis committee, who all offered me valuable advice, support, and encouragement. My advisor, Dr. Jeffrey Glover, provided valuable counsel and insight throughout the completion of my thesis. His patience and cheerfulness were always something that I relied upon and appreciated. Dr. Christopher Morehart continually challenged me and provided me with the foundation for the skills and knowledge to pursue a career in environmental archaeology. His enthusiasm and support of my research were valuable motivators throughout the project. Dr. Terry Powis has continued to advise me since I was an undergraduate. The words “thank you” do not seem sufficient enough to express the depth of my appreciation for the years of patience and guidance, as well as the opportunities to conduct fieldwork at Pacbitun, that he has provided for me. Dr. Daniel Bigman challenged me to write for a broader audience. His energy and zeal towards archaeology and learning helped to keep me motivated during the process of writing my thesis.

This research was partially funded with a Sigma Xi Grants-in-Aid-of-Research grant (Grant ID #G20130315164161). The funding Sigma Xi provided allowed me to perform Scanning Electron Microscopy on wood charcoal samples, providing valuable high-resolution magnification images that aided in the identification process. I would also like to express my gratitude to the Alphawood Foundation, who funded the Pacbitun Regional Archaeological project during the 2012 field season through a grant awarded to Terry Powis. I am grateful as well to the Institute of Archaeology of Belize, especially Dr. Jaime Awe and Dr. John Morris, for their continual support of PRAP.

Thank you to the Tzul family for your continued support of PRAP and continued permission to excavate at Pacbitun. Thank you Joe Tzul and Antonio Mai, who guided me through the jungle day after day and navigated us safely in and out of the caves, while teaching me valuable knowledge about local flora and fauna along the way. I am grateful to Jon Spenard, C. L. Kieffer, and Mike Mirro for sharing their knowledge of caving with me as well as being incredibly patient in dealing with this stubborn novice. Additionally, I would like to thank PRAP staff and field school students for a great field season. I am also grateful to Georgia State University and the Department of Anthropology, including the faculty and my fellow students, for giving me a home away from home and endless support. Special thanks to my classmates who held me up when I was ready to give in and who contributed to maps and figures. I could not have done it without you guys.

Thank you to my grandparents, my darling sisters Ashley Parker and Tryniti Fayth, and my friends and family for all of their love and support. Finally, I would like to thank my parents. You both always encouraged me to be who I wanted to be and pursue what made me happy. You probably regretted it when I declared my intentions to spend my summers in the jungles of Central America. But you reluctantly tolerated it and continue to support me and encourage me to follow my dreams. There is no better gift that a parent can give to a child. Thank you.

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1 INTRODUCTION

This thesis presents recent paleoethnobotanical investigations conducted at the Maya site of Pacbitun in western Belize (Figure 1.1). Pacbitun was continually occupied from the Middle Preclassic period (c. 900 B.C) to the Late Classic period (c. A.D. 900) (Healy et al. 2007). The site is located in the upper Belize River valley in the Cayo District outside the contemporary Maya community of San Antonio. Because of the site's location in a rich transitional zone between the upper Belize River valley and the Mountain Pine Ridge, inhabitants had access to a wide variety of natural resources that could be exploited for utilitarian, economic, political, and ritual gain. The surrounding landscape is also rich in karst features such as caves, rockshelters, and sinkholes. Caves and other features of the karstscape (Spenard 2012) were primary components of a sacred landscape (e.g., Awe 1998; Bassie-Sweet 1991, 1996; Brady 1997, 2000, 2003; Brady and Prufer 2005a, 2005b; Brady and Veni 1992; Freidel et al. 1993; Heyden 1981; Morehart 2005, 2011; Morehart et al. 2005; Morehart and Butler 2010; Prufer and Brady 2005a, 2005b; Schele and Freidel 1990; Stone 1995; Thompson 1959; Vogt 1969; Vogt and Stuart 2005). Caves were entrances to the homes of earth deities, where direct contact with powerful supernatural forces could occur. As generators of ritual activity, liminal spaces such as caves become significant loci for understanding the ritual relationships and obligations that the ancient Maya maintained with their natural and supernatural world. In addition, because of Pacbitun's long occupation and location in an ecological transition zone with increased biodiversity, it is an ideal site for exploring how people were responding to macro-regional environmental change during the Late/Terminal Classic period.

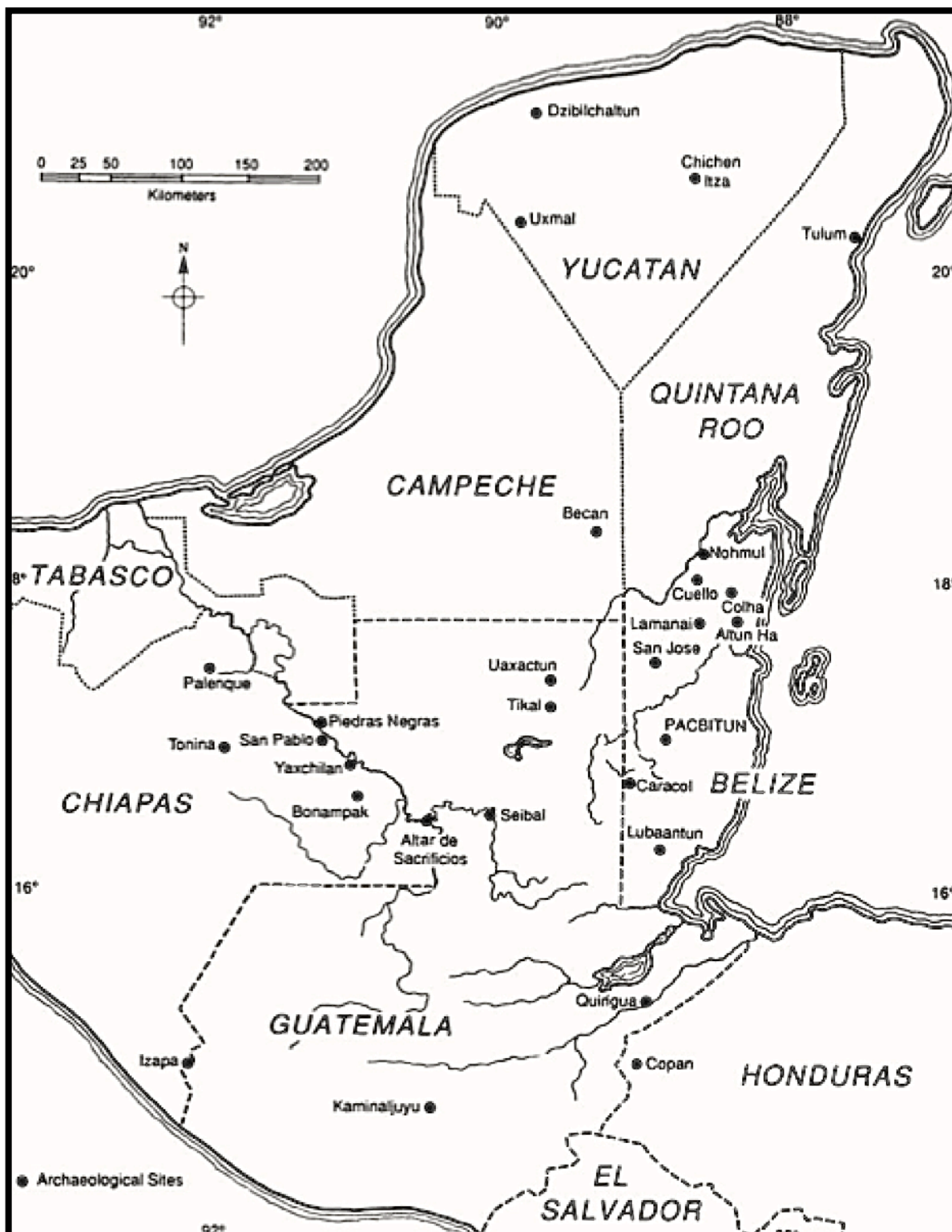


Figure 1.1: Map of the Maya subarea showing the location of Pacbitun in relation to other Maya sites (after White et al. 1993:Figure 1:349).

1.1 Purpose of the Study

The purpose of this research is to reconstruct ritual plant use among the ancient Maya at Pacbitun through the analysis of archaeobotanical remains recovered from nine karst features in the site periphery. Furthermore, Pacbitun's abandonment c. A.D. 900 raises questions regarding the ways in which local urban centers in the upper Belize River valley responded or adapted to macro-regional political, economic, and social instability resulting from environmental changes. Since little is known about the conditions surrounding Pacbitun's decline, carbonized wood charcoal was examined to determine patterns of resource use during the Late Classic period. These data are then tested against different behavioral models in order to determine how changes throughout the Maya Lowlands affected local ritual responses. By focusing on paleoethnobotanical materials, rather than other material remains recovered from cave sites, questions can be asked regarding the ways in which environmental circumstances directly influence ritual plant use. Archaeologists can also address the impact of environmental change on ritual behavior, and the implications for human adaptation. Ritual can be a useful proxy for elucidating social, ideological, political, and economic relationships (e.g., Lucero 2003; Monaghan 2001). Whether or not it can be a direct proxy of environmental change is questionable, however it may provide promising insights into how the ancient Maya reacted to changes in their local ecosystems.

Palynological data from the Yucatán and Petén regions indicates drastic environmental change during the Late/Terminal Classic periods (e.g., Brenner et al. 2002; Curtis et al. 1998; Dunning and Beach 2000; Dunning et al. 1998b). Multi-decade droughts may have been exacerbated by anthropogenic environmental degradation. However, limited paleoenvironmental data are available for the Belize Valley region (see Moyes et al. 2009; Webster et al. 2007 for

exceptions). So how were people in the Belize Valley responding to social and climatological changes throughout the Maya Lowlands? What were the localized responses to environmental change, and what can those responses tell us about ancient Maya society? Indeed, can ritualized behavior, intertwined with symbols and political motivations, be an effective tool for illuminating these responses? Ritual is a behavior despite being a “cognitive paradox” (Legare and Souza 2012:1), and as such it may be useful for understanding the degree that human biological needs for resources competes with the cultural rationale that influences practice.

Interactions between humans and the plant world are an important component to understanding culture and society throughout the world. Paleoethnobotany, or the archaeological study of the relationships between humans and plants (e.g., Hastorf and Popper 1988; Pearsall 2010), has seen dramatic increases in theoretical and methodological development in the past 30 years or so, though its utility and popularity ranges geographically. In the Maya area, paleoethnobotany has become increasingly important in recent decades. Central America is recognized as a global diversity hotspot, with over 5000 native vascular plant species (DeClerk et al. 2010:2301), suggesting that a richer and more complex relationship likely existed between the plant kingdom and the ancient Maya than is often addressed. One reason that paleoethnobotanical research was somewhat slower to gain momentum in the Maya area is in part due to preservation concerns, as the tropical environment of much of Mesoamerica does not lend itself to the preservation of organic materials. However, the degree of preservation cannot be established, and no data can be obtained, if investigation does not first take place. Previous paleoethnobotanical cave investigations (see Morehart 2005, 2011) have indicated that cave environments are more conducive to the long-term preservation of organic materials and provide promising avenues for future archaeobotanical research in the Maya area.

Because of recent concerns regarding anthropogenic climate change, the Maya region lures academics seeking to further understand the ways that the ancient Maya manipulated their ecosystems to their advantage (or disadvantage). One way to gain insight into this intricate relationship between mankind and nature is to analyze the complex interactions that the ancient Maya had with the plant world. Previous paleoethnobotanical investigations that have been undertaken in the Maya area have focused primarily on reconstructing ancient diet or paleoecology. While these subjects are significant and have laid the foundation for paleoethnobotanical research, more recent studies have begun to address the social relationships between the ancient Maya and the plant world, a shift that reflects broader theoretical concerns in anthropology and archaeology (see Morehart and Morell-Hart 2013). This shift in focus is marked by research questions that address social issues such as the ritual use of plants (e.g., Benz et al. 2006; Bozarth and Gujerjan 2004; Goldstein and Hageman 2009; McNeil 2006a, 2006b, 2009; McNeil et al. 2006, 2010; Morehart 2005, 2011; Morehart et al. 2004; Morehart and Butler 2010; Morehart et al. 2005; López 1998, 2001, 2006, 2007, 2009), their role in maintaining and enforcing gender roles (Morehart and Helmke 2008), and their place within the ancient political economy (e.g., Carr and Crane 1994; Cliff and Crane 1989; Crane 1996; Lentz 1991; Lentz et al. 2005; Morehart and Eisenberg 2010; de Tapia 1977, 1980, 1985; Turkon 2004, 2006).

Morehart and Morell-Hart (2013) encourage researchers to regard plant remains as more than just ecofacts. Paleoethnobotanical remains are more appropriately categorized as artifacts (Morehart and Morell-Hart 2013). Few plants deposited into the archaeological record are unmodified by human behavior (Schiffer 1987 in Morehart and Morell-Hart 2013). The dynamic relationships between plants and people have served to create and transform culture throughout history. As such, human-plant relationships can be a valuable tool for exploring social

archaeological research. Analyzing human-plant relationships at the intersection of social and ecological systems can provide insights regarding structural constraints on human behavior and culture (Brumfiel 1992). This thesis promotes the use of paleoethnobotanical remains as artifacts that actively participate in the construction of culture and are part of complex socioenvironmental interactions.

This research also contributes information regarding the use of plants in Maya cave ritual. It lends itself to a fuller understanding of the ways in which the ancient Maya interacted with their sacred landscape, navigated ideology and religion, and maintained social relationships with the supernatural. Christopher Morehart's work in the Belize Valley, conducted in 2000, has remained the only regional paleoethnobotanical cave survey for over a decade (Morehart 2002, 2011). This research contributes to that regional survey, providing data from nine additional karst sites to our understanding of ritual plant use among the ancient Maya of the Belize Valley. The use of data from nine sites in the region surrounding Pacbitun provides the opportunity to analyze spatial patterns of ritual behavior between caves that are all associated with the same urban center. Some of the karst sites in this study have unique attributes that may help to understand the social dimensions of their use and function. Morehart documented regional variation in cave rituals and this research will provide the opportunity to evaluate contrasts in ritual behavior between cave sites as well. By doing so, it will be an informative comparison with the regional data obtained by Morehart (2002, 2011) to provide a better understanding of cave ritual in the Belize Valley during the Late Classic period.

By reconstructing plant use in Maya cave ritual, this study seeks to further our understanding of the breadth of the relationships that mankind has forged with the plant kingdom. It emphasizes the potential for paleoethnobotanical data to address social questions

relevant to contemporary societies. It also investigates the ways in which ritual experience and behavior interacts with the environment and explores whether ritual is influenced by ecological change or whether change is obscured in the socially established operations of ritual practice.

1.2 Expected Results

Wood charcoal was the most frequent form of archaeobotanical remain recovered during this research project. Therefore the dataset lends itself to examining questions regarding the impacts of deforestation during the Late Classic period. Although the extent of forest clearance is unknown in the region, the upper Belize River valley was heavily populated during this time and large areas of land would have been cleared to allow for agriculture. Exploring behavioral responses to ecological change allows for considerations of its potential impact on the cultural processes that governed everyday life, including ritual obligation. The use of macrobotanical remains as opposed to pollen from sediment cores offers the benefit of a clear linkage between human action and the archaeological record. When using pollen as a proxy for environmental reconstruction, the extent of human involvement can only be inferred. The wood charcoal examined in this study represents direct human-environmental interaction within the context of ritual activity. Therefore, the data utilized in this study provide an alternative perspective into the intricacies of both environmental and social interaction, and the influence of ritual obligation on these relationships among the Maya at Pacbitun. Indeed, it is crucial to understand environmental change and the restructuring of Maya culture during the Late/Terminal Classic periods not only regionally, but also on a more local scale. By examining the data recovered from ritually utilized caves associated with Pacbitun, site-specific information regarding

localized responses to macro-regional change can be gained. This allows for a finer-grained understanding of the range of human response and adaptability to the environment.

While the dataset can provide insights into the direct interactions between humans and plants, the ritual context limits what can be inferred about the ancient environment. Ideological and religious preferences in plant selection determined inclusion into the archaeological record. Therefore, since interpretations of the archaeobotanical remains are mediated through their ritual context, they are likely not a direct reflection of environmental conditions. However, they may be a useful proxy for examining human behaviors embedded in complex socioenvironmental contexts.

In order to determine whether the ancient Maya at Pacbitun were reacting to macro-regional socioenvironmental instability, the data is tested against two basic models (Parker and Morehart 2014). The first is derived from behavioral ecology and tests whether ritualized behavior is subject to fitness-related decision-making during times of environmental stress. The second is derived from cognitive anthropology and tests whether or not cultural logics and social constraints are a more powerful motivator in ritual behavior. Ritual and ecology are intimately associated with one another and ritual activity can serve as a regulating mechanism of environmental and social conditions (e.g., Rappaport 1999). Behavior and ecology are equally intertwined, existing in a continual feedback loop of cause and effect, responding one to the other. Gordon (2011:225) asserts that “ecological relationships are expressed as behavior.” Behavioral ecology predicts that people will respond to resource scarcity by adapting their behavior to the local ecosystem based on the availability of materials. Cognitive anthropology predicts that people will behave according to principles of cultural logic, possibly obscuring environmental changes in the cultural milieu that human behavior is embedded in.

1.3 Overview

In Chapter 2, the theoretical hypotheses and above models are explored in greater detail. This chapter also provides reviews of the relevant scholarship regarding some of the theoretical perspectives used to interpret the data. An overview of theory regarding human-environmental interactions establishes the basic framework for understanding ancient Maya plant use in the upper Belize River valley during the Late Classic period. A review of behavioral ecology provides a means for the construction of a model that can be used to understand resource consumption at a time of environmental and cultural change. This is followed by a review of theory regarding ritual behavior. The specialized context of the sites investigated as ritual spaces requires an evaluation of ritual theory. Focus is given to cognitive anthropology, which studies thought and knowledge as it is distributed through communities (Boster 2012:372). Cognitive anthropology, therefore, can provide insights into the psychological and cultural factors influencing responses to climate change. Finally, the chapter provides models drawn from these two primary bodies of theory to test how the ancient Maya were reacting to climate change at the intersection of the environment and ritual practice.

The field of paleoethnobotany is defined in Chapter 3. Definitions and methods are discussed in detail to provide an overview of some of the major research questions addressed by paleoethnobotanists. Chapter 3 addresses both macrobotanical and microbotanical remains and recovery techniques. The chapter also provides a review of some of the major paleoethnobotanical work conducted in the Maya area and draws from both archaeological and ethnographic studies.

Chapter 4 focuses on the role of caves in ancient Maya society. Karst features were socially significant components of a sacred landscape. A review of the history of cave

archaeology in the Maya area is provided, followed by a brief discussion of cave archaeology in the upper Belize River valley. In the earliest years of cave archaeology in Mesoamerica, caves were believed to have been early habitation sites. However, the integration of years of archaeological, ethnographic, and ethnohistorical data resulted in the conclusion that caves were used primarily for ritual (see Brady 1989). Caves and mountains were crucial elements of the sacred landscape. Artificial or pseudo-karst features were created where caves were naturally absent, and important structures were oriented around karstic features. The significance of caves in Maya culture make them critical sites for addressing archaeological issues such as politics, social identity, economics, and religion.

Chapter 5 provides background information that will place the current research project in its relevant environmental and archaeological context. A review of archaeological investigations of climate change in the Maya area is provided. Palynological data indicate that drought may have played an essential role in the Late/Terminal Classic Maya “collapse” (Brenner et al. 2002; Hodell et al. 2001). While not all studies are in agreement about the extent or severity of the drought (Curtis et al. 1998), evidence supports a drying period in the Maya Lowlands that would have resulted in dramatic social and cultural changes with widespread effects across Mesoamerica (Brenner et al. 2002). There is less paleoenvironmental data available for the upper Belize River valley, however people living there were economically, politically, and culturally associated with other areas in the Maya Lowlands. Environmental stress in regions such as the Petén, therefore, would have triggered cultural changes in the Belize Valley.

Chapter 5 also provides background information regarding the archaeological history of Pacbitun. The site of Pacbitun is a medium-sized urban center located on the margins of the upper Belize River valley and the Mountain Pine Ridge. Since the 1980’s the site has been under

archaeological investigation (Healy 1990, 1999; Healy et al. 2007; Powis 2009, 2010, 2011, 2012, 2013). A cave component to the archaeological project has begun investigating the karstscape in Pacbitun's hinterlands (Powis 2010; Spenard 2011, 2012a, 2012b, 2013a, 2013b). Chapter 5 concludes with a discussion of the nine karst features included in this study.

The methods and cellular characteristics used to identify carbonized wood charcoal are discussed in Chapter 6. This chapter also presents the data. Wood charcoal was the most abundant type of archaeobotanical remain recovered from all sites. Pine is the most ubiquitous species of wood present, recovered from eight of the nine sites. Other tree species are found in limited contexts. The burning of wood such as pine symbolically transformed the object into food offerings for earth deities by releasing the spiritual essence (Morehart 2011:121). Each karst site is addressed individually, followed by an intersite comparison. The data is then tested against the behavioral models developed in Chapter 2. Finally, a discussion is offered in Chapter 7, as well as concluding remarks regarding future directions that could strengthen the findings of the research.

2 THEORY

This chapter presents the theoretical background and framework used to interpret the data. It incorporates the relevant theory on human-environmental interaction as well as ritual behavior, with a focus on behavioral ecology and cognitive anthropology. These discussions are followed by the predictive models used to test the data.

2.1 Human-Environmental Interaction

Understanding the variety of relationships and interactions between humans and their environments can not only inform us about a significant aspect of a culture's past, but it can also provide powerful information for navigating environmental change in the future. The relationships between people and the environment have always been intricately and delicately balanced. Lentz (2000:2) emphasizes that "humans are components of a dynamic biosphere," both influencing ecosystems and adjusting to them as they naturally fluctuate and change. It is critical to understand these relationships both on a regional scale and a more localized scale. Mesoamerica's diverse, composite landscape of ecosystems presents a valuable opportunity to explore localized responses to the environment, as well as how these responses contributed to regional development and change (e.g., Dunning and Beach 2000; Dunning et al. 1998a, 1998b).

Gill (2000:4) argues that the Maya were the "victims, not the perpetrators" of environmental change with no control over the outcome. Referring to the Second Law of Thermodynamics, he discusses the phenomenon of social organization in a world tending toward chaos and disorder (Gill 2000:44). Social organization, he argues, is a byproduct of the exchange of chaos from culture and into the environment. In other words, social and cultural structures import raw materials while exporting waste products into the environment, increasing

internal order and neutralizing internal entropy (Gill 2000:44; see also Iantsch 1980:31; Prigogine and Allen 1982:6). However, while Gill does not believe that people can predict or prevent environmental change, he fails to account for the impact of human influence attributed to the exchange of disorder into the environment.

Contrary to Gill, Friedman (2006) argues that complex systems collapse or decline not as a direct result of environmental catastrophe, sudden or gradual, but as a result of strains on the social system that prevents it from responding successfully to such events. Ecological overexploitation, Friedman (2006:101) suggests, often masks the true underlying societal factors that lead up to systemic declines. Therefore, rather than concentrating the entirety of our efforts on understanding the environmental changes that coincide with cultural decline, it is crucial to examine them in relation with various social institutions that would have been directly impacted by change. In doing so it may be possible to tease out the nuanced social factors that placed so much strain on the system in question as to dangerously increase its vulnerability to environmental change.

Cote and Nightingale (2012:475) approach socio-ecological systems through the framework of resilience, which is defined as “the ability of socio-ecological systems (SES) to absorb disturbance without flipping into another state or phase” (see also Gunderson 2000; Holling 1973:14). Cote and Nightingale (2012:476) deviate from the usual approach to socio-ecological systems by emphasizing the social and ecological interplay within such systems and approaching resiliency through a social theoretical lens. Specifically, the role of knowledge at the junction of society and the environment is used as a heuristic tool for analyzing how power and value systems are a primary component in the development of socio-ecological systems (Cote and Nightingale 2012:476). Neither humans nor the environment can be understood in

isolation from each other, but must be acknowledged as two fundamental factors of a constant system of feedback and transition (Cote and Nightingale 2012:477). The focus should not be on the availability of resources, but rather on the availability of response options to environmental change (Cote and Nightingale 2012:478).

Cote and Nightingale (2012:477) argue that social institutions modify resource consumption and the landscape in response to local knowledge of environmental change (see also Gadgil et al. 2003). However, some social actions may be supported by one part of society and rejected by another while some “undesirable” systems can be highly resilient (Cote and Nightingale 2012:478-479). The processes underlying social dynamics contribute to both stability and change within socio-ecological systems (i.e., differing resource values, leadership, economics, politics, and social stratification). These social aspects and institutions often restrain adaptive action (Cote and Nightingale 2012:480-484). Adger et al. (2005) suggest that social inequality should be a component to the evaluation of institutional adaptability to environmental change. Power relations and cultural values play an integral role in the management of local ecosystems and institutional dynamics in human-environment relations, and therefore should be incorporated into socio-ecological systems analyses (Cote and Nightingale 2012:480, 484; see also Nightingale 2003; Peet and Watts 2004; Schroeder and Suryanata 1996; Shove 2010).

Head and Atchison (2009) examine human-plant relationships and their place within a broader geographical landscape. They place these interactions upon a shifting cultural landscape within which is embedded identity and belonging (Head and Atchison 2009:240). Knowledge of and dependence upon particular plants create patterns of migration and mobility across geographic and culturally contrived landscapes, which are manipulated, appropriated, and transformed by this feedback of interaction. Human-plant relationships are crucial components

to the construction of boundaries across landscapes (Head and Atchison 2009:241). Head and Atchison (2009:241) refer to these relationships as the “social lives of plants”, and their influence on the landscape plays a critical role in the relationships that humans maintain with their surrounding environment.

Kottak and Costa (1993:335) discuss ethnoecology, or “any society’s traditional set of environmental perceptions, its cultural model of the environment, and its relation to people and society.” If no perception of ecological danger or threat is immediately present, than no efforts will be made to mediate anthropogenic environmental degradation. Additionally, efforts at environmental conservation, they argue, must be culturally appropriate and acceptable, however “[i]mported values and practices often conflict with those of natives” who have traditional methods for environmental preservation, particularly in today’s globally integrated society, which tends to displace indigenous ethnoecologies (Kottak and Costa 1993:336-337). Risk is culturally constructed, and the absence of an immediate threat decreases the potential to perceive risk (Kottak and Costa 1993:338). Efforts to mediate environmental stress, therefore, generally occur slowly and in local communities. Although the authors are speaking from a contemporary perspective, I believe that the concept of risk perception and localized sustainability practices are applicable across time and space. Indeed, it is crucial for archaeologists to consider these things in order to gain a greater understanding of how past peoples responded to social and environmental risks.

Bodemer et al. (2013) determined that populations have a greater fear of short-term and sudden population losses (dread risks) than cumulative population losses over time (continuous risks). Not only is there a psychological component to witnessing large numbers of a community lost at once, but Bodemer et al. (2013:5) were able to demonstrate through simulation models

that it is an “ecologically rational” strategy to fear dread risks more than continual population losses. Sudden losses of population (resulting from earthquakes, floods, etc.) impact large numbers of people and then drastically reduce reproduction rates. Continuous risks (i.e., those associated with drought) do not necessarily raise an immediate concern because the slow loss of population over time does not have the same direct and dramatic affect on population growth (Bodemer et al. 2013:5-6). Understanding the nature of environmental risks and how local communities perceive them, therefore, can illuminate how people were behaving in response to macro-regional environmental stress.

2.1.1 Behavioral Ecology

Behavioral ecology (BE) models have been used to study human-environmental interactions related to resource consumption. BE is a subset of evolutionary ecology. Evolutionary ecology is the study of the “adaptive design in behavior, life history, and morphology” and considers behaviors to be adaptive when they “enhance an individual’s inclusive fitness” in their environment (Bird and O’Connell 2006:143-144; Cronk 1991). Behavioral ecology analyzes the fitness-related trade-offs of certain behaviors and examines why those behaviors develop and are maintained (Bird and O’Connell 2006:144; Cronk 1991; see also Dochtermann and Jenkins 2011; Gordon 2011).

Behavioral ecology is operationalized through a variety of models, such as optimal foraging strategy, patch choice, diet breadth, costly signaling theory, and risk reduction. Optimal foraging theory operates with the understanding that maximizing nutrition increases fitness (Bird and O’Connell 2006:146). With patch models, optimal foraging theory predicts that locations for exploitation are ranked based upon their expected return rates, including factors such as

distance (Bird and O'Connell 2006:147). BE predicts that patches will be abandoned once return rates decrease below that of a secondary patch.

Gordon (2011:225) argues that “behavioral responses in different conditions lead to different ecological outcomes” and that “[b]ehavior is linked to ecology at every level.” Evolution of traits does not occur in static environments, but diverse ecosystems subject to dramatic and sometimes quick changes. Evolution occurs as a result of adaptation to a specific context, but that context is in constant flux. A trait that is beneficial in one context may be detrimental in another (Gordon 2011:226). Environmental processes are not uniform and it is unlikely that any trait would be adaptive in every situation (Gordon 2011:229). By using evolutionary ecology with behavioral ecology, behaviors can be examined in their ecological contexts, which may provide a more nuanced understanding of human action.

Behavioral ecology has been limited when studying evolutionary approaches to social and institutional behaviors (Kantner 2010:232). Ritual, for example, has often either been relegated to epiphenomenal by-products of culture or painstakingly formulated to appear evolutionarily advantageous, however “not everything we do is related to enhancing evolutionary success” (Kantner 2010:232). Ritual is often lumped into a broad category of activities deemed “wasteful behavior” that includes grave goods, stylistic attributes, feasting, trade of non-utilitarian commodities, and monumental architecture (Bird and O'Connell 2006:162). Bird and O'Connell (2006:163) offer several potential theories to explain such activities, including “costly signaling theory”, which suggests that more motivated individuals perform “wasteful behaviors” to demonstrate their ability to do so, which in turn may discourage others from wasting energy on a fruitless and costly pursuit; therefore, the signaling is mutually beneficial. While these models have proven useful in understanding resource consumption, they do not allow for a

culturally-motivated understanding of ritual practice. Additionally, sometimes individuals are forced to respond rapidly to changing circumstances, and while these decisions may be rational, they may not promote individual or group fitness (Kantner 2010:223).

Behavioral ecology assumes that all people have the cognitive capacity to make rational decisions (e.g., Kelly 2000; Smith 2000), however this capacity is variable between individuals (Hayden 1995:20-21). Additionally, “rationality is contingent on goals, currencies, and utilities, which can be culturally mediated” (Kantner 2010:234). Natural selection shapes human decision making, but does not rule over it (Kantner 2010:235), as cultural mediation of decision-making leads to behaviors that can diminish individual and group fitness (Tracer 2003). Kantner (2010:235) argues that BE needs to address behavior with no direct or clear association with individual fitness, pointing out that “the choices available to individuals and the decisions they make depend on environmental, social, and historical constraints.” The interplay between cognitive processes on human evolution and how these processes are affected by cultural factors may mimic adaptive behaviors that might actually have little or no benefit to overall fitness (Kantner 2010:236-237). Behavioral ecology, therefore, can be beneficial to the study of resource consumption, but how well does it apply to ritual resource consumption during a time marked by dramatic environmental changes?

2.2 Ritual

Ritual is distinct from belief, which cannot be accessed archaeologically (Prufer and Brady 2005a:5). Ritual, however, can be the physical and material manifestation of religion, belief, and dominant political ideologies, and therefore can be examined in the archaeological record (see DeMarrais et al. 1996). Fogelin (2007:56) describes religion as an abstract symbolic

system of beliefs and myths, and ritual as repetitive behavior and action. Through the analysis of rituals, information can be gained about past religious systems and their social, political, and economic relationships (Prufer and Brady 2005a; see also Aldenderfer 2012; Bell 1992, 1997; Joyce 2012; Kus 2012; Morehart and Butler 2010; Rowan 2012). Joyce (2012:181) defines ritual as “religion in action”. A key component to understanding religion archaeologically is identifying patterns of consistency and change between ritual objects and contexts (Joyce 2012:182; see also Morehart and Butler 2010). Rowan (2012) argues that archaeology has the potential to record changes in religious practice and belief by examining such patterns in the archaeological record, both spatially and temporally.

Rakita and Buikstra (2008:4) refer to religion as a system that “define[s] what is believed about supernatural forces and how people should interact with those forces” that are “embedded in worldviews or ideological frames of reference.” Wallace (1966:102) states that ritual is the “primary phenomenon of religion”. As phenomena of action, rituals are in part materialized, and therefore tangible (Rakita and Buikstra 2008:7). Bell (1992:16) takes a performative approach to ritual, referring to it as “a type of critical juncture wherein some pair of opposing social or cultural forces comes together.” Through repetitive behavior, ritual constructs an internal organization of binary oppositions that create flexible relationships between supernatural beings, communities, and others (Bell 1992:125). Morehart and Butler (2010) also address this flexible nature of ritual and the interplay between the material and the immaterial. Bell (1992:125) points out that ritual, even as it can establish differences in a community, at the same time can integrate communities and “ritualization appears to be a type of social strategy that can simultaneously do both.”

Victor Turner (1957, 1967, 1968, 1974) is well-known for his anthropological work on ritual and symbolism. Turner (1968:2) defined ritual as “an aggregation of symbols,” symbols being the “molecules of ritual” (Turner 1969:14). Turner also described ritual as “quintessential custom” (Turner 1968:23), a “patterned process in time” (1967:45), and a “prescribed formal behavior” (1967:19). Turner argued that ritual was embedded with symbols, and that these symbols were incorporated into a context of ritual rife with social controversies. Ritual, Turner (1968:269) argues, is a dynamic and ever-evolving process that includes the performance of roles and the acceptance of conflicting knowledge (see also Turner 1957, 1968, 1974). Ritual symbols, to Turner (1957:93), are the means of mediating conflicting dichotomies embedded in temporally distinct sociocultural contexts. Ritual, rather than a static act of confirmation, is a dynamic process of transformation and social change.

Morehart and Butler (2010) discuss ritual in terms of Mauss’s (1990) conception of the fourth obligation – exchange between humans and gods, a debt owed for the gift of life that demands eternal reciprocity (Mauss 1990:16; Morehart and Butler 2010:603). Ritual is both material and immaterial, a transaction and an interaction, and “provide[s] a material form to immaterial beliefs seen to exist beyond normal boundaries of space and time” (Morehart and Butler 2010:591). The material aspect of ritual, they argue, is shaped by broader material interactions (i.e., the political, economic, and social cycles of production) that are not subject to the ritual itself. This provides a means for those unbound by the ritual to influence the ritual and, as a result, the material aspects of such behavior (Morehart and Butler 2010:592).

Rappaport (1971:60) argues that ritual “cycles” serve as a regulating mechanism to maintain environmental integrity, as well as limit warfare, facilitate trade, and distribute goods. This functional component of ritual behavior emphasizes the mechanisms that regulate and

maintain cultural systems, which are crucial for adaptation (Rappaport 1971:59-60). Among the Tsembaga, Rappaport continues, the ritual cycle serves as a means to regulate both internal and external systems, limiting the frequency of conflict, population sizes, and fallow periods, while also transmitting “energy” from local subsystems to regional systems (Rappaport 1971:61). In this way, ritual is a regulatory mechanism, and “[d]espite the complexity of the system its regulatory operations are simple” (Rappaport 1971:66). The formula for correcting deviations in the system is a fixed set of rules and procedures. The actors only need to decide whether or not a deviation from a set range of variables has occurred.

Seligman et al. (2008; see also Seligman 2009) argue that ritual functions to construct “as if” worlds in contrast to a conflicting social reality. They propose a model to understand ritual as subjunctive, stating that ritual embodies “the creation of an order *as if* it were truly the case... ritual action creates a new world, in self-conscious tension with an unritualized world” (Seligman et al. 2008:20-21). The creation of these “as if” worlds, Seligman et al. (2008:25) argue, is psychologically necessary for human life. The subjunctive component of ritual is not only found in religious ritual, but all social rituals, and “is crucial to many forms of civil social behavior” (Seligman et al. 2008:25).

Rituals allow people to exist in a broken world by constructing an illusion that becomes a reality, however the new reality can only be maintained “as long as we adhere to the illusion” (Seligman et al. 2008:8, 22). Ritual actions are the transition or boundary between the two worlds of reality and illusion (Seligman et al. 2008:12). Ritual creates temporary order and “is a human construct to maintain social cohesion” (Seligman et al. 2008:19). Turner (1974) also described ritual as functioning to redress social crisis, concealing social contradictions and enacting them simultaneously as a means of mediation. Humans have the capacity to construct

different and sometimes conflicted versions of reality and to believe in both simultaneously, which is argued to be a unique cognitive function within the animal kingdom (Seligman et al. 2008:13).

2.2.1 Cognitive Anthropology

Cognitive anthropology seeks to study thought and knowledge as it is distributed through “communities of individuals” (Boster 2012:372), and has therefore been used to investigate such things as folk taxonomies (e.g., Hunn 1982; Lampman 2010; López et al. 1997; Medin and Atran 2004) and ritual (e.g., Barrett and Malley 2007; Legare and Souza 2012; Tremlett 2011; Viviers 2012; Yelle 2006). It considers the psychological components of social behavior, and how thought processes influence and are influenced by culture. Local knowledge is “the conceptual structure used to interact with the environment” (VanPool and VanPool 2009:529). Folk taxonomies are useful for understanding how people conceive of and organize their environments (VanPool 2009:530; see also Atran 1998; Faunce 2000; Hunn 1982). They are “part of the cognitive framework that people use to organize their behavior and perceptions of the world” (VanPool and VanPool 2009:530). Understanding how people classify their natural environment can provide insights into the cultural logics influencing ritual plant use.

Hunn (1982) analyzes folk taxonomies from a native utilitarian perspective. He argues that previous analyses of the utilitarian explanation for classification primarily focus on Western notions of use value, rather than cultural values (Hunn 1982:831-832). Using a cognitive psychological approach to folk taxonomic systems, Hunn argues that culturally significant models of classification have “practical relevance” (1982:831). There is significant overlap between Western taxonomies and folk biological systems, which Hunn (1982:833) argues

reflects a structure of nature that humans have the innate ability to perceive at the most basic level. The human capacity for pattern recognition enables people to discern this basic structure. However, many folk taxonomies will only classify genera to the species level if they are in some way relevant, such as the Tzeltal Maya, who sort butterfly and moth larva that are edible and attack crops into smaller classifications, but lump their adult counterparts together into a broad category (Hunn 1982:831). Similarly, the Sahaptin of North America have more specific classifications for the 60% of native fish species from which they subsist (Hunn 1982:834). Plants and animals that are not culturally significant will be lumped into broad categories of classification, such as “bird”, “tree”, or “flower”. These organisms are grouped into “residual taxa” and are “alike only by virtue of having been passed over in the process of cultural recognition” (Hunn 1982:835).

Hunn (1982) proposes an alternative model of folk biological classification as opposed to the “taxonomic hierarchy model” based on Linnean principles. Hunn’s model is the “natural core model,” which distinguishes taxa with a general cultural purpose. Hunn (1982:835) divides folk taxonomies into the “generic core”, or the culturally significant taxa, and the “residual taxa” that “collectively represent a nonresource.” The cultural value of a resource needs to be addressed from the emic perspective, and not Western notions of utility and value. Organisms are divided into a core of taxa with a specific/special purpose, and peripheral taxa (Hunn 1982:835). The core follows the principles of natural classification while the periphery is composed largely of artificial categories. Additionally, cultural knowledge is adaptive (Hunn 1982:844), therefore so are folk systems of classification.

López et al. (1997) argue that humans have evolved to construct systems of classification, or taxonomies, that guide them in interpreting and drawing inferences from the natural world.

These categorizations are the result of mutual cognitive and cultural processes (López et al. 1997:253). Categories are “cultural projections of the structure of the mind” (López et al. 1997:253). The authors study systems of classification among the Itzaj Maya and American undergraduates in order to demonstrate how cultural taxonomies are employed in reasoning (López et al. 1997:258). These studies indicate that both groups classify organisms based primarily on behavior and morphology. Both taxonomies had similarities in the number of levels present (six), however the Itzaj were less likely to lump mammals into broad categories and ecological information was built into Itzaj classifications (López et al. 1997:274-275).

Further studies indicated that inductive reasoning about the natural world was built into folk taxonomies (López et al. 1997:279). Similarity-based inductions suggest that these are universal features of folkbiological reasoning between groups. However, Americans made diversity-based inductions while the Itzaj made ecologically-based inductions (López et al. 1997:279, 284). López et al. (1997:284) argue that this indicates that the Itzaj Maya made diversity rationalizations in real-world contexts and that this was not a universal feature of folkbiological systems, but a culturally mediated method of reasoning. López et al. (1997) provide a unique study to examine logic and behavior related to systems of classification, however their analyses are limited to two populations and small sample sizes. As such, it would seem difficult to make universal generalizations. The justification for doing so is the significant differences between populations, however the study would be further supported by the use of additional cultural populations.

Medin and Atran (2004:963-964) argue that “learning landscapes” are biologically constrained and shape how information is learned and categorized. However, culture plays a role in mediating this process and it is unclear which social factors (i.e., age, education, religion,

language, etc.) play a crucial part in undermining the universal cognitive processes operating in systems of classification (Medin and Atran 2004:964). Studies indicated that individuals who are frequently exposed to natural organisms have a more advanced basic classification system than those from industrialized societies who are not, suggesting a degeneration of basic-level categories as an individual no longer has a use for more precise classifications (Medin and Atran 2004:972). Medin and Atran (2004:980) conclude that core cognitive processes do not limit cultural diversity in biological classifications.

Lampman (2010) analyzes mushroom classification among the Tzetzal Maya and how it relates to broader ethnoecological knowledge. Among the Tzetzal, mushrooms were classified into two primary categories based on cultural utility. Species that had no use were generally not named, and were lumped into a broad nonresource group (Lampman 2010:42-43). Those that were culturally useful were often categorized by ecological characteristics, thus reinforcing ethnoecological knowledge in local communities (Lampman 2010:43). The knowledge associated with culturally significant species included an awareness of life-cycles, habitat, seasonality, soil preferences, hallucinogenic properties, toxic properties, nutritional properties, and general phenotypical characteristics (Lampman 2010:47). For example, mushrooms are recognized as growing near specific tree species, such as oaks or pine, which allows the Tzetzal to harvest mushrooms based on habitats of associated trees. Lampman (2010:47) asserts that ecological information regarding culturally useless species was not consistent among informants. Classification systems, therefore, “act like a filter for ethnoecological knowledge” (Lampman 2010:47).

In addition to folk classifications, cultural psychology can provide insights into the cognitive influences on decision-making. García-Zambrano’s (1994) study of Mesoamerican

ritual during the Contact period demonstrated that when establishing a settlement, certain landscape features and characteristics were selected for with religious significance. Better ecological areas that lacked specific features were often not chosen. Features were chosen based on their resemblance to the primordial origins, “the mythical moment when the earth was created”, a four-sided, watery universe with mountains (García-Zambrano 1994:217-218). The mountain at the center would have many caves and springs and be surrounded by smaller hills. García-Zambrano’s findings suggest that patch quality can not only be measured in terms of physical resources, but on a landscape’s resemblance to ideologically salient components of an idealized sacred landscape. However, the use of a cosmological template for choosing a settlement location does not exclude the potential for the primordial landscape to have abundant resources. Additionally, the action of passing up “superior” quality land for features with symbolic and ideological significance may also indicate the acquisition of a form of social capital (i.e., community identification with a sacred landscape and its features) that is unseen in the archaeological record.

The event of a severe drying period lasting decades that impacted Maya civilization during the Late/Terminal Classic has been well established, therefore it is important to consider the psychological effects of long-term environmental strain, such as chronic droughts. Unlike other environmental catastrophes such as floods, earthquakes, and severe storms, drought is a phenomenon that has no predictable end (Stain et al. 2011:1593). Stain et al. (2011:1594) examine the mental health impacts of prolonged periods of environmental stress, which indicate the presence of a “coping threshold.” As environmental degradation increases, active coping methods give way to more passive strategies for coping, resulting in a lack of problem solving, reduced communication, and a need to seek support (Stain et al. 2011:1594). This threshold is

reached when “the level of degradation [is] perceived as being out of one’s control” (Stain et al. 2011:1594; see also Van Haaften and Van de Vijver 1999). There is an increased risk of depression, anxiety, and distress “among individuals exposed to repeated traumatic events over a prolonged period” (Stain et al. 2011:1594). Drought seems especially influential to an individual’s mental health, interrupting social, economic, and subsistence needs over extended periods of time.

Albrecht et al. (2007) explains that solastalgia, or the distress resulting from environmental pressures, is a result of the positioning of one’s personal identity with the land. Farmers in Australia, and those living in rural areas, reported increased levels of stress during extended drought compared with those in urban settings (Stain et al. 2011:1596). This is in part a result of the anxiety and depression associated with community fracturing and migration of friends and family to areas less impacted by environmental stress, which has been demonstrated to result in increased mental health problems (Stain et al. 2011:1598). Those who reported having a stronger “sense of place” also exhibited higher levels of stress than those who did not (Stain et al. 2011:1596-1597). Considering the ancient Maya selected settlement locations based on features reminiscent of the primordial landscape and the Maya were agroforesters with long ties to the environment and surrounding landscape, it is reasonable to believe that the Maya had a deeper “sense of place” in comparison to the contemporary studies indicated above.

Stain et al. (2011:1596) demonstrated that not only were drought-affected and non-directly drought-affected areas in Australia reporting increased levels of stress, but that high worry over the drought was correlated with higher levels of neuroticism. In addition, Stain et al. (2011:1598) suggest a link between hope and psychological health, indicating that chronic adversity and demoralization increase the risk for adverse mental health during times of stress.

Alternatively, community support and social cohesion were shown to be psychologically therapeutic during times of environmental pressure (Stain et al. 2011:1594; see also Hawkins and Maurer 2010; Putnam 2004; Ziersch et al. 2009). Because ritual has been shown to maintain social and community solidarity, it would have potentially been an effective strategy for mediating social and environmental stress.

The increase in ritual cave activity during the Late/Terminal Classic period in some regions has been interpreted as a direct response to environmental stress (Moyes et al. 2009). Local elites likely appropriated power through these ideologically salient representations and activities, the need to vie for power being the result of macro-regional political instability. However, because ritual has been shown to encourage a collective identity, social cohesion, and community bonding (e.g., Turner 1967), the majority of individuals attending rituals during the Late/Terminal Classic may have been doing so in an effort to obtain comfort during times of cultural and environmental stress. Additionally, once the “coping threshold” had been reached, individuals may have turned not only to the divine for strength and comfort, but to their elite leaders as well. People were likely more susceptible to the appropriation of power by certain individuals out of a need to seek support from those who could fulfill the roles of problem solvers.

2.3 Models

Testing the archaeobotanical data against a set of predictive models enables broader theoretical questions to later be addressed. Understanding the processes that govern ritual behavior among the Late Classic Maya is an important first step towards addressing these broader questions. These models are derived from models first proposed by Parker and Morehart

(2014). Behavioral ecology postulates that people act exclusively to increase reproductive success and that the consideration of cost-benefit differences is a primary motivator for behavioral responses. Cognitive anthropology suggests that social logics of ritual practice would eclipse the notion that individual fitness is a dominant driving force for ritual behavior.

According to a model derived from behavioral ecology, if ritual practitioners in the upper Belize River valley were responding to climate change then these patterns would be evident in the data: a shift in the significance of resources from primarily local angiosperm species to non-local woods such as pine, species that grow in disturbed or open habitats, and change in wood maturity. Immature wood and smaller branches would become more prevalent as populations increased and forests declined. If cultural logic was the dominant influence of human behavior in ritual practice, then the data would reflect these patterns: the persistence of resources, the use of plants that grow in primary forests, and no significant difference between mature and immature wood. Regional variability would indicate that no single model of behavior can be applied to diverse and changing landscapes. Other aspects may provide additional information regarding behavior, such as the symbolic associations attributed to specific plant species utilized in cave rituals.

2.4 Chapter Summary

This chapter provided a review of theory regarding human-environmental interaction and ritual practice. Special attention is given to behavioral ecology, and cognitive anthropology. These two theoretical perspectives are used to construct the models to test the data. These models will indicate whether or not macro-botanical data can be used to understand how local communities adapt to environmental change.

3 PALEOETHNOBOTANY

This chapter presents a definition of paleoethnobotany, followed by a review of the subject. The methods, techniques, and questions commonly addressed by paleoethnobotanists are described. A review of previous paleoethnobotanical work conducted in Mesoamerica is provided, as well as a discussion of important plant resources utilized by the ancient Maya. Information about plant use is drawn from ethnographic, iconographic, and archaeological data in order to establish the role that plants played in Late Classic period Maya ideology and ritual practice.

3.1 Definitions and Methods

“Paleo” and “ethno” are words derived from Greek origin (*palaios* and *ethnos*), meaning “ancient” and “people” respectively, while botany is the study of plants within biology (Morehart 2011:3). Paleoethnobotany is the study of archaeological plant remains and addresses the relationships between humans and plants in the past (Hastorf and Popper 1988:1; Pearsall 2010:2). It involves the recovery and analysis of botanical remains from archaeological contexts. The term was introduced by Hans Helbeck (1959) and includes the retrieval and analysis of macrobotanical remains, such as wood charcoal and seeds, and microbotanical remains, including pollen, starch grains, and phytoliths (e.g. Ford 1979:299; Helbeck 1959; Morehart 2011:2; Pearsall 2010:2; Popper and Hastorf 1988:1-2). Since this thesis relies exclusively on macrobotanical data, greater focus is given to this form of paleoethnobotanical remain.

Archaeological plant remains are often relegated to the category of “ecofacts”, or unmodified remains such as plants and animals that were deposited as a result of human

activities (Morehart and Morell-Hart 2013; Renfrew and Baun 2000:45; Sutton and Arkush 1996:335). However, such a classification greatly limits what can be learned from the past. Recent scholars have been emphasizing the need to move “beyond the ecofact” and instead regard plants as dynamic components of shifting social relationships throughout history (Morehart and Morell-Hart 2013). Plants can be a compelling proxy for elucidating cultural values, ritual practices, social inequalities, politics, and economics, as Morehart and Morell-Hart (2013) demonstrate. Plants are “necessary artifacts in the structure, reproduction, and transformation of human society” (Morehart and Morell-Hart 2013). Every human being on the planet has established relationships with the plant kingdom, whether through food, medicine, ritual, or economics. Our evolutionary trajectories have been tied together from the beginning (and is not limited to only plants, but animals as well). Since the 1980’s the social meanings embedded in these relationships have received increased attention, emphasizing the significance of paleoethnobotanical remains to address such questions (Morehart and Morell-Hart 2013).

Paleoethnobotanical methods encompass recovery and analytical methods. Macrobotanical remains in general become preserved through human action (usually burning), making them the easiest form of paleoethnobotanical remains to link to human activity (Pearsall 2010:247). There are several methods of macrobotanical recovery. One method of macrobotanical recovery is collecting archaeobotanical remains in situ (see Pearsall 2010:12) during the excavation process. Organic remains such as wood charcoal and seeds are sometimes large enough to be identified as excavation occurs. The problem with this method is that it relies solely on an archaeologists’ ability to detect (and recognize) botanical remains in the matrix of an excavation (Pearsall 2010:12).

Botanical remains can also be recovered via various screening techniques (see Pearsall 2010:12-14; Wagner 1988), such as dry screening and water screening. These methods can be problematic because the recovery of archaeobotanical remains is based on the mesh size of the screen. Additionally, fragile botanical remains are often damaged by both methods. Dry screening is the same process by which other archaeological remains are recovered. This method is also heavily dependent upon the type of soil. Sandy, dry soil can be sifted easily, allowing for the least possible damage to archaeobotanical remains such as charcoal, whereas moist, clayey soil that does not sift easily decreases the possibility of recovery (Wagner 1988:18-19). Wet screening involves a series of screens. The size of the mesh is decreased in subsequent screens, the soil is placed in the uppermost screen, and water is sprayed over it. This method, however, allows for the least recovery of paleoethnobotanical remains in comparison to other methods, because recovery is dependent on the size of the smallest screen as well as the pressure of the water (Wagner 1988:18).

Flotation techniques (see Pearsall 2010:14-65; Wagner 1988) tend to be the most favorable for the recovery of macrobotanical remains. This method involves the use of smaller screens (usually 1/16" window screen) and water, which is agitated in order for organic materials to rise to the surface (Pearsall 2010:14-15). Professional paleoethnobotanists generally utilize a flotation tank, which involves a frothing or bubbling mechanism that agitates the soil and water from below (Pearsall 2010:27-31). This is known as machine-assisted flotation. A less sophisticated but sometimes more practical flotation method in the field is a simple bucket flotation technique. This is called manual flotation and soil is placed into a screen in a bucket of water, agitated by hand, and the organic material that floats to the top is skimmed off with a sieve (Pearsall 2010:16, 29-31).

The organic materials recovered during flotation are called the light fraction and everything else is called the heavy fraction (Wagner 1988:19). Flotation allows for maximum recovery of botanical remains of various sizes, but it also has its limitations and does not guarantee that all botanical remains will be recovered (Wagner 1988:23). Though manual flotation is more practical for in-the-field flotation, the recovery rate is not as accurate as the machine-assisted flotation method. Additionally, dense materials may not float and manual systems are not generally as effective in recovering specimens such as seeds (Pearsall 2010:15). Flotation has become the most popular method of macrobotanical recovery for paleoethnobotanists today.

Microbotanical remains include plant residues not visible without the aid of magnification (Pearsall 2010:249-494; Piperno 1998). The recovery and analysis of microbotanicals such as pollen, starch grains, and phytoliths has been a more recent development in the field of paleoethnobotany. Such methods have greatly increased archaeologists' understanding of ancient plant use, as each of these forms of microbotanicals can provide significant insights into past relationships between people and plants and are useful forms of data in geographical regions where preservation of organic remains is poor.

Palynology, the study of pollen grains, primarily seeks to answer questions regarding past climate and environmental change. Pollen is often analyzed from sediment cores extracted from lakebeds in order to reconstruct paleoecology (Piperno 1998:418). The use of pollen has become relatively widespread in paleoethnobotany since the 1960s (Pearsall 2010:262). Soil samples for pollen analysis are taken and processed in the laboratory. Pollen grains are isolated using various chemicals and then concentrated via centrifuge so that they can be mounted on microscope slides for analysis (Pearsall 2010:290). Pollen is then counted and comparative

samples are consulted for identification. Pollen grains are identified by morphological characteristics distinctive between plant genera.

Phytoliths are silica bodies from plants that preserve in soil long after decomposition. Phytolith analysis has begun to grow in popularity since the 1980s and 1990s (Pearsall 2010:355). Phytoliths are also generally extracted from soil samples. Though phytoliths are also processed using chemicals and centrifuging (Pearsall 2010:416) the chemicals used are destructive to pollen in the soil, and therefore the two techniques cannot be used on the same soil sample. Phytoliths have the benefit of long-term preservation in comparison to other botanical remains (Pearsall 2010:355). They are also identified using distinctive morphological characteristics. Piperno (1998:395) indicates that phytoliths are a promising avenue of paleoethnobotanical research in the Neotropics, because many tropical angiosperms produce abundant phytoliths. Furthermore, phytolith production is localized in particular tissues (i.e. leaves, seeds, etc.), which can provide more specific data regarding plant use (Piperno 1998:398).

Starch is another form of microbotanical remain that is receiving greater attention in the field of paleoethnobotany. Starch can be used to identify primarily roots and tubers (Piperno 1998:423), plant products that are generally consumed and leave little macrobotanical evidence. Starch can be recovered directly from processing tools (Messner 2008:53; Piperno 1998:426), which links them directly to human behavior and practice. The tools also offer additional information regarding possible processing techniques and use. Additionally, different processing methods (such as cooking, boiling, grinding, etc.) can be detectable on the starch grains themselves, leaving distinctive damage patterns on starch (Messner 2008:63). However, this sometimes renders starch unidentifiable, as it gelatinizes at certain cooking temperatures

(Messner 2008:49; Piperno 1998:425). Starch can also be isolated from sediments, and while recovery is limited in number of grains, they retain distinctive morphological characteristics (Piperno 1998:427). Starch grains are morphologically distinct not only between plant species, but also within some plant parts (see Messner 2008; Piperno 1998:424). Starch grains, therefore, can provide greater specificity of data regarding not only the plants being utilized, but also what parts of the plant were used and how they were processed.

3.2 Paleoethnobotany in the Maya Area

Paleoethnobotany in Mesoamerica has faced limitations in the past, particularly in the tropical Maya Lowlands (see Lentz 1999). Concerns regarding preservation have been the primary cause of the reluctance to investigate the paleoethnobotany of the region. The preservation of organic materials in the tropics is poor, but varies between sites and regions.

The ancient Maya demonstrated a long-term and elaborate relationship with the plant world that is reflected in iconography, art, and architecture and has been demonstrated in the archaeological record (Morehart 2011:5). The ancient Maya domesticated numerous plant species, practiced arboriculture, and extracted medicines and materials for fuel and construction from forests (Morehart 2011:5). The vegetation endemic to the Maya Lowlands is diverse and a great deal of contemporary global foods were first cultivated in Mesoamerica, including maize, beans, squash, tomatoes, chili peppers, manioc, sweet potatoes, vanilla, and chocolate. This short list of domesticates demonstrates the dual nature of many plants. All of the above cultigens were used for subsistence to some extent. At least maize (e.g., Morehart 2011), chili peppers (e.g., Powis et al. 2013), vanilla, and chocolate (Hurst et al. 2002; McNeil 2006b, 2009; McNeil

et al. 2006; Powis et al. 2002) also served a ritual function, and beans and squash remains have been recovered from ritual contexts as well (e.g., Morehart 2011; see also Willey et al. 1965).

The ancient Maya had a diverse array of agricultural practices that were developed to enhance the productivity of the land in a local area. Types of agricultural practices included slash and burn (Fedick 1994, 1996; Ford and Fedick 1992), terraced-based (Abramiuk et al. 2011; Fedick 1996; Healy 1990; Turner 1978; see also Willey et al. 1965:574-575; Wright et al. 1959:112-113), and wetland agriculture through raised or drained areas (Pohl 1990; Pohl et al. 1996; Turner and Harrison 1983). These are considered outfield methods of cultivation, opposed to infield cultivation, which included home gardens or land closer to farmers' residences (Fedick 1996; Morehart 2011:6).

Maize (*Zea mays*) has been documented in northern Belize as early as the Late Archaic (c. 3400 B.C.) based on palynological evidence (Pohl et al. 1996:363) and was prevalent in the Maya Lowlands by the Middle Preclassic period (c. 900 B.C. – 300 B.C.) (Dunning et al. 1998b; Islebe et al. 1996; Rue 1987; Tsukada 1966:63; Vaughan et al. 1985; Wiseman 1978). In addition to microbotanical evidence of maize cultivation, macrobotanical remains have been recovered from sites such as Copán (Lentz 1991), Pacbitun (Wiesen and Lentz 1999), Cerros (Cliff and Crane 1989; Crane 1996), and Cuello (Miksicek 1991; Miksicek et al. 1981), all dating to the Preclassic period. Classic period sites where maize has been recovered include Cerén (Lentz et al. 1996:253), Altar de Sacrificios (Willey 1972:248), and Barton Ramie (Willey et al. 1965:529).

The earliest paleoethnobotanical remains from the Belize Valley were recovered at the site of Cahal Pech, dating to the Early Middle Preclassic period (Healy et al. 2004a). The archaeobotanical assemblage included maize cupules (Lawlor et al. 1995:157-160). Also

recovered from the site was squash remains (*Curcubita* sp.) and possibly beans (*Phaseolus* sp.) (Lentz 1991; Wiesen and Lentz 1999). Other botanical remains from Cahal Pech include fragments of coyol palm fruit (*Acrocomia aculeate*), a cotton seed (*Gossypium* sp.), and the carbonized wood of several tree species, including pine (*Pinus* sp.), palo mulato (*Astronium raveolens*), fig (*Ficus* sp.), and malady (*Aspidosperma* sp.) (Wiesen and Lentz 1999; see also Lawlor et al. 1995). Wiesen and Lentz (1999:65) determined that the recovered wood all belonged to mature specimens, suggesting that stands of primary forest were available for use during the Middle Preclassic period (see also Healy et al. 2004a:119). A Late Middle Preclassic deposit at Tolok, a settlement group associated with the larger center of Cahal Pech, also recovered a diverse array of botanical remains, including maize, beans, and squash (Healy et al. 2004a; Lawlor et al. 1995; Powis et al. 1999:374; Wiesen and Lentz 1999; see also Powis 1996).

Willey et al. (1965) reported finding the remains of various domesticates at Barton Ramie, though some of the identifications were uncertain. Charred maize was found in at least two house mounds at the site. Notably, however, in a Late Classic stone slab cist grave a small mass of clay and two briquettes were recovered with deep maize impressions. The clay impression shows a maize ear and leaves, suggesting that whole plants were deposited into the burial and may have been burned beforehand (Willey et al. 1965:520, 528-529). The two briquettes used in the wall construction show the impressions of shelled cobs overlapping one another and deeply embedded in the clay, which Willey et al. (1965:520, 528-529) suggests could indicate that fragments of maize cobs were mixed with the mortar used to line the grave.

Maize production increased as populations rose and was a primary component to the ancient Maya diet. During the Late Classic period, higher status groups had greater access to maize, demonstrating social differentiation in access to food resources (Lentz 1999; Morehart

2011:5; White et al. 1993:363). Morehart (2011) reported charred maize from Classic period cave deposits at the sites of Actun Chapat, Actun Chechem Ha, and Barton Creek Cave. Maize was the most common domesticated crop recovered from ritual cave contexts (Morehart 2011:100). In one deposit from Barton Creek Cave (Feature 23), it is possible that entire maize plants were deposited, indicated by the presence of some complete ears with husks and stems (Morehart 2011:82). Maize remains from Actun Chechem Ha were immature, suggesting the use of green corn during first fruit rites (Morehart 2011:66, 104, 115). Some modern Maya groups such as the Lacandon and Yucatec Maya offer young maize ears to the earth deities, who must be the first to partake in the harvest (Boremanse 1993:334; Morehart 2011:115; Redfield and Villa Rojas 1934:127).

Other important cultigens recovered archaeologically include beans (*Phaseolus* sp.), though this species is underrepresented in the archaeological record, in part due to the fact that the seed cotyledons that would be the most likely part of the plant to preserve was also the plant part consumed (Lentz 1999:5). However, *Phaseolus* sp. specimens have been recovered from sites such as Cuello (Miksicek 1991), Cahal Pech (Wiesen and Lentz 1999), Albion Island (Miksicek 1990:309), Cerén (Lentz et al. 1996), Copán (Lentz 1991), Barton Ramie (Willey et al. 1965:529), and Cobá (Beltrán Frias 1987). The earliest samples of beans recovered archaeologically date to the Middle Preclassic period (c. 1100 B.C. - 900 B.C.), though these may be a wild variety. Recognizably domesticated bean varieties have been recovered during the Late Preclassic period at Cahal Pech (Wiesen and Lentz 1999), however beans found in ceramic vessels at Céren in El Salvador from the Classic period included a mix of domesticated and wild varieties (Lentz 1999:5). *Phaseolus* sp. specimens were also recovered from Barton

Creek Cave and Actun Chapat in the Belize River Valley dating to the Late Classic period (Morehart 2011:74-75).

Squash (*Curcubita* sp.) was another important domesticate commonly grown alongside maize and beans, forming the Three Sisters of Mesoamerican crops. Carbonized rind fragments from *C. moschata* have been recovered archaeologically (Lentz 1999) and *C. pepo* pollen has been identified from Edzná (Lentz 1999; Turner and Miksicek 1984). Possible squash seeds were also recovered from an Early Classic burial vessel at Barton Ramie (Willey et al. 1965:529). Carbonized squash rinds were recovered from Actun Chapat (Morehart 2011:53), while both rinds and seeds were identified from Barton Creek Cave (Morehart 2011:74).

Chili peppers (*Capsicum annuum*) do not preserve well archaeologically, however recent residue analyses have provided insights into the history of chili peppers in Mesoamerica. Powis et al. (2013) documented the chemical signature of *Capsicum* sp. from vessels recovered from Chiapa de Corzo in Chiapas, Mexico dating from 400 B.C. to A.D. 300 and represents the earliest conclusive evidence of chili pepper use in Mesoamerica (Powis et al. 2013:9). Of the thirteen vessels sampled, five tested positive for chili peppers including a spouted vessel. Since chili peppers have often been used to flavor beverages made from chocolate (*Theobroma cacao*), and since spouted vessels are commonly associated with cacao beverages, these vessels were also tested for the presence of *T. cacao*. However, the results were negative for the presence of chocolate or any other substance, indicating that chili peppers were likely the sole substance contained in each vessel, and served either culinary, medicinal, or ritual purposes (Powis et al. 2013:6). These five vessels were found in elite contexts; four vessels were recovered from a palace structure and one from a ritual temple complex that contained at least five elite tombs

(Powis et al. 2013:5-6). However, vessels from low status households have never been sampled for *Capsicum* sp. residues (Powis et al. 2013:9).

Powis et al. (2013:8) suggest that the chili peppers were prepared as a paste because macrobotanicals were not present in any of the vessels. Additionally, all five vessels, though representing different forms, were serving vessels (Powis et al. 2013:9). The presence of chili peppers in a spouted vessel may indicate use as a spicy beverage or sauce (Powis et al. 2013:9). The contexts of all five vessels (three from elite burials and two from caches) indicate that *Capsicum* sp. may have had symbolic and ideological importance (Powis et al. 2013:8-9). The ritual use of chili peppers is supported by the recovery of forty-one seeds and a calyx (fruit base) from a single feature in Barton Creek Cave, indicating the deposition of whole fruits (Morehart 2011:74). Chili pepper seeds have also been recovered from Cuello (Miksicek 1991:82) and Cerros (Cliff and Crane 1989:312; Crane 1966:268-270) in northern Belize. Additionally, seeds, rinds, and calyxes were identified from Cerén in kitchen and storeroom contexts (Lentz 1999:10; Lentz et al. 1996:255).

Aside from cultigens, various tree species were significant for the Maya for a variety of purposes, including construction materials, fuel, food, medicine, and ritual. The Maya likely practiced aboriculture, or the cultivation and maintenance of economically useful tree species (Gómez-Pompa 1987; Lentz 1999:12; Morehart 2011:9). Ethnohistoric data shows that elites kept orchards as inheritable possessions (Tozzer 1941:64) and groves were dedicated to elite children (Tedlock 2010:35-36). Fruit trees, therefore, were an elite source of wealth at least during the Classic period (McAnany 1995:75; Morehart 2011:9). Such economically valuable species may have included trees such as nance (*Byrsonima crassifolia*), cashew (*Anacardium occidentale*), hog plum (*Spondias* sp.), coyol palm (*Acrocomia aculeate*), ramón (*Brosimum*

alicastrum), cohune (*Attalea cohune*), avocado (*Persea americana*), calabash (*Crescentia cujete*) and cacao (*Theobroma cacao*). Remains from economically valuable trees have been recovered from a variety of sites, including Copán (Lentz 1990), Cahal Pech (Lentz et al. 1997; Miksicek 1991; Wiesen and Lentz 1999), Cerros (Cliff and Crane 1989; Crane 1996), and Wild Cane Cay (McKillop 1994, 1996).

Pine (*Pinus* sp.) wood is the most commonly recovered species from both ritual and utilitarian archaeological deposits throughout the Maya area (e.g., Chase and Chase 1998; Dickau and Lentz 2001; Lentz 1991, 1994, 1999; Lentz et al 1996, 1997; Miksicek 1983, 1991; Morehart 2011, Morehart et al. 2005; Morehart and Helmke 2008; Wiesen and Lentz 1999). It's geographical habitat, however, is limited to certain regions, such as the Mountain Pine Ridge in the Maya Mountains of Belize, as well as the swampy savanna regions of northern, central, and southern Belize and limited areas of the Petén region of Guatemala (Morehart et al. 2005:156). While pine sources may have been more ubiquitous in the past, there is little evidence to support this. It is believed that pine was a commonly traded item and part of a complex economic system (see Lentz et al. 2005; Morehart et al. 2005). As a valuable commodity, access to pine appears to have been to some degree mediated by the elite (see Lentz et al. 2005; Morehart 2011; Morehart and Helmke 2008). In addition to being a utilitarian resource, pine was also a significant ritual resource and appears to have been a required component to a “toolkit” of ritual paraphernalia (Morehart 2011; Morehart et al. 2005). As such, its control by a certain subset of individuals indicates that social hierarchy may have mediated ritual activities to a certain extent in regions where pine was a non-local resource.

Ethnographic analogy suggests that pine may have been converted into charcoal before being traded (Breedlove and Laughlin 2000; Lentz et al. 2005:574; Wisdom 1940:21; see also

Lentz 1999:14; Morehart et al. 2005:256; Thompson 1970:146). Charcoal would have burned more cleanly, as pine wood produces a great deal of smoke, and been easier to transport long distances. The resin in pine also makes it a valuable resource for torches (Atran and Ucan Ek' 1999; Barrerra Martin et al. 1976; Breedlove and Hopkins 1979; Breedlove and Laughlin 2000; Lentz et al. 2005:574; Oakes 1951), and pine torches are often found in cave sites (Morehart et al. 2005:263). Pine also continues to be used for ritual purposes. Resin is often used as incense (Atran and Ucan Ek' 1999; Berlin et al. 1974; Breedlove and Laughlin 2000; Deal 1988; Lentz et al. 2005; McGee 1990; Tedlock 1992; Vogt 1969; Wisdom 1940) and altars are sometimes decorated with pine branches and needles (Lentz et al. 2005:574; Vogt 1976:6).

Lentz et al. (2005) demonstrates that pine charcoal remains exhibit a non-random distribution during the Late/Terminal Classic periods across three archaeological sites, Xunantunich, San Lorenzo, and Chan N'óohol, all located in western Belize. Pine was found in archaeological contexts similar to those described ethnographically, such as refuse in domestic middens and construction materials (Lentz et al. 2005:580), but the ubiquity of pine between the three sites demonstrated dramatic differential access. At both Xunantunich and San Lorenzo, inhabitants appear to have had access to pine regardless of their socioeconomic status. When lower status households at San Lorenzo were compared to similar status households at Chan N'óohol, though, it was evident that even the lowest classes at San Lorenzo had greater access to pine than their counterparts in the small farming hamlet (Lentz et al. 2005:581).

Lentz et al. (2005) argued that pine was most likely imported to the Xunantunich polity from the Mountain Pine Ridge, and the results of their analysis raised questions regarding how it was distributed once it arrived. Lentz et al. (2005:582) argue for a political-economic model to explain the distribution of pine between these three sites. Had pine been accessible through a

free market, there would not have been a dramatic difference in access to it between low-status households, regardless of the proximity of each site to Xunantunich. However, given that lower status households at San Lorenzo had greater access to pine than those of relatively equal status at Chan N'óohol, it suggests that the circulation of pine was likely restricted and controlled by elite leaders (Lentz et al. 2005:582). Pine would have been given to subordinates in politically motivated exchanges to strengthen social relationships. Since there were elite residences at San Lorenzo, pine likely entered lower status households through relationships with community leaders. Since the community of Chan N'óohol consisted solely of peasant farmers, their ability to access pine via this elite social network was significantly limited (Lentz et al. 2005:582).

Morehart et al. (2005) discuss the significance of pine among the Lowland Maya as a multiple-use artifact, serving both utilitarian (i.e., domestic fuel, construction material) and ritual functions, even despite its geographical restrictions. Morehart et al. (2005:258) noted regional variations in the ubiquity of pine wood charcoal in comparison with hardwood charcoal from seven cave sites in the Upper Belize River Valley (see also Morehart 2011). The distribution of pine between sub-regions indicates differential access to pine resources used in ritual activity. Outside the Belize Valley, other cave sites have yielded the remains of pine, including unburned fragments, torches, and charcoal, suggesting that its use in cave ritual is not limited to the Belize Valley (Morehart et al. 2005:262). Pine has also been found in ceremonial contexts at surface sites, including in caches and tombs (e.g. Chase and Chase 1998:317; Lentz 1989:197, 1991).

Morehart's (2011) regional paleoethnobotanical cave survey demonstrated the significance of pine in ancient cave rituals. Of 29 identified tree taxa, *Pinus* sp. was the only species recovered from all seven caves sites (Morehart 2005:261, 2011). However, the variance in availability seems to support the hypothesis that pine was an elite-restricted resource. The

presence of pine from all seven sites supports the likelihood that it played a crucial role in Maya ritual. In the Q'uiiche Maya book of creation, the Popul Vuh, the creation of people made from wood were destroyed in a flood of "resin" that has been interpreted as the resin, sap, or turpentine of pine (Christenson 2003:74), indicating a possible association with cleansing and pine resin. Morehart's (2011) investigations also established the importance of cave sites for future paleoethnobotanical research, demonstrating that cave environments were more conducive to the long-term preservation of organic materials.

Wood charcoal may have also been a valuable fertilizer for the Maya. Terrace investigations in the Bladen Branch region of the Maya Mountains indicate that charcoal may have been used to enrich the soil (Abramiuk et al. 2011). Excavations suggest that inflow canals from streams were used to release both water and nutrient-rich sediments into terraces, which were alternated with episodes of intentional burning (Abramiuk et al. 2011:267). Wyatt (2008) investigated terraces at Chan, a small farming hamlet associated with Xunantunich, which also indicated that terraces were fed by irrigation canals from uphill aguadas. Wyatt's (2008:251-252) paleoethnobotanical investigations recovered local hardwood species and non-local pine charcoal in each terrace sample. Pine was recovered in lesser quantities than hardwoods, however Wyatt (2008:253) argues that the occurrence of pine charcoal suggests that refuse from household hearths was likely used to fertilize terrace soils.

Lentz (1991) demonstrates the utility of archaeobotanical data for elucidating questions regarding social inequality at Copán in Honduras. Through the analysis of carbonized macrobotanical remains, Lentz reconstructed diet at the site during the Late Classic period (c. 600 – 900 A.D.). By doing so, he was able to document the diversity and quantity of plant remains between residences of differing socio-economic status. Economic status, he argued,

determined accessibility to botanical resources. Lentz's work demonstrates the utility of archaeobotanical remains in addressing questions regarding the intersection of social class, economics, and nutritional access.

Cliff and Crane (1989; see also Crane and Carr 1994; Crane 1996), using macrobotanical and palynological data at the site of Cerros in Belize, document a shift in subsistence during the site's occupation between the Late Preclassic period and the Late Classic period. Reliance on maize decreased as population increased, and a greater abundance of tree crop remains are evident during later periods. Although elite families practiced aborigiculture (e.g. McAnany 1995; McNeil 2009; Morehart 2005, 2011; Schele and Mathews 1998), Cliff and Crane (1989:317) interpret the greater quantity of tree crops as a reliance on market-based trade goods.

Morell-Hart et al. (2014) use both macrobotanicals and microbotanicals to understand plant use at the site of Los Naranjos in Honduras during the Middle Formative period. Botanical data was recovered from both sediments and obsidian artifact residues. Their findings suggested that during this time, residents were exploiting a diverse array of botanical foods and medicines (Morell-Hart et al. 2014:78). This is contrary to earlier pollen sediment cores, which suggested that maize agriculture was the primary form of subsistence by 1000 B.C. However, evidence for maize, beans, and squash are not abundant in the data collected by Morell-Hart et al. (2014:78). The recovery of microbotanical data from obsidian tools is notable, because it yielded significant data regarding plant use and tool function, such as direct evidence of processing. The authors emphasize the use of multi-proxy paleoethnobotanical analyses to "increase the visibility of taxa difficult or impossible to recovery macrobotanically... or microbotanically" (Morell-Hart et al. 2014:78). The use of both macrobotanicals extracted from sediments and microbotanicals extracted from tools demonstrated that each method of paleoethnobotanical recovery yielded

different data that together provided significant insights into plant use at the site (Morell-Hart et al. 2014:78).

Ann Scott's (2009) dissertation research is an ethnoarchaeological investigation of Kaqchikel Maya ceremonies in Guatemala and their relation with the sacred landscape, including caves. One of the primary components to these rituals is candles (Scott 2009:42; see also Josserand and Hopkins 1996; Love and Peraza Castillo 1984; McGee 1990; Oakes 1951; Redfield and Villa Rojas 1934; Tedlock 1992; Thompson 1930; Vogt 1976; Wisdom 1940). Among the Chol Maya, candles are associated with flowers (Josserand and Hopkins 1996). Among the Kaqchikel, black and yellow candles are symbolic of sacred corn (Scott 2009:43-44), as white candles are among the Tzotzil (Vogt 1976). Taube (1995:89) notes the association between the glyph *taj* and its relation to maize symbolism. Morehart (2011:108-109) notes the glyph's depiction as a bundle of burning pine torches, interpreting the ancient burning of pine as a symbolic food offering to the gods.

Scott (2009:48-55) also discusses the importance of incense, or *pom*, in Kaqchikel ritual. The aroma of incense is used to attract and feed the ancestors and heal. Incense is generally procured from pine or trees in the Burseraceae family such as the Copal tree (*Protium copal*). Other resinous and aromatic saps can also be used. Pine serves a variety of functions in addition to incense, including as medicine, to detect illness, to protect from illness, to light the fire, and to honor the ancestors (Scott 2009:62). Leaves and branches of other plants, not all native to the New World or the region, are burned to achieve specific outcomes, such as success or cleansing (Scott 2009:56). Fruit offerings used in ceremony include limes, melon, papaya, orange, watermelon, pineapple, banana, and mangos (Scott 2009:60-61). Ornamental flowers are also popular in ceremonies among many contemporary Maya groups (Figure 3.1) (Scott 2009:70-71).



Figure 3.1: San Isidro altar, elaborately adorned with flowers and candles, Espita, Yucatán, Mexico.

3.3 Chapter Summary

Paleoethnobotany is the archaeological study of human-plant relationships that can be used to answer questions regarding subsistence, ecology, economics, politics, and ritual. The variety of methods and forms of data make it a multi-proxy tool for reconstructing past plant use. In the Maya region, paleoethnobotanists have elucidated questions regarding diet, social inequality, agriculture, and ritual using both archaeological and ethnographic data. Ethnographic work conducted among contemporary Maya populations has played a crucial role in helping

paleoethnobotanists understand the symbolic and ritual import of botanical remains in the archaeological record. Analogies drawn between the past and the present have proven useful, even despite hundreds of years of cultural transformation and change between the ancient and modern Maya. The changes between past and present can emphasize the continued similarities and provide additional insights into Maya culture and plant use. This research relies exclusively on macrobotanical data draws interpretations of recovered plant remains from both archaeological and ethnographic research.

4 CAVES IN MAYA SOCIETY

In this chapter, I discuss the cultural and archaeological background of ancient Maya cave use with a focus on the Upper Belize River Valley. In Mesoamerica, caves provide insights into a variety of cultural institutions, including ritual, politics, and economics (e.g. Brady 2005; Brady and Colas 2005). They were the ritual stage for interactions between humans and the supernatural, symbolically appropriated for political power, and the final repository of objects traded across the region. However, they served a wide variety of other utilitarian purposes and functions, which are equally important to address.

4.1 Ritual Use and Cultural Significance

Caves and mountains were physical manifestations of Maya cosmology. They were integral parts of the sacred landscape that played an important role in ritual (Awe 1998; Bassie-Sweet 1991, 1996; Brady 1997, 2000, 2003; Brady and Veni 1992; Freidel et al. 1993; Heyden 1981; Morehart 2011; Morehart et al. 2005; Morehart and Butler 2010; Schele and Freidel 1990; Stone 1995; Thompson 1959; Vogt 1969; Vogt and Stuart 2005). As liminal spaces, a place-type theorized to generate ritual activity (Turner 1967), caves were the loci of politically and ideologically charged ritual behavior throughout Mesoamerica (e.g., Brady and Ashmore 1999; Brady and Prufer 2005b; Halperin 2005; Morehart 2011; Morehart et al. 2005; Morehart and Butler 2010). These subterranean features represented the boundary between the earth and the underworld, the natural and the supernatural, life and death (Morehart 2011:20-21; Vogt and Stuart 2005:155). Caves were the dwelling place of earth deities who were responsible for successful harvests (Brady 2003:87), and it was from caves that maize is said to have first emerged (Figure 4.1) (Bassie-Sweet 1996; Morehart 2011:18; Christenson 2003).



Figure 4.1: Original plaster fresco at Ek Balam in northern Yucatán depicting a sacred Ceiba tree, the roots extending into the underworld. Beneath the roots, small ears of maize are growing (reminiscent of the immature cobs of a first fruit ceremony) (see Boremanse 1993:334; Morehart 2011:115; Redfield and Villa Rojas 1934:127).

Caves have been incorporated into the built environment of ancient cities (e.g., Brady 1997, 2003; Halperin 2005; Weber 2011a) and constructed where they were naturally absent (e.g., Prufer and Kindon 2005; Pugh 2005). The ancient Maya were known to have removed speleothems and crystals from caves (Brady et al. 2005; Brady and Prufer 1999; Parker 2013; Peterson et al. 2005; Spenard 2011:39; Valdez et al. 2011:29) and deposit them in surface contexts (Brady et al. 2005:213; Brady and Rissolo 2006; Peterson et al. 2005:226; Valdez et al. 2011:29). Caves were also the sources of sacred water (*zuy ha*) (Thompson 1959). Caves were resources of both sacred and social power (Brady and Ashmore 1999; Halperin 2005; Morehart and Butler 2010). Caves have historically been used as pilgrimage sites and remain as such even today among contemporary Maya groups (Halperin 2005; Patel 2005; Sandstrom 2005). They are powerful features of the sacred landscape that continue to retain meaning and cultural significance.

The glyph *ch'en* is associated with caves, but the general concept of “cave” is not as narrowly defined as is commonly perceived. *Ch'en* refers to any fissure in the earth, including caves, rockshelters, and sinkholes (Rissolo 2005:354-356; Spenard 2011, 2012, 2013a; Wrobel et al. 2013:126). It can also refer to community, indicating a practice of associating caves with social identity (Brady 2003:89; Vogt and Stuart 2005). Ethnographic and ethnolinguistic studies indicate that the Maya regarded a broad range of karstic features as caves. Recently, archaeologists have addressed this concept by increasing investigation of rockshelters. Comparing the artifact assemblages of rockshelters to that of caves could also aid in reconstructing patterns of ritual activity. Burials have been reported at rockshelters at other sites in central Belize (see Gibbs 2000; Glassman and Bonor Villarejo 2005; Halperin 2005; Stemp et

al. 2013; Wrobel et al. 2007; Wrobel et al. 2013; Wrobel and Shelton 2011); however, in most cases these rockshelters are components of larger caves with dark zones.

Artificial caves have been identified at sites where natural caves were absent, providing an opportunity for archaeologists to understand these features as deliberate representations of how the sacred landscape was conceptualized by the ancient Maya (Brady 2003:88). The incorporation of caves into the built environment is reminiscent of Arnold Modell's (1984) psychoanalytical work regarding the incorporation of natural geologic formations in Paleolithic cave art. Formations, speleothems, and other natural cave features were incorporated as crucial components of the images being represented. Modell (1984:190) calls this "the interpenetration of reality with the artistic vision... [as] a tangible expression of the mental process of creation itself," which forms a transitional space that is neither wholly human or wholly of the natural world. Seligman et al. (2008:39) call this the "appropriation of a space between the object world and the human one," which becomes both and is transformed into "an intermediary arena of living [that] can constitute a potential space, which negates the idea of space as separation."

Caves "are a unique setting that impart a special meaning to rituals and the paraphernalia used in them" (Brady 2003:87). Eliade (1959) suggests that the time of origins is a significant concept of ritual, and Isaac (1962) suggests that this would inspire the modification of the landscape in an attempt to reconstruct the cosmic landscape (Isaac 1962:12 cited in Brady 2003). Brady (2003:87-88) points out that Mesoamerican religion is focused "on the act of creation" and that caves may have "carried a far more important and specific meaning beyond their simply being access points to the sacred earth." It is precisely the *place* of origin that imbues the setting with the sacred and social significance that give religious rites their validity. Brady (2003:89) argues that "[t]he place of creation is the living justification of human existence and defines the

center of the cosmos because the great acts of creation always occur at the center.” This act of creation embodies the debt owed between humanity and powerful creator deities, a debt which drives ritual interaction between humans and the supernatural (Morehart and Butler 2010:603; see also Monaghan 2001).

Plants played an integral role in cave ritual. Plants were symbolic food offerings for the gods and sometimes signified social and political power (Morehart 2011:10). Plant remains can be interpreted as offerings to earth deities given to secure agricultural fertility (Morehart 2005:174, 2011:114). Wood charcoal, such as pine, is a common component to archaeobotanical cave assemblages (Morehart 2011:97; Morehart et al. 2005) and is of particular ceremonial import among the modern Tzotzil Maya, who live in close proximity to pine resources (Morehart et al. 2005:264). Additionally, certain cave formations are sometimes regarded as ceiba trees, valued as the tree of life that held up the sky (MacLeod and Puleston 1978:74). A huge ceiba tree was believed to stand at the heart of the earth, the place of creation (Brady 2003:89).

A significant feature of ritual activity, and one of its primary functions, is to establish “relations of power between the practitioner and the audience” (e.g. Bell 1992, 1997; Kertzer 1988; Rappaport 1999; Woodfill et al. 2012:112). Caves in Mesoamerica potentially served as ritual stages, and it has been suggested that this is why ceramics in cave entrances or easily visible platforms tend to be the most elaborate, while ceramics in difficult to access locations or restricted dark zones are commonly of a less elaborate nature (Woodfill et al. 2012; 111-112; see also Brady 1989; Peterson 2006; Prufer 2002; Woodfill 2002, 2007, 2010). Woodfill et al. (2012:112) argue that this is because “there is typically no need for the “spectacle” of using and destroying elaborate, beautifully decorated vessels” without the benefit of an audience (see also Houston 2006). The function of these two forms of ritual is distinct, the latter directed toward

establishing a relationship with a supernatural audience rather than a human one (Woodfill et al. 2012:112).

In the upper Belize River valley, increases in ritual offerings during the Late Classic may suggest that the Maya reacted to environmental stress with ritual supplication (Morehart 2011:27; see also Moyes et al. 2009). The earth deities who resided in caves were believed to be able to provide rain and agricultural fertility, and so “[t]he ancient Maya probably reacted to ecological stress by increasing ceremonial offerings to such earth deities” (Morehart 2011:27). Much of this ritual activity cannot be extracted from the political and social intent to legitimize control through the appropriation of powerful religious symbols during a time of cultural instability. Maya religion and politics, like in many state organized societies, cannot be easily distinguished from one another, or from other aspects of daily life (Webster 2002:147). Caves were used to legitimize authority and identity, either through the orientation of monumental architecture in relation to caves, such as at the site of Dos Pilas (Brady 1997), or the construction of artificial caves where they were naturally absent, such as at Utatlan (Brady and Ashmore 1999).

4.2 Archaeological Background of Caves in the Maya Area

Cave archaeology in the Maya area is directed at investigating ancient ritual cave use by integrating data from a variety of historical, ethnographic, and iconographic sources (Brady 1989:7). James Brady (1989) provided the first systematic review of cave archaeology in Mesoamerica. Brady was the first archaeologist to emphasize the need to regard cave sites as significant archaeological sites deserving of the same rigorous methodology and analysis as surface sites. For decades, archaeologists regarded caves as early habitation sites, despite

ethnographic and ethnohistoric documentation supporting the ritual function of caves throughout Mesoamerica. Even when items clearly distinguishable as having a ritual purpose were encountered, archaeologists recorded caves primarily as early habitation sites. Early works in Maya cave archaeology also lacked many important components, such as maps or detailed artifact descriptions.

In the 1890s, Henry C. Mercer conducted the first major cave investigations in the Maya area (1975 [1896]), surveying over 29 caves and excavating 10 of them. Prior to Mercer's investigations, caves had been noted and described only sporadically and lacked depth of inquiry or interpretation. Mercer's work was published in *The Hill-Caves of Yucatan* (1975 [1896]) and his investigations are recognized for the inclusion of maps in his reports. However, based on his investigations he interpreted caves as ancient habitation sites by early man, perpetuating the prevailing bias that overshadowed Maya cave studies for decades.

It was not until Edward H. Thompson's later work at Chichén Itzá's Cenote of Sacrifice (1965 [1932]), which he dredged between 1904 and 1907, that the ceremonial significance of karst features described in ethnohistoric records (e.g., Tozzer 1941) was confirmed. Thompson recovered a variety of artifacts, including metal and wooden objects, rubber, copal, textiles, ceramics, and human remains (Coggins 1992), which were interpreted as ritually significant based on ethnohistoric descriptions of human sacrifice in cenotes (Thompson 1965 [1932]:280-289). Thompson's earlier works (1897) were also exceptional for the time, containing detailed maps, drawings, and descriptions. Additionally, his work at Chichén Itzá in 1896 (1965) demonstrated the role of caves in determining the location of significant structures.

However, the idea that caves were habitation sites persisted and no efforts were made to synthesize cave data into a broader understanding of the role of caves in ancient Maya society

(Brady 1989:15-16). As a result, cave literature produced between 1914 and 1950 lacked the methodological rigor and detailed descriptions necessary to propel cave archaeology in Mesoamerica toward a more theoretically rich dialogue (see Bassauri 1931; Blom 1928, 1929; Blom and LaFarge 1926; Brainerd 1942; Burkitt 1930; Joyce 1920; Kidder 1942; LaFarge and Byers 1931; Lothrop 1924; Lundell 1934; McDougall 1943, 1946; O'Neale 1942; Shook 1947; Shook and Smith 1950; Smith 1946; Stirling 1945, 1947). Gann (1918, 1924, 1925, 1926, 1928, 1929, 1930) conducted extensive work in caves, however continued to adhere to the idea that they represented ancient habitation sites despite evidence, such as hundreds of bundles of copal in a single cave, that supported their ritual function (Gann 1918:138-139). A notable exception is Thomas Joyce (1929; Joyce et al. 1928), who worked in a cave near Pusilhá and speculated on the possibility that it served a ritual function based on the recovery of human remains from a stratified midden deposit.

The 1960s and 1970s saw an improvement in the documentation, descriptions, mapping, and recording of caves in Mesoamerica and archaeologists began integrating this data into broader interpretations of the role of caves among the Maya. David Pendergast (Pendergast 1969, 1970, 1971, 1974) contributed to cave investigations in Belize during this time, carrying out excavations independent of a larger surface site project. This was followed in the 1980s by Brady's work at Naj Tunich in Guatemala (1989). The Petexbatun Regional Archaeological Project, initiated by Arthur Demarest, began to provide resources for cave investigations as a component of a larger surface project (Demarest 1997). It was during this period that caves became truly regarded as places of religious and ritual importance among the Maya, based on both archaeological investigations (i.e., Brady 1989) and iconographic and ethnographic analyses (i.e., Bassie-Sweet 1991, 1996).

Since this time, cave investigations have increased in the Maya area as their role in understanding the past has been recognized. Ishihara (2007) analyzed the relationships between religion and politics at Aguateca by examining the Grieta Principal, a fissure running through the center of the site. Peterson (2006) documented patterns of elites and commoners using caves for public and private rituals as part of the Xibun Archaeological Research Project. The project sought to link surveys of landscape use with settlement surveys in the Sibun Valley of Belize and demonstrated that caves were integrated into religious community rituals and played an important role in constituting the valley's sacred landscape. Spenard (2006), working in the San Francisco Hill-Caves near Cancuen in Guatemala, examined ancient Maya cave ritual within the theoretical perspective of a system of reciprocity between humans and supernatural deities. He interprets material remains from caves as the remnants of these transactions, which are transformed from material objects to an appropriate gift for the gods.

These more recent studies represent theoretical shifts in cave archaeology that seek to understand the social dimensions of ritual cave use, and the broader relation of these activities to Maya culture and surface sites. By doing so, archaeologists are discovering the broader significance of caves in ancient Maya communities, identity construction, politics, economics, and religion. Caves are also now recognized as crucial elements to understanding Maya settlement and religion and are now investigated as components of larger sites. They are no longer studied independently, but as part of their relation to surface sites, in order to provide the greatest depth of understanding of the Maya and their sacred landscape.

4.2.1 Cave Archaeology in the Belize Valley

The cave systems of central Belize are the most thoroughly studied in the Maya region (e.g., Awe 1998; Awe and Griffith 2002; Awe et al. 1998; Griffith 1998; Griffith et al. 2000; Griffith et al. 2003; Helmke and Awe 2004, 2006, 2007; Ishihara et al. 2001; Morehart 2005, 2011; Morton 2009; Moyes 2003; Peterson 2006; Stemp et al. 2013:125). The Western Belize Regional Cave Project, directed by Jaime Awe, initiated investigations in the region. The purpose of the project was to systematically map, explore, document, and excavate caves to provide a more complete interpretation of ancient Maya settlement (see Awe et al. 2005; Griffith 1998; Lohse 2007; Moyes et al. 2009).

In 2000, Christopher Morehart (2002, 2011) conducted a regional paleoethnobotanical study of cave sites in the upper Belize River Valley. This study included seven caves from three sub-regions: Actun Nak Beh, Twin Caves 2, and Tarantula Cave in the Roaring Creek valley; Barton Creek Cave in Barton Creek valley; and Actun Chcehum Ha, Actun Halal, and Actun Chapat in the Macal River valley. The archaeological investigations demonstrated the significance of plants in the material assemblage of cave rituals among the Late Classic Maya. Morehart also established caves as crucial research sites for paleoethnobotanists working in the region. The stable cave environment allows for significantly better preservation of archaeobotanical materials, sheltering organic matter from climatic fluctuations of tropical wet and dry seasons. During his investigations, Morehart (2011) recovered more archaeobotanical remains from a single feature than is commonly recovered from an entire surface site, including charred maize cobs and even a textile fragment.

Moyes (2008) analyzed use-intensity at Chechem Ha cave in the Belize River valley using charcoal as a proxy for ritual behavior. With the understanding that pine was used for

torches ethnographically and historically, and that pine torches would have been the most practical form of light in caves due to its ability to burn well, Moyes experimented with burning pine torches. She discovered that torches produce a steady stream of charcoal flecks (Moyes 2008:143). Moyes (2008:144) points out that pine charcoal flecks are an ideal method for use-intensity analyses because torches were a necessity regardless of ritual associations with other wood species. Moyes was able to document changing patterns in ritual behavior, with an intensity of use in Chechem Ha cave occurring during the Terminal Preclassic/Early Classic (Moyes 2008:152). During the Late Classic period, there are significantly greater artifacts present, however far less charcoal. This indicates that ritual practitioners were spending less time conducting cave rituals or were entering in smaller groups with greater quantities of offerings. Moyes (2008:153) suggests that the change in ritual behavior may have been a response to environmental stress given the agricultural associations with caves.

Moyes et al. (2009) examine ritual use of Chechem Ha cave using archaeological and paleospeleothem data. They determined that a change in ritual behavior occurred during the Late Classic period at the beginning of a prolonged regional dry period. Moyes et al. (2009:201) interpret the archaeological and climate data as evidence of behavioral responses to environmental stress. Moyes et al. (2009:201) suggest that a drought cult developed in Belize, and possibly throughout the Maya Lowlands, devoted to water-related rites and deities. This dry period was a “*perceived* problem”, rather than an “abstract concept” (Moyes et al. 2009:201, emphasis in original), suggesting that the effects of the drought were directly impacting the Belize River Valley during this time.

Mirro (2007) studied the political appropriation of caves in the Belize Valley during the Late Classic period (see also Halperin 2005). His analysis of ceramics from caves demonstrated

the ability to determine the political association of groups using these karstic features. He identified a pattern in the Belize Valley where caves fell into one of three categories: 1) caves aligned with regional politics, 2) politically contested caves, and 3) politically neutral ones. Caves aligned with regional politics tend to be concentrated in the eastern region of the valley and included cave sites such as Barton Creek Cave, Actun Tunichil Muknal, Actun Nakbe, and Tarantula Cave. Actun Chechem Ha was politically affiliated with Xunantunich. Actun Chapat and Actun Halal had a more even distribution of ceramics, however, which is argued to demonstrate a shift from a regional political alignment to use by those affiliated with Xunantunich once the larger site rose to power. These caves may also have been neutral territory and utilized by people from both polities (Mirro 2007).

Archaeological cave investigations in the upper Belize River valley have provided significant insights into ancient Maya cave use. Caves in the regions have yielded information regarding political associations, ritual practice, and climate change. They demonstrate the importance of karstic features to Maya culture and are important sources of archaeological data. Unfortunately, looting in the region has destroyed and continues to impact archaeological and historical data. Public education and continued archaeological investigation can ensure that these features and their archaeological materials are properly protected, documented, and recorded.

4.3 Chapter Summary

The Maya regarded caves as the place of origin, where powerful deities gave life to humanity, creating an eternal debt between mankind and the supernatural. When the Maya settled a location, they frequently chose or created a local cave of origin, where they could

continue to return to make offerings to the divine for the gift of life. These liminal spaces, gateways between words and the homes of the gods, served as the arena where interactions between the human world and the supernatural could occur. Imbued with sacred meaning, caves and other karstic features became powerful components of the landscape. Their cosmological significance made them crucial for conducting day-to-day life among the ancient Maya. They served as loci for community ritual, but there is also evidence that the elite appropriated them to gain social power and prestige, making them essential features for shedding light on past political associations that may not have survived in the written record.

5 BACKGROUND

This chapter provides background information about the environmental, cultural, and archaeological history of the Maya area with a focus on the Upper Belize River Valley and the site of Pacbitun. The Upper Belize River Valley is a rich environment with an abundance of local resources. Likewise, the nearby Mountain Pine Ridge, although it could not support large habitation due to highly acidic soil (Healy 1990:247-248), did provide other valuable resources. Pacbitun, located in the transitional zone between these two ecological habitats, was able to access resources from both environments. This likely enabled Pacbitun to develop economic ties throughout the Belize Valley and beyond. In addition to the environmental and archaeological background, the research sites included in the study are described, including all previous and current archaeological work conducted.

5.1 Climate Change in Mesoamerica

Climate change has been associated with the cultural reorganization of the Maya referred to as the “collapse.” While there is no doubt that environmental stress contributed significantly to this event, responses to this change are likely just as variable as the landscape itself. Archaeologists are discovering that the Maya had a wide array of cultural adaptations to the environmental settings unique to their local areas, from complex water-management systems (e.g., Scarborough 1998), slash and burn agriculture (e.g., Fedick 1994, 1996; Ford and Fedick 1992), terrace agriculture (e.g., Abramiuk et al. 2011; Healy 1990; Turner 1978; Wyatt 2008) wetland agriculture, and canals and irrigation systems (Fedick 1996). As such, responses to climate change were just as diverse. As Webster (2002:47) points out, some Maya centers saw an abrupt cessation of activity in the Late/Terminal Classic, while others persisted for many

years amidst environmental flux. A wide range of variables, such as local environmental conditions, economics, politics, and social organization determines the level of vulnerability and response options to environmental crises. Only by understanding localized responses to environmental stress can scientists develop a better picture of how climate change impacted Maya society, as well as what climate change may mean for the future of humanity in such an interconnected, globalized world.

Gill (2000) argues the Maya were victims of a great drought over which they had little control. Without the occurrence of a drought in the Maya Lowlands “the society would have continued to function with all of its predispositions intact” (Gill 2000:95). His argument is based on the probability that drought would have brought with it starvation and disease. Gill concludes that famine was the true destroyer of Maya society, as the drive to obtain food often results in severe social chaos, such as economic decline, wealth hoarding, disease, increased morbidity, migration, theft, and even cannibalism (Gill 2000:96). However, Gill also notes that historic records indicate that famine was a common occurrence in Mesoamerica pre- and post-Contact (Gill 2000:74). Since this appears to be the case, than it would seem as if the Maya would have been to some extent adapted to famine and hunger in their environment, suggesting that factors other than famine may have played a greater role in the Late Classic Maya decline.

The Maya “collapse,” Webster (2002:218) explains, was a cessation of the elite, noble classes governing Maya society and their traditions, more so than a decimation of Maya culture, what he refers to as an “elite collapse.” The decline of the top levels of Maya society resulted in (or were the result of) a dramatic reorganization of society. However, it is easier to trace the decline of the elite class because of the ease in detecting elite individuals in the archaeological record (Webster 2002:258).

As Webster (2002:218-219) points out, while ecological causes are generally referred to as being a primary factor in the reorganization of Maya society, no single event or source can stand alone. One reason a “megadrought” is believed to have caused such an impact on the Late Classic Maya is because drought has frequently occurred in the Maya region and would not be an unlikely ecological stressor (Webster 2002:239). A drought lasting decades or centuries, however, would eventually take its toll regardless of how accustomed the Maya were to dry periods. Webster (2002:243) cautions the use of the megadrought theory, though, because it is based primarily on hemispheric climatological data, and paleoecological data derived from Yucatán. There is less paleoecological data derived from the Maya Lowlands to support the drought theory, and even a large multi-decade drought would not have necessarily affected the entire Maya area equally (Webster 2002:243).

Additionally, the greatest impact of the Maya “collapse” occurred in the humid Maya Lowlands, rather than the more arid Yucatán peninsula, where there is less annual rainfall or groundwater sources (Webster 2002:243). The only ecological advantage the Maya in Yucatán would have had, Webster (2002:244) argues, was that the land was too flat for soil erosion to pose as great a threat. Drought, Webster (2002:244) determines, does not reflect the archaeological record as nicely as some would like to believe, at least not as the primary cause of collapse. The paleoecological data, in fact, does not reflect the desiccation of lakes in Yucatán and evidence from lakes in the Petén suggest that “the Maya dramatically transformed the local landscape by clearing forests for construction and agriculture” (Islebe et al. 1996 cited in Webster 2002:244).

The deforestation model for collapse is not a new idea. C. W. Cooke, a botanist working in the Peten in the 1930s, theorized that the swamps around Tikal had once been lakes and were

filled in with soil eroding from the hillsides as a result of deforestation (Webster 2002:251). Large-scale deforestation would have not only eroded the thin soils of the Maya Lowlands, it would have restricted the efficiency of evapotranspiration to occur (Webster 2002:257; see also Gotangco Castillo and Gurney 2013). Evapotranspiration is the process by which moisture is evaporated from forests and cycled back as rainfall. Large portions of rainfall result directly from forests, therefore extensive elimination of those forests would drastically reduce rainfall, potentially exacerbating a commonly occurring drought in the Maya region and creating a megadrought. Not only would deforestation disrupt food supplies through erosion and drought, but animal habitats would be destroyed, forcing sources of protein to flee to other areas. Additionally, building materials and fuel would become more difficult to obtain.

Jones (1991) utilizes palynological data from sediment cores extracted from Cobweb Swamp in order to address human-environmental interaction at the site of Colha in northern Belize. Colha was chosen as the site for analysis because of its proximity to Cobweb Swamp. The pollen cores Jones analyzed recorded paleoenvironmental data beginning around 6000 B.C. The pollen record indicates that after 1000 B.C., the environment changes dramatically until most of the trees in the area are cleared, though the date for when this occurs is not clear (Jones 1991:102). The abandonment of the area is also evident in the pollen record and likely occurred around A.D. 850-900 (Jones 1991:102).

Abrams and Rue (1988) and Abrams et al. (1996) propose a deforestation model of collapse at Copán in Honduras based on palynological evidence from a core extracted from the Aguada de Petepilla 5 km from the site core (Abrams and Rue 1988:382). The pollen data indicated that a reduction in arboreal pollen coincided with an increase in pollen from grasses, ferns, and other herbaceous plants (Abrams et al. 1996:69-70; Abrams and Rue 1988:384).

Deforestation, they argue, would have resulted in soil erosion, which would have reduced agricultural productivity even as population pressures demanded greater production (Abrams et al. 1996:68; Abrams and Rue 1988:384-385). Abrams and Rue (1988:385) cite studies of controlled experiments (Hudson et al. 1983a, 1983b cited in Abrams and Rue 1988) which indicate that the angle of a slope had little effect on erosion rates compared to a reduction of surface vegetation (Hudson et al. 1983a:279). Burning of upland slopes resulted in significant soil runoff and nutrient loss (Hudson et al. 1983a:275, 1983b:297). Abrams and Rue (1988:388) suggest that the foothills around Copán were cleared for settlement and agriculture; the uphill zone, which contained significant pine forests, was likely cleared primarily to meet demands for domestic fuel wood, lime plaster production, and construction materials. Abrams et al. (1996) argue that the failure to supply growing populations with adequate food as a result of erosion inevitably led to the collapse of the Copán State. However, the pollen core analyzed and discussed by Abrams et al. (1996) and Abrams and Rue (1988) was not long enough to reach beyond the end of the Terminal Classic period. As a result, Late Classic data could only be inferred (Abrams and Rue 1988:383).

McNeil (2012) also utilizes palynological data from a sediment core extracted from the Aguada de Petepilla to refute previous understandings of environmental change in the Copán region. Previous theories that Copán collapsed as a result of deforestation do not hold up to the new pollen core analyzed by McNeil, which is longer and includes data beyond the Preclassic period (McNeil 2012:24). The Maya of the Copán Valley, she argues, practiced land management strategies that allowed them to navigate resource consumption and environmental change (McNeil 2012:27). It was the Middle Preclassic and Late Preclassic/Early Classic periods, McNeil (2012:28-29) determines, when deforestation impacted the Copán Maya the

greatest, leading future generations to develop more sustainable methods of forest use. The Copán Valley, she argues, was actually more densely forested during the Late Classic period than the Early Classic (McNeil 2012:27). During latter periods, the Maya of the Copán Valley appear to have sustainably managed forest resources to avoid overexploitation (McNeil 2012:28-29).

Curtis et al. (1998) discuss sediment cores recovered from the Petén region of Guatemala that indicates heavy deforestation by the Middle Preclassic period and throughout the Late Classic period. Their study focuses on a core extracted from Lake Petén-Itza, and several proxies are used, including palynology, water chemistry analyses, stable isotope geochemistry, and magnetic susceptibility. Their analyses indicated that throughout Maya occupation, forests declined rapidly followed by increased soil erosion (Curtis et al. 1998:154). Forest regeneration begins to occur around A.D. 1025 (Curtis et al. 1998:155). Oxygen isotopic data from Petén-Itza do not suggest that a drought occurred in the Maya Lowlands during the Terminal Classic period (Curtis et al. 1998:155), which is contradictory to palynological studies from lakes Chichancanab and Punta Laguna in Yucatán, Mexico (Curtis et al. 1996; Hodell et al. 1995), however the discrepancy may be the result of Lake Petén-Itza being a significantly larger body of water. It may also indicate that drought conditions were restricted to the Yucatán, though data from Costa Rica and Peru indicate that this is not the case, and that a drying period affected the tropics north and south of the equator at similar times (Curtis et al. 1998:155; see also Morse 2009:144).

Investigations of Laguna Tamarindito in the Petén by Dunning et al. (1998) were done in conjunction with settlement archaeology in the region. Investigations of a soil core included pollen data and the analysis of gastropods. The core showed two periods of major forest clearance, one during the Late Preclassic period and the other during the Classic period (likely

the Late Classic) (Dunning et al. 1998b:147). During the Late Preclassic, deforestation occurred while populations were relatively small and scattered, and was accompanied by an influx of soil likely due to erosion (Dunning et al. 1998b:147). However, during the Late Classic period forest clearance is not associated with nearly as great an influx of soil, indicating the possibility that in the Tamarindito area, conservation measures were being taken by the local Maya (Dunning et al. 1998b:147). Archaeological evidence of terraces and dams around Lake Tamarindito support this possibility (Dunning et al. 1998b:141). It was unclear from the core whether or not there had been a significant drying period in the Lake Tamarindito area during the Late/Terminal Classic period (Dunning et al. 1998b:147).

Morse (2009) analyzed a sediment core from Laguna Verde, associated with the site of Blue Creek in northern Belize. The pollen diagram indicated that there was a continuation of “wet savanna” environment even as the local vegetation changed (Morse 2009:338). Human disturbance becomes evident during the Middle Preclassic period, followed by large sediment deposits indicative of erosion during the Late Preclassic/Early Classic period (Morse 2009:341-343). Channeled fields were created in the wetlands during this period, to increase agriculture (Morse 2009:344). During the Terminal Classic there are few indicators of high rain forest and an increase in sediment deposition coinciding with what appears to be evidence of a dry period (Morse 2009:345).

Palynological evidence from the Maya Lowlands indicate that severe deforestation took place during two periods of Maya occupation, the Late Preclassic period and the Late Classic period. During the latter period, measures seem to have been taken to alleviate the impact of forest clearance, though these responses varied. Evidence also indicates an extended drying period during the Terminal Classic period that likely lasted 200 years (Brenner et al. 2002:151).

However, Brenner et al. (2002:151) point out that dry periods seem to have been normal in Yucatán and are correlated with Maya social reorganizations, suggesting cultural responses to regional climate change. Conversely, some pollen cores seem to indicate that drought may not have played a major role in the Late Classic Maya “collapse” (i.e., Curtis et al. 1998; Dunning et al. 1998b), or human impact on the environment may have obscured climate change in some areas (Leyden et al. 1998:111). The pollen records that have been analyzed indicate that there are regional similarities, but also localized differences, in the ecological record, which suggests that there were various social factors influencing Maya responses to environmental change.

5.2 The Upper Belize River Valley

The upper Belize River valley (Figure 5.1) is a region in west, central Belize that in the past was part of a vast social, economic, and political network. The archaeological record indicates early settlement primarily during the Middle Preclassic period (c. 1000 – 300 B.C.) with many sites experiencing a period of abandonment during the Late/Terminal Classic periods (c. A.D. 800 – 1000). During the region’s later occupation, the upper Belize River valley experienced political instability that reflected broader environmental and cultural changes affecting many parts of the Maya Lowlands. During this same time period there is an increase of ritual cave activity evident in the archaeological record, which indicates that one response to broader social and environmental pressures was ritual supplication (Aldenderfer 2012:28; Moyes 2006, 2007; Moyes et al. 2009). Additionally, settlement surveys indicate that a population increase occurred at this time, causing expansion into the erosion-prone valley uplands and subsequent deforestation of the surrounding region (Healy 1987, 1990, 1999; White et al. 1993).

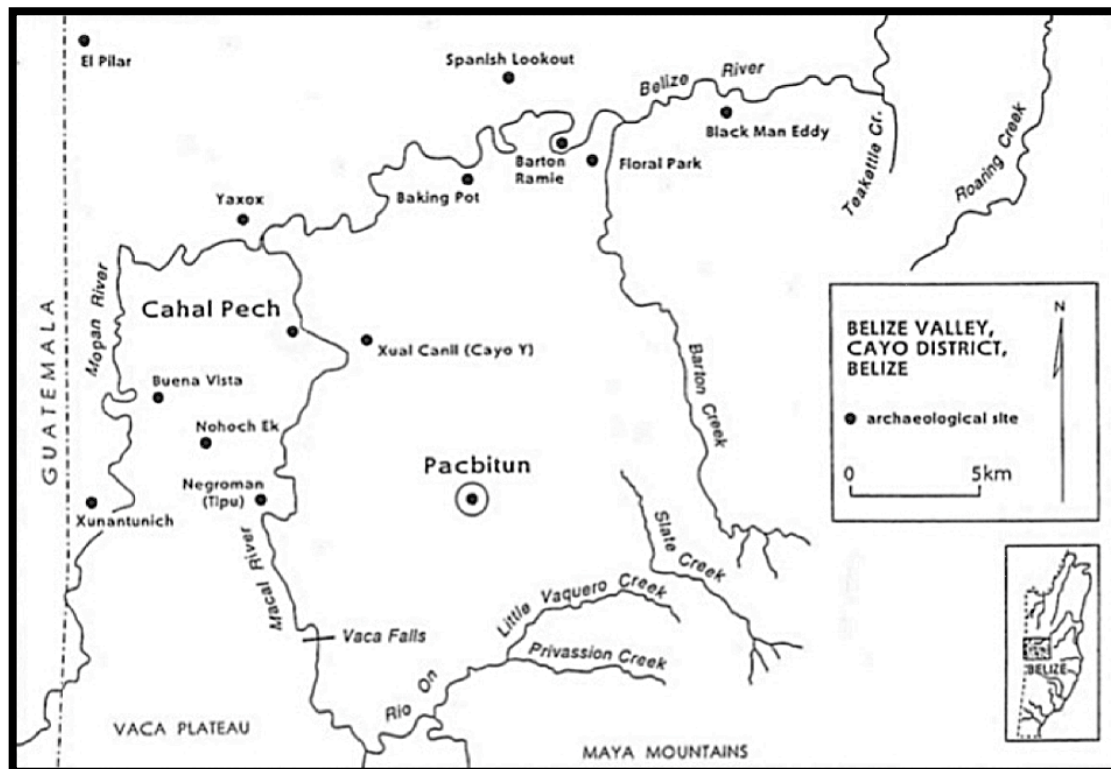


Figure 5.1: Map of the upper Belize River valley showing the location of Pacbitun in relation to other sites in the region (after Weber 2012:Figure 1:31).

5.2.1 Environment and Ecology

The upper Belize River valley is located where the Belize River forms at the confluence of the Mopan and Macal Rivers north of the modern city of San Ignacio in the Cayo District of Belize. It is a subtropical region of diverse and dense vegetation and is subject to an annual rainfall pattern sharply divided by wet and dry seasons. During the eight month wet season from May to January, the rainfall is approximately 250 mm per month (Fedick 1995:9; Wright et al. 1959:183). During the drought-like dry season, which begins in the middle of January and lasts through May, less than 25 mm of rain falls per month (Fedick 1995:19).

The region is comprised of low-lying alluvial terraces. North of the Belize River and to the west of the modern town of San Ignacio is a mountainous area of karstic limestone hills,

whereas to the east open valleys and plains dominate the landscape (Fedick 1989:217-218, 1995:18; Ford and Fedick 1992:36). The soil in the alluvial bottom of the valley is richly fertile (Fedick 1995:19) and follows a gradient as elevation rises to more calcareous, erosion-prone soils in the upland areas (Turner 1978:168). Evidence of terrace systems in the uplands, including at Pacbitun, suggests agricultural adaptations to population increases and environmental circumstances (Fedick 1994; Healy 1990, 1999; Healy et al. 1983; Thompson 1931:228-229; Turner 1978:168-170; White et al. 1993:349-350; Willey et al. 1965:574-575; Wright et al. 1959:112-113).

The vegetation in the upper Belize River valley region falls in line with the Subtropical Moist Forest Life Zone (Fedick 1995:19; Ford and Fedick 1992:36) and consists mainly of deciduous broadleaf forests except in areas where pine ridges extend north from the Mountain Pine Ridge into “flank” valley areas (Turner 1978:167), such as the Upper Roaring Creek and Barton Creek valleys. The northern ridge lands (Turner 1978:166-167) extend west from where the Mopan and Macal Rivers merge and into the Petén region of Guatemala. The flatlands (Turner 1978:166-167) extend east through most of central and northeast Belize.

The only paleoenvironmental data available near the region is stalagmite data from the Macal Chasm in the Vaca Plateau on the outskirts of the upper Belize River valley (Webster et al. 2007). An active speleothem was removed from the cave entrance, where it would be more sensitive to outside environmental conditions (Webster et al. 2007:3). Using a variety of analytical techniques such as luminescence, color, and stable isotopes, the paleoclimatological data documented inordinate dry conditions during periods of dramatic cultural changes among the Maya. For example, major droughts occurred in A.D. 141, 517, 780, and 910, coinciding with events such as the Late Preclassic Abandonment, the Maya Hiatus, and the Late/Terminal

Classic “collapse” (Webster et al. 2007:12-13). Furthermore, periods marked by wetter conditions coincide with Maya cultural florescence, such as during the Early Classic and the first half of the Late Classic periods (Webster et al. 2007:14).

5.2.2 Socio-political Background

A majority of Maya settlements in the Belize Valley were situated along or near the banks of one of its three rivers (the Belize River, Macal River, and Mopan River). Sites in the upper Belize River valley generally have a focal center with a dispersed periphery, and architecture tends to be larger in scale than at sites in the Central Belize Valley (Chase and Garber 2004:5), likely due to close ties to powerful sites in the Petén (i.e., Tikal, Naranjo) and the Maya Mountains (Caracol). The social composition of sites within the Belize Valley is debated (e.g., Ball and Taschek 1991; Chase 1993; LeCount 1999) however archaeological evidence indicates that groups in the Maya Lowlands shifted from more egalitarian social organizations to stratified and ranked societies during the Preclassic period (Awe 1992; Cheetham 1998; Clark et al. 2000; Clark and Hansen 2001; Clark and Cheetham 2003; Hammond 1992; Healy 1999; Healy et al. 2004a; Powis 1996; Powis et al. 1999).

Settlement in the Belize Valley began during the Middle Preclassic period (c. 1000 – 300 B.C.) (Figure 5.2) at several sites, including Pacbitun (Healy 1999; Healy and Awe 1996), though Early Preclassic occupation has been documented at Cahal Pech (c. 1000 B.C.) (Awe 1992:113). Other sites in the Belize Valley with early occupation during this time include Barton Ramie (Willey et al. 1965), Baking Pot (Bullard and Willey 1965), Blackman Eddy (Brown 1998), and Las Ruinas de Arenal (Ball and Taschek 1991). During the Middle to Late Preclassic periods (c. 600 B.C. – A.D. 250), archaeologists begin to see evidence of social stratification in the archaeological record (Awe 1992; Healy and Awe 1996). Evidence of long-

distance exchange (Awe and Healy 1994; Healy 1999; Powis et al. 1999), the cultivation of a variety of economically valuable crops (Coyston et al. 1999; Lawlow et al. 1995; Powis et al. 1999:369-370; Wiesen and Lentz 1999), and the incorporation of coastal resources into the local economy (Hohmann 2002; Powis et al. 1999:368-369; Stauchly 1999) indicate the possibility that the upper Belize River valley was an important trade link between the inland and the coast starting at this time (Ford and Fedick 1992:35; McKillop 1980). The rivers and tributaries coursing through the region would have provided easy transportation of raw materials and goods into the valley from the coast (Ward 2013:22).

During the later Classic period, evidence suggests that there was no central political entity structuring social relations, but rather communities of autonomous urban centers (Ball and Taschek 1991; Demarest 1992; Fox and Cook 1996; Fox et al. 1996; Morehart 2011:24; Sanders and Webster 1988; Taschek and Ball 1999:231). These urban centers would have been politically, and certainly economically, aligned with one another as well as more distant and politically powerful cities in the Petén and Maya Mountains. An alternative interpretation of the archaeological record suggests that powerful polities exerted political and economic control over the valley's smaller urban centers (Chase and Chase 1996; Folan 1992; Haviland 1992, 1997). It is possible that the upper Belize River valley was a region of production under the influence of the polity of Naranjo during the Late Classic period (Morehart 2011:24-25) through the direct influence of a closer center such as Buena Vista del Cayo (Ball and Tashcek 1991) or Xunantunich (Ashmore and Levant 2001; see also Lentz et al. 2005:575-576). Xunantunich continued to exert some measure of authority over the upper Belize River valley into the Terminal Classic period (A.D. 790 – 1000) (LeCount 1999).

During the Late to Terminal Classic periods the upper Belize River valley was impacted by broader social, political, and economic instability throughout the Maya Lowlands. Environmental pressures (Abrams and Rue 1988; Abrams et al. 1996; Curtis et al. 1996; Dunning and Beach 2000; Hodell et al. 1995; Islebe et al. 1996; Leyden 1987; Leyden et al. 1998; Paine and Freter 1996; Rice 1978; Tsukada 1966; Wiseman 1978), military conflict (Chase and Chase 2001; Demarest et al. 1997; Fash 1991; Fox 1994; Martin and Grube 2000; Miller 1993; Pohl and Pohl 1994; Schele and Freidel 1990:165-215), and population concerns (Abrams and Rue 1988; Abrams et al. 1996; White et al. 1993; Paine and Freter 1996) created an atmosphere of ritual competition as elite groups attempted to legitimize themselves through associations with powerful symbols of cosmological and ideological authority (Brady 1989:60; Helmke et al. 1998; Morehart 2011:25; Stone 1995). The region may have been producing resources for larger sites in the Maya Lowlands (i.e., Tikal, Caracol, Narajo), and Chase (2004:332) argues that the arrangement of settlements in the Belize Valley during this time is reminiscent of a contested border zone. Schortman and Urban (2003:137, cited in Ward 2013) suggest that peripheral sites in the region were “nexus[es] where complexly related variables such as wealth, power, identity, and autonomy [were] interwoven”, and that these sites may have been able to exert greater control within the larger power struggles occurring at the time.

Major Periods		Time	Ceramic Phase
P O L S A T S S I C	LATE	1400	New Town
		1200	
	EARLY	1100	
	TERMINAL	900	Spanish Lookout
C L A S S I C	LATE	600	Tiger Run
	EARLY		Hermitage
	PROTO-CLASSIC	300	Floral Park
F O R M A T I V E	LATE	100 A.D.	Mount Hope
		B.C. 100	Barton Creek
	MIDDLE	300	Jenney Creek
		600	Cunil
	Early	1000	
	1800		

Figure 5.2: Major time periods of Mesoamerica associated with ceramic phases of the Belize Valley (adapted from Gifford 1976:Figure 8 in Morehart 2011:Figure 4.2:24).

5.2.3 Archaeological Background

Investigations in the Belize Valley primarily began with Gordon Willey (Willey et al. 1965), who introduced settlement archaeology to the region in the 1950's. His work restructured archaeological investigations in the Maya region, shifting focus from elite lifeways to the non-elite (Chase and Garber 2004:1). Willey (Willey et al. 1965) worked primarily at Barton Ramie, a site that consisted of earthen mounds faced with stone, rather than the monumental architecture more commonly associated with sites such as Tikal and Uaxactun. Willey's work established the long chronological history of the Belize Valley and turned attention to the lives of common people in Maya history. Gifford's (1976) ceramic analysis, extrapolated from an extensive ceramic collection from Barton Ramie, was used to develop a chronological type-variety for the region. This collection documents chronological materials from the Middle Preclassic period to the Late Postclassic period (A.D. 1200-1530) and remains a valuable dating reference for archaeologists working in the region today.

Though a significant portion of work in the Belize Valley has focused on the Classic period, the Preclassic period has become of increasing importance to archaeological research in the region. Chase and Garber (2004) focus on the Preclassic period in the valley. Architectural construction began by around 1100 B.C. at some sites (Garber et al. 2004:46). Jaime Awe's (1992; see also Awe et al. 2009) work at Cahal Pech in modern San Ignacio has explored some of the earliest chronology of the region, determining the site to have been occupied from 1000 B.C. to A.D. 800 (Awe et al. 2009:179). Large-scale archaeological projects, such as the Belize Valley Preclassic Project and the Western Belize Regional Cave Project, have made significant contributions to understanding the development of Maya culture in the region. These projects have covered vast and diverse areas of archaeological research.

5.3 Pacbitun

Pacbitun is a medium sized Maya site located on the southern rim of the upper Belize River valley. It is 3 km east of San Antonio, a contemporary Maya village settled by Yucatec Maya during the Caste War (Joe Tzul, personal communication, 2012). Pacbitun was occupied continually from at least the Middle Preclassic to the Late Classic periods (c. 900 B.C. – A.D. 900) (Healy 1990, 1999; Healy et al. 2004b; Healy et al. 2007; Powis 2010). Shortly after the site and surrounding area was occupied, there is evidence of Pacbitun's involvement in a diverse trading system (Powis et al. 1999:368-369; Staunchly 1999). Pacbitun's location in an ecologically diverse region allowed it to develop relatively quickly from a small farming community during the Middle Preclassic Period to a prosperous urban hub in the upper Belize River valley during the Classic Period (Coyston et al. 1999:222-223) with diverse craft production (see Healy 1990:253-254; Hohmann and Powis 1999; Powis 2009, 2010; Ward 2013) and elaborate ceremonialism (White et al. 1993:348). A wealthy elite class commissioned the construction of monumental public architecture and carved monuments and those individuals were interred in elaborate burials with exotic grave goods (Healy 1990; White et al. 1993:348-349).

It has previously been argued that Pacbitun was likely politically aligned with Xunantunich or Caracol (Chase 2004:220; Healy et al. 2004b:225; see also Weber 2011a:39-40). Burial practices indicate a relationship with both Belize Valley and Caracol customs (Healy et al. 2004b:225; Weber 2011a:40). However, it is also possible that during the Classic period Pacbitun was politically and economically aligned with Tikal in the Petén region of Guatemala.

Twenty carved stone monuments were identified from Pacbitun (Healy et al. 2004b), including Stela 6, one of the earliest dated monuments in the Maya Lowlands (Helmke et al.

2006). The stela depicts a seated lord in elaborate attire wearing a curassow headdress and sitting on a large turtle. On his right is the “Jaguar God of the Underworld” and on his left is a character resembling God K (Schele and Miller 1986:49-50 cited in Helmke et al. 2006:72). This Early Classic monument, dated to March A.D. 485, is a dedicatory monument declaring the succession of one of Pacbitun’s rulers, possibly named “Foliated Curassow” (Helmke et al. 2006:74). It has been suggested that this ruler was endorsed by the more powerful polity of Tikal (Andres et al. 2014:55). The seated position of the lord is unusual, but has been identified in iconography at Tikal, Altun Ha, Takalik Abaj, Tonina, and Copán (Helmke et al. 2006:72). However, a more unusual “agency expression” glyph may be present on the stela, which is similar to those found at Caracol and Naranjo, which were previously thought to be the earliest examples of the glyph, however Pacbitun’s predates these by almost fifty years (Helmke et al. 2006:74).

Pacbitun may have had connections with all three of these powerful sites, especially considering its long occupation. Additionally, as a peripheral site in the Belize Valley, it is possible that Pacbitun was one of the urban centers able to exert some sort of autonomy during the instability of the Late Classic period (Schortman and Urban 2003:137). With an impressive command of surrounding resources, including the social capital of multiple cave sites, Pacbitun may have been able to maintain relationships with competing political centers.

5.3.1 Diet at Pacbitun

Dietary analyses, including stable isotope analyses, indicate that Pacbitun’s population relied heavily on maize agriculture for subsistence (Coyston et al. 1999; White et al. 1993). White et al. (1993) performed stable isotope analysis on 33 individuals from Pacbitun, as well as

some faunal specimens. Faunal analysis revealed that deer and peccary were consuming significant amounts of maize, indicating that either they were invading agricultural fields or were possibly semi-domesticated or tended by the Maya (White et al. 1993:359); ethnohistoric data seems to support this as well as archaeological and isotopic evidence from Lamanai (White and Schwarcz 1989 in White et al. 1993). Analysis of the human osteological remains indicates that maize was the most significant plant source for food at Pacbitun. Differential access to C4 foods, such as maize, is evident (White et al. 1993:360). Higher status individuals (determined by burial type) had a diet comprised of 70% maize or maize-based products, while among individuals in lower status burials, maize consisted of an average of 51% of the diet (White et al. 1993:363).

It is interesting to note that at Lamanai, elite individuals actually consumed less maize than lower class individuals and instead consumed higher amounts of marine food. Marine food was more readily accessible to the inhabitants of Lamanai, whereas at Pacbitun maize was clearly a more highly valued food source (White et al. 1993:362-366). However, Freiwald (2010) notes that while estimates of maize consumption in the Petén region of Guatemala suggest that this staple crop comprised over half of the Maya diet, isotopic data from the Belize Valley indicates that it comprised less than half at sites such as Baking Pot, Barton Ramie, Blackman Eddy, Cahal Pech, Esperanza, Floral Park, and Saturday Creek (Freiwald 2010:400; see also Gerry 1993, 1997). Based on this isotopic data, the amount of maize consumption at Pacbitun appears to be an anomaly compared with other sites in the Belize Valley. However, the sample size from Pacbitun was small and more isotopic data from other areas in the region would provide a better understanding of this phenomenon.

Temporally, isotope analysis revealed shifting patterns in maize consumption over time. As population increased between the Early Classic and the Late Classic, reliance on maize dropped 10% (White et al. 1993:366). Coyston et al. (1999) has suggested that it was a reliance on maize and a failure to meet population demands that contributed to the site's abandonment around A.D. 900 (Coyston et al. 1999:239-240). Evidence indicates that a population increase during the Late Classic coincided with the construction of agricultural terraces in the site's hinterlands, and that construction of terraces continued into the Late Classic Period (Healy et al. 2004b:221). These attempts to increase maize production appear to have been unsuccessful, as dietary data indicates that consumption of maize or maize-fed animals decreased toward the onset of site abandonment (Coyston et al. 1999:240).

Another significant food source at Pacbitun were freshwater shellfish, called jute, collected from local, fast-moving streams and rivers. Hundreds of thousands of jute have been recovered from the site (see Staunchly 1999:43-44) and are found in a variety of contexts, but mainly construction fill. A vast majority of the jute recovered have had the spire snapped off and removed (Staunchly 1999:44), a technique for acquiring the meat inside. It is clear from the quantity of this freshwater shellfish that jute comprised a significant portion of the diet at Pacbitun. Jute are also recovered from other sites in the Belize Valley, such as Cahal Pech (Staunchly 1999:44). They are also found in ritual contexts at karst sites and may have been valued for their symbolic associations with water (Halperin et al. 2003).

Boileau (2012) identified several potential food sources from Middle Preclassic period plaza deposits in the site core to reconstruct diet at Pacbitun during this period. Faunal remains identified include deer, armadillo, peccary, opossum, tapir, Paca, agouti, rabbit, domesticated dog, turtle, snakes, iguanas, freshwater and marine fish and shellfish, and turkey (Boileau

2012:97-100) were identified. Most of these protein sources can be found locally, however marine fish and shellfish were being imported from the coast. Marine shell was used in bead production at the site beginning in the Middle Preclassic period (Hohmann 2002; Powis 2009, 2010), but may have also been used as a food source.

5.3.2 Site Features

The Pacbitun site core (Figure 5.3) sits on a natural, modified limestone plateau in the valley and is oriented along an east-west axis (Healy et al. 2004b:208). It is roughly .5 km² and consists of 41 monumental structures, including ceremonial buildings, elite palaces and clusters of residences with private courtyards. The site core also contains 20 erected stone monuments, five plazas, a ball court, at least three *sacbeob*, Mai Causeway, Tzul Causeway, and Tzib Causeway, and a raised walkway, the Southwest Passage, connecting two structures in the site core (Weber 2011a, 2012, 2013). The ball court is one of the earliest examples in the Maya Lowlands, constructed during the Middle Preclassic period (Healy et al. 2004b:211). The site periphery is 9 km² and the population of the entire area is conservatively estimated to have been between 5000 and 6000 people during Pacbitun's florescence in the Classic period (Healy et al. 2007:12; Ward 2013:25; Weber 2011a:55).

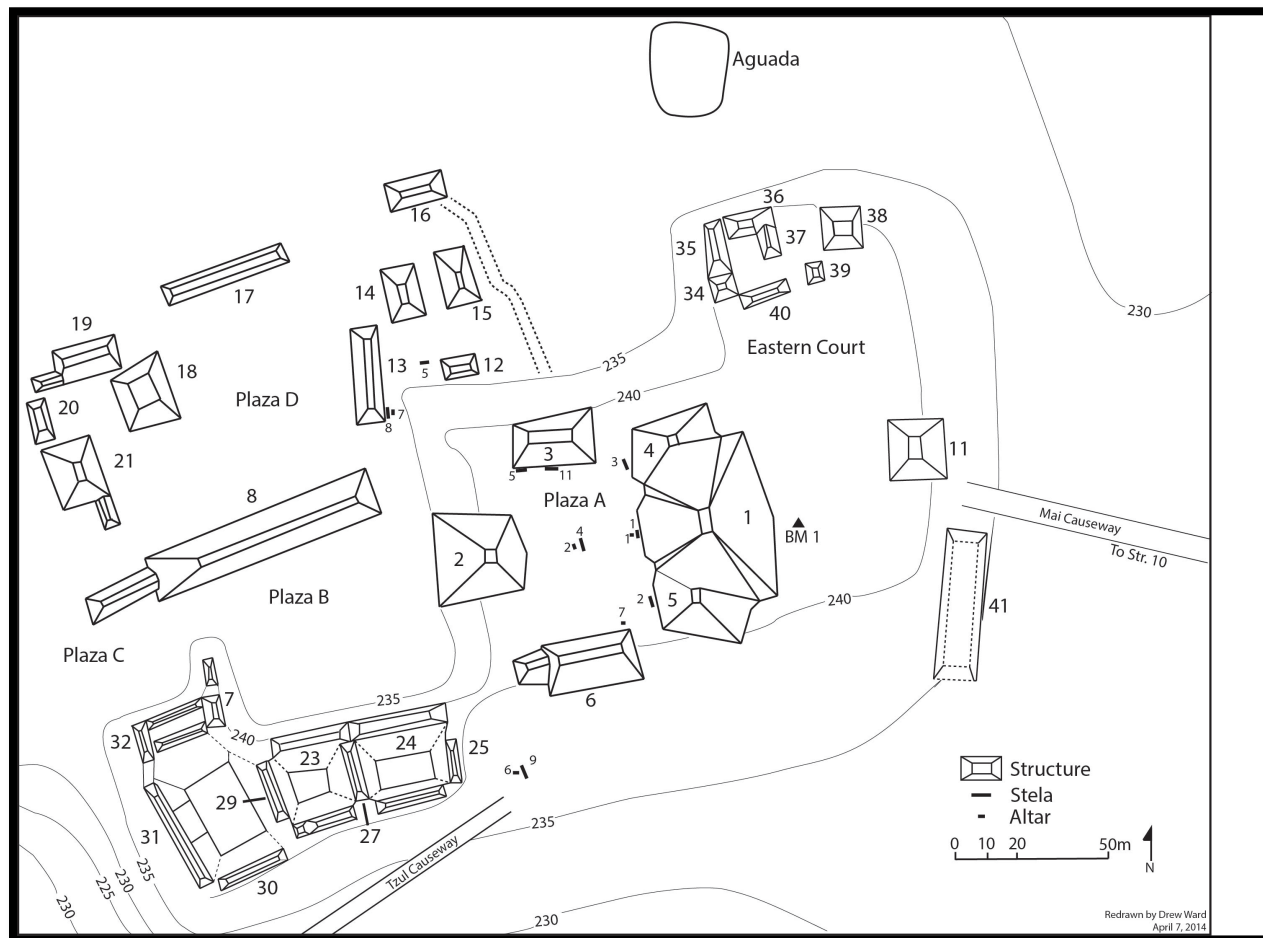


Figure 5.3: Pacbitun site core (map drawn by Drew Ward).

Structure 1 and its two smaller flanking structures, Structures 4 and 5, dominate the site's main ceremonial space, Plaza A. Due to the position of Structure 2 on the opposite side of the plaza, this arrangement has been argued to represent an E-Group complex (Healy 1990:251; Healy et al. 2004b:208). Sprajc et al. (2009:82) identify a similar architectural phenomenon at El Mirador, in which the astrological alignments associated with E-Group architecture are correlated with an east-west alignment of the entire city. E-Groups have been identified at many other sites and are possibly locations for the observance of astrological phenomenon or activities related to calendric dates based upon their alignment with solstice events (Sprajc et al. 2009:79-

83). It is suggested that the significance of the east-west alignment is associated with the path of the sun (Sprajc 2009:82; see also Ashmore and Sabloff 2002; Morales-Aguilar et al. 2007) and is supported by the alignments of some E-Group architecture within the azimuth of the sun's path across the sky at various days throughout the year (Sprajc 2009:82). Doyle (2012:370) interprets E-Groups as evidence of Middle Preclassic communities "consciously positioning themselves on the landscape." Usually public spaces, E-Groups were the locations of important community events (Doyle 2012:374) and may represent evidence of a shared social identity in the Maya Lowlands, where they are concentrated during the Middle Preclassic period (Doyle 2012:374).

Pacbitun's causeway system also yields insights into social interactions in the urban center and its hinterlands. The Mai and Tzul Causeways extend out from the site core. The Mai Causeway begins at Structure 11 and ends at Structure 10, a large ceremonial termini complex. The Tzib Causeway is an outlier causeway and intersects with Tzul Causeway in the hinterlands (Weber 2011a:93, 2011b:32, 2012, 2013). Tzib Causeway runs east to west, is approximately 600 meters in length, and connects a minor center to a plazuela group (Weber 2011a:95). Tzul Causeway is a core-outlier sacbe (Shaw 2008:86-87; Weber 2011a:92) and is Pacbitun's longest causeway. It begins at the site core around Structure 30 and continues southeast, intersecting Tzib Causeway after approximately 900 meters. It then continues for another 1.2 kilometers before terminating at the mouth of Tzul's Cave (Weber 2011a:92).

Ashmore and Sabloff (2002) argue that Maya civic centers demonstrate considerable deliberation and planning that emphasizes "meaningful arrangement in the placement of buildings, monuments, and open spaces" (Ashmore and Sabloff: 2002:201). Pacbitun's causeway system displays possible symbolic elements of Maya cosmology. Since caves were perceived as entrances to the lower world (e.g., Brady and Prufer 2005a, 2005b; Prufer and

Brady 2005a), the termination of the Tzul Causeway at the entrance of Tzul's Cave suggests the possibility that the inhabitants of Pacbitun intentionally incorporated this lower world imagery into their built environment. The termination of Mai Causeway at the base of Structure 10 could potentially also be the incorporation of a symbolic sacred mountain (Stone 1992), or representation of the upperworld, into the site's built environment. The word for temple in Mayan is "witz", which means "mountain" (Stuart 1987; Stuart and Houston 1994:82), and according to Vogt (1976:32) mountains were the homes of gods and ancestors. If Pacbitun's causeways are cosmologically significant, the site's layout could represent a complete cosmogram of the upper, lower, and middle worlds, with the site center serving as the middle realm. However, there is much debate surrounding the reading of cosmological significance in site arrangements due to a lack of textual evidence to support this phenomenon (see Smith 2005) and these observations should be regarded cautiously.

5.3.3 Pacbitun's Environmental Setting

Pacbitun is located in a portion of the upper Belize River valley referred to as "flank lands" by Turner (1978:167) because it is located in the margins of the alluvial valley, where slope and elevation increase as one approaches the karstic Maya Mountains. However, this "flank" of the upper Belize River valley is an ecotone, or transitional zone where at least two distinct habitats come together, an area which by its nature generates biodiversity (Gill 2000:16). Pacbitun straddles both the alluvial upper Belize River valley and the acidic, sandy Mountain Pine Ridge, providing inhabitants with access to a wider variety of natural resources. A variety of springs and creeks are also located throughout the area. The site core itself is located in the

lowland tropical rainforest zone and to the south the landscape transitions into the Mountain Pine Ridge (Figure 5.4).

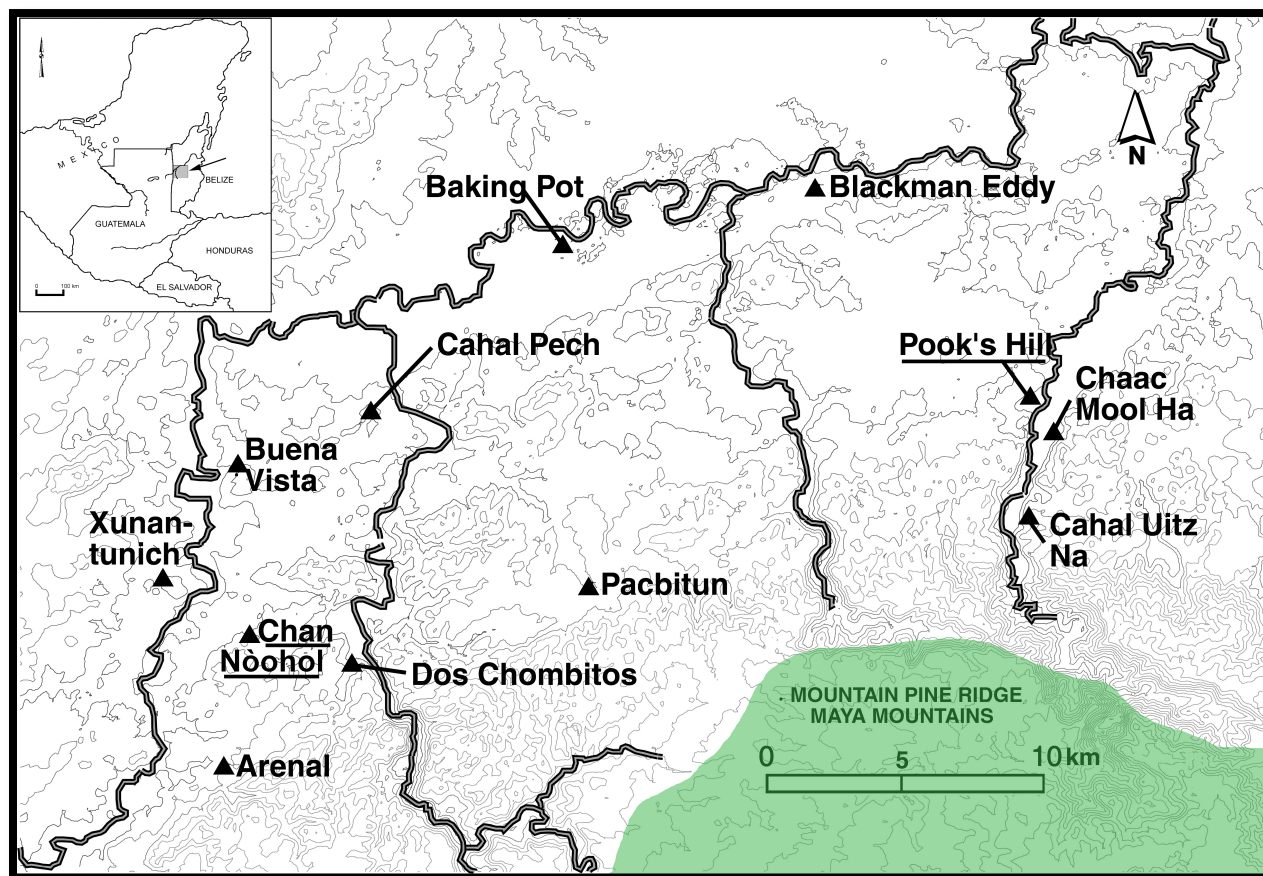


Figure 5.4: The location of pine forests in relation to Pacbitun site core (map courtesy of Christopher Morehart).

The Mountain Pine Ridge soils are highly acidic, forming from granite bedrock. As such, the soil is agriculturally poor and the region has never supported large densities of habitation (Lentz et al. 2005:573). However, open-canopy pine forests flourish in the area. There are two species of pine that grow in the Mountain Pine Ridge, Caribbean Pine (*Pinus caribaea* var.

hondurensis) and Red Pine (*Pinus oocarpa*) (Balick et al. 2000:49; Lentz et al. 2005:573-574; Perry 1991:199-200). However, the two species are nearly indistinguishable microscopically.

The upper Belize River valley provided tropical hardwoods, freshwater shellfish, rich alluvial soil, and wild game that inhabited the tropical valley region, such as white-tailed deer and peccary (Staunchly 1999). The Mountain Pine Ridge was the source of granite (Graham 1987; Ward 2013), pyrite (Drueker 1978:56, 58; Graham 1987:754), hematite, slate, shale (Graham 1987:754), and pine, a highly valuable resource for both utilitarian and ritual needs (Lentz et al. 2005; Morehart et al. 2005; Morehart and Helmke 2008). The rivers and streams that drain into the Belize Valley are known to carry boulders of granite, slate, and other stone materials from the Maya Mountains, eliminating the need to travel into the interior of the region to benefit from its resources (Graham 1987:754).

Additionally, Pacbitun's location at the foothills of the Maya Mountains placed it in close proximity to numerous karst features, such as caves, rockshelters, and sinkholes. Collectively, these features are referred to here as the "karstscape" (Spenard 2012). A regional cave survey conducted in 2011 by Jon Spenard, a PhD student at University of California, Riverside and the Pacbitun cave project director, recorded a total of 57 karstic features in the site's hinterlands (Spenard 2012:180-181). The Mendip Caving Group (see Francis et al. 1995) had originally recorded some of these features, which were rediscovered during the 2011 survey. PRAP's attempts to relocate 10 additional caves identified by the group have been unsuccessful so far. Many of these karst features contain archaeological materials associated with the ancient Maya.

5.3.4 *Archaeological History*

Dean H. Snow possibly first recorded Pacbitun's presence in 1969 (Snow 1969:47), but the Belize government did not officially recognize the site until 1971 (Healy 1990:248). A surface survey by Paul Healy (1990) revealed preserved architecture and extensive terracing in the site periphery (1990:249). Limited excavations at the site core were conducted in 1984 and were expanded upon in 1987 and 1989 (Healy 1990:249). Both the site core and its periphery were the subject of survey and mapping during the later field season. These surveys revealed at least forty structures within the core zone, a system of raised roadways (or *sacbeob*), hundreds of house mounds extending into the hinterlands, a complex system of terraces, and numerous minor centers (Healy 1990:250-251).

Richie (1990) and Sunahara (1994) conducted surveys in the site periphery under the direction of Paul Healy. These surveys, while limited, indicated a dispersed periphery with household structures dating primarily to the Late Classic period, with the western zone being more heavily settled (Richie 1990:194; Sunahara 1994:130). In the eastern zone, rich alluvial soils give way to the sparse and agriculturally poor soils of the Mountain Pine Ridge (Healy 1990:247-248). A majority of the house mounds located on upland hills and slopes were concentrated around terraces, indicating that as populations increased during the Late Classic, so did a reliance on terrace-based agriculture. These upland areas have been interpreted as marginal areas for agricultural production, suggesting that locations in the alluvial bottomlands were possibly not available for exploitation at this time (Healy et al. 2004b:222).

Terry Powis took over the archaeological work at Pacbitun in 2008 as director of the Pacbitun Regional Archaeological Project (previously Pacbitun Preclassic Project). One of the main objectives of Powis' work concentrated on better understanding Pacbitun's occupation

during the Preclassic Period. Powis' excavations in plazas in the site core have revealed rich evidence of the site's earliest occupations (Powis 2009, 2010, 2011, 2013; Powis and Healy 2012). In 2009 he initiated a cave survey component to the work already being conducted in the site core (Powis 2010).

Weber (2011a; see also 2011b; 2012) investigated Pacbitun's causeway system in order to examine relationships between the site core and caves in the periphery. Weber's research represented one of the few settlement surveys to analyze the intermediate area between sites and caves, contributing to an understanding of how ritual behavior and pilgrimages may have influenced settlement patterns. Weber focused not only on the religious significance of Pacbitun's causeway system, but also its functional capacity.

In 2012, Ward (2013) investigated the Tzib Group, a mano production site in Pacbitun's hinterlands. This was the first archaeological groundstone production site investigated in Mesoamerica. The site's location in an unassuming field in the periphery suggests that groundstone tool production took place in rural areas, which is supported by ethnographic evidence (Ward 2013:11-17). The fortuitous discovery of the Tzib Group has provided unique insights into groundstone tool production that shows some continuity between the archaeological and the ethnographic record (Ward 2013:13-18, 54-55). What is interesting is that while there are granite outcroppings in the Mountain Pine Ridge, and streams that carry granite cobbles into the upper Belize River valley (Graham 1987), an additional source of granite was being used at the site (Ward 2013:52-53). Groundstone tools at Pacbitun were being produced with granite from both the Mountain Pine Ridge and the diagnostically pink granite from the Hummingbird batholith in the Stann Creek District of Belize (Ward 2013:53).

Additional work at Pacbitun has focused on an elite residential complex (Cheong 2011, 2012; Cheong and Snetsinger 2012), and the minor satellite center of Sak Pol Pak (Lawrence 2012; Reece 2012). Karst investigations (discussed below) have revealed clues about Pacbitun's ceremonial cave practices. In 2012, a fossilized giant sloth was recovered from Actun Lak in the site periphery; while not associated with cultural levels of use, analysis of the remains provided one of the few accounts of Central American ground sloths (Staunchly et al. 2013). It is also the southernmost example of this particular species (Staunchly et al. 2013:131). Recent investigations have also begun on Structure 10, Pacbitun's largest monumental structure (Weber and Kieffer 2013) and the use of terrestrial LiDAR has produced detailed scans of structures and even some caves at the site (Lund and Weber 2013). Additionally, a public archaeology project has recently been initiated (Burnette and Powis 2014).

5.3.5 *Caves at Pacbitun*

The caves in Pacbitun's hinterlands have been explored to various degrees in the past, but have only recently been the focus of more thorough and intensive archaeological investigation (Spennard 2011, 2012). Rockshelters and other features of the karstscape have also received attention in the past. Exploring caves, rockshelters, and other aspects of the karstscape allows archaeologists to better understand the views and attitudes that helped to shape ancient Maya conceptions of the sacred landscape (Brady and Ashmore 1999). Unfortunately, looting and destruction of caves has occurred in the past and continues today. Valuable archaeological data is consistently lost, and the caves around Pacbitun are no exception. While some caves have been gated for protection, this can be an expensive measure. Additionally, it prevents people from enjoying the beauty and the history that these caves have to offer, particularly for those

individuals who still utilize caves in the area for ritual purposes. There is no obvious solution to the problem except for archaeologists to continue investigating caves and gathering as much data as possible before any further disturbance or destruction takes place, as well as educating the public on the delicate and irreplaceable nature of caves in the region.

In 1994 the Mendip Caving Group identified the location of 19 caves outside of the town of San Antonio (Flavell et al. 1994; Francis et al. 1995; Hollings 1996; Spenard 2012). Though cultural materials were noted, no excavations took place. In 1995 the Belize Valley Preclassic Maya Project explored, mapped, and documented artifacts in a cave called Actun Petz (now Actun Pech) in the Pacbitun periphery, but no excavations occurred at this time (Healy et al. 1996; see below for full description). In 2009 the Pacbitun Regional Archaeological Project, under the direction of Terry Powis, located 12 caves in the southern periphery of the site and three were preliminarily investigated: Actun Pech, Actun Merech, and Tzul's Cave (Powis 2010:22-36; see also Spenard 2012). Some of these caves have been revisited in more recent years for further investigations. Spenard's (2011, 2012, 2013a, 2013b) explorations of the karstscape around the site revealed the presence of an abundance of features of archaeological interest. These explorations have also indicated a rich and complex relationship existed between the ancient Maya of Pacbitun and the landscape around them. The caves in Pacbitun's hinterlands were the location of ritual activities in ancient times, and some continue to be utilized for that purpose today. Archaeological evidence to suggest past ritual activity includes ceramic assemblages, paleoethnobotanical remains, greenstone, architecture, and petroglyphs. Evidence of modern cave use is also present, especially in Crystal Palace.

The Maya "molded sacred space around themselves" (McAnany 1995:110) and at Pacbitun extensive measures were undertaken to incorporate at least one of its caves (Tzul's

Cave) into the built environment by constructing a sacbe from the site core to its entrance. Knapp and Ashmore (1999) describe this type of site planning as a mixture of both “constructed” and “conceptualized” landscapes, which “exhibits both material features found by humans and natural features imbued with religious symbolism and cultural meaning” (Halperin 2005:72). This phenomenon may have been religiously motivated at Pacbitun, but also could have been a means by which an elite ruling class could maintain control and social order over commoner populations in the periphery (Weber 2011a).

These “cultural landscapes” may have been material forms of power, which could be controlled as a means for “displaying, legitimizing, and negotiating social power” (Halperin 2005:72-73). Additionally, by linking these natural features with monumental architecture, elites have the ability to legitimize their right to rule by associating themselves with powerful symbols of ritual and ideological significance (Halperin 2005; Leone 1984:26). Brady (2000:129-130) argues that at Dos Pilas elite authority was sometimes legitimized through the incorporation of the “established power vested in sacred landmarks within the site boundaries”, particularly caves, and that this practice likely dates to at least the Middle Preclassic period.

This particular site arrangement has also been recorded at Cahal Uitz Na, located in the neighboring Roaring Creek Valley. At Cahal Uitz Na, a southwestern oriented causeway extends from the site core for 240 meters before terminating at the mouth of a cave called Actun Nak Beh (Halperin 2005; see also Morehart 2005, 2011; Morehart and Butler 2010). It has been recently discovered that Cahal Uitz Na is one of three sites connected in the Roaring Creek Valley by a causeway system (see Andres et al. 2014). Given the resemblance in arrangement and proximity of Pacbitun and Cahal Uitz Na’s site centers, it is not unreasonable to consider the

possibility of social interaction between the two sites providing a means for cultural influences to pass between the two.

Halperin (2005:125) suggests that the open plaza access to the causeway at Cahal Uitz Na, which is also seen at Pacbitun, indicates a space for public rituals. Another similarity between the two sites is the accessibility of multiple other caves nearby. Morehart (2011:33) argues that Cahal Uitz Na's association with one particular cave "communicates that high status groups... were in control of the space", conferring social, economic, and political power on the elites who controlled and maintained the cave and its ritual activities. In this way, caves could become symbolic capital (Bourdieu 1977:171-183) for elites by linking them with ritually and cosmologically salient components of the sacred landscape. This incorporation of the sacred landscape into the built environment by Pacbitun's elite could possibly reflect the broader atmosphere of social, political, and ritual competition permeating the Maya Lowlands.

Though there are few examples of causeways terminating at the entrance to caves in the Maya Lowlands (Halperin 2005; Shaw 2008:70; Weber 2011a) it is possible that it is a more common phenomenon than currently understood. This could be a result of being unaware or unable to locate the remains of causeways. Though investigators at Pacbitun had been aware of the presence of Tzul's Cave for some time, it was only recently noted that the causeway, which was partially obscured beneath a modern road, continued to the entrance of the cave. Additionally, the ancient Maya potentially constructed less visible pathways between architecture and features of the landscape.

5.4 Descriptions of Cave and Rockshelter Sites

Nine sites within the Pacbitun hinterlands, including six caves and three rockshelters, were included in the present study in order to provide a micro-regional perspective. Each of the cave sites are located within the 9 km² area that has been established as Pacbitun's hinterlands. Establishing a local perspective of cave use at Pacbitun allows archaeologists to develop a more complete understanding of ancient Maya cave ritual and its variations. Regional surveys have become the standard in cave investigations within the last two decades (see Awe 1998; Bonor Villarejo 1987; Morehart 2011; Peterson 2006; Prufer 2002; Rissolo 2001; Spenard 2011, 2012, 2013a, 2013b, Wrobel et al. 2009; Wrobel et al. 2013) in order to address broader similarities and differences in cave use.

5.4.1 *Nohoch Tunich Rockshelter (Great Wall Rockshelter)*

Nohoch Tunich is a rockshelter located within a network of karstic features associated with a large bedrock outcropping named the Nohoch Tunich Rockshelter Complex (NTC). The NTC consists of exposed limestone bedrock, boulders, small caves, chasms, cracks, and rockshelters, all of which contain evidence of extensive use and modification in the past (Spenard 2012:159). Actun Xtuyul (described below) is also a component of the NTC. Nohoch Tunich Rockshelter is approximately 55 m long and 13 m tall and naturally divided into three sections due to the morphology of the limestone outcrop (Figure 5.5) (Spenard 2012:160).



Figure 5.5: Nohoch Tunich Rockshelter (photograph courtesy of Jon Spenard).

5.4.2 *Actun Subuul*

Actun Subuul is 40 m southeast of NTC and is a large boulder located on the side of a path that not only serves as an alternative route to Actun Lak (see below), but also leads to the NTC (Spenard 2012:167). The boulder (Figure 5.6) was selected for further investigation because of ceramics observed on the surface just below the drip line. The boulder is approximately 10 m wide and 10 m long with an undercut that creates a small, sheltered opening with “a natural, cave-like matrix” (Spenard 2012:167).



Figure 5.6: Actun Subuul (photograph courtesy of Jon Spenard).

5.4.3 Actun Xtuyul (*Termite Cave*)

Actun Xtuyul, another component of the NTC, is approximately 7.5 m long, 3 m deep, and 2 m tall (Spenard 2012:164). The context of the site is believed to have been relatively intact because of the restricted access to the rockshelter. Additionally, a groundstone mano, which rested in the approximate center of the rockshelter, and a possible partial pottery mold were collected from the surface near the rear wall (Spenard 2012:164-165). The ceramic mold (Figure 5.7) has been reworked, exhibiting two partial drill holes along one broken edge, possibly to allow it to be worn like a pendant.



Figure 5.7: Partial, modified pottery mold from Actun Xtuyul (after Spenard 2012:Figure 14:166).

5.4.4 *Actun Merech (Lizard Cave)*

Actun Merech (Figures 5.8 and 5.9) is a dry cave 3 kilometers southeast of the Pacbitun site core. It is an L-shaped cave with nine chambers and is approximately 50 m long (Powis 2010:26). The entrance faces west and is located on the summit of a steep hill. At its base is a natural spring with evidence of a slate wall constructed around its edge (Powis 2010:26; Weber 2011a:42).

Room A is the main entrance to the cave and is 3 m in diameter. Rooms B, C, and D are small and can accommodate only one individual at a time. Room E is larger, with a 6 m high domed ceiling and horizontal ledges running along the walls. There is a vertical chute at the back of the chamber that descends 5.5 m before splitting into two separate chutes (Powis 2010:26; Spenard 2012:172; Weber 2011a:43). The western chute continues an additional 12 m, and during the 2009 field season, pottery sherds and animal bones were recorded at the bottom (Powis 2010:26; Spenard 2012:172). The eastern chute drops an additional 17.5 m; at the bottom is a chamber where two cultural blockages were recorded, one in front of an alcove and another in front of a small passage (Spenard 2012:172).

Rooms F, G, and H are also small and restricted. Room I is a large chamber at the back of the cave with horizontal ledges running along the walls. Powis (2010:26) notes that residents of San Antonio described three ceramic vessels that had once been located in the chamber – one red slipped cylindrical jar, one red slipped bowl, and one polychrome dish – that had been removed sometime in the 1960s. Powis (2010) first investigated Actun Merech during the 2009 field season. No excavations took place, but the cave was mapped and artifacts were recorded and photographed. Late Classic ceramic sherds were noted throughout. The cave was revisited in subsequent field seasons (Spenard 2011, 2012; Valdez et al. 2011) for varying levels of investigation. Some excavations took place in the 2010 field season (see Valdez et al. 2011), however very few subsurface artifacts were recovered.

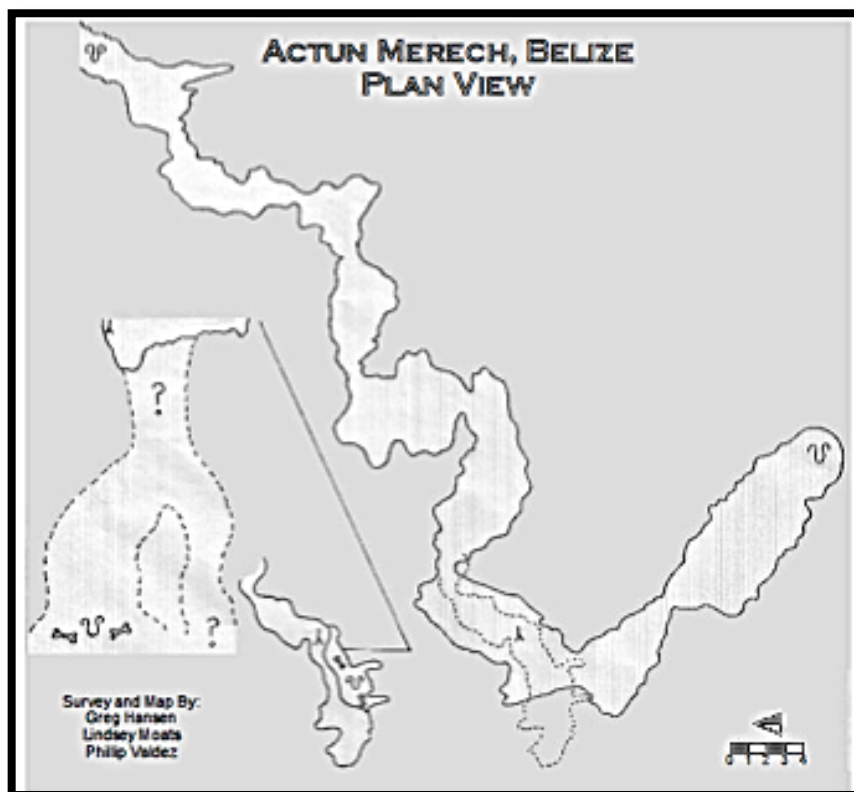


Figure 5.8: Plan view map of Actun Merech (after Powis 2010:Figure 20:29).

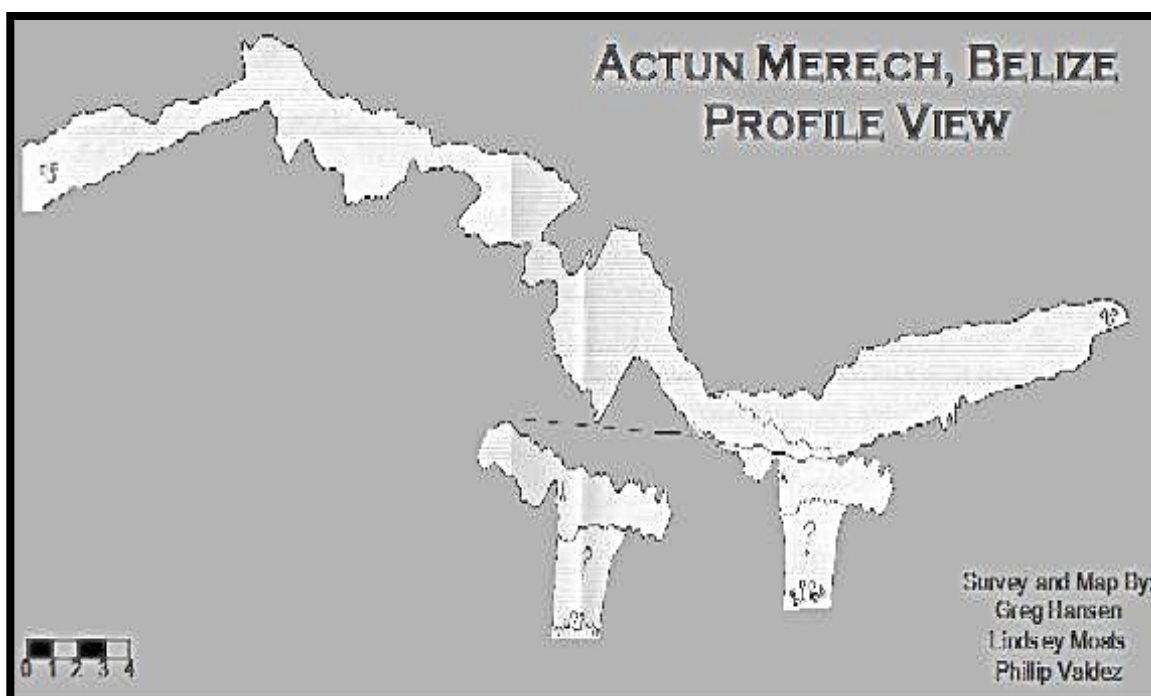


Figure 5.9: Profile view map of Actun Merech (after Powis 2010:Figure 21:29).

5.4.5 *Actun Pech (Tick Cave, formerly Actun Petz)*

Actun Pech (Figure 5.10) is a small cave with 4 rooms (Rooms A – D) located on a hilltop approximately 2.5 km southwest from the site core. Healy et al. (1996) first investigated Actun Pech in 1995. These investigations mapped the cave and inventoried the artifacts present. Healy et al. (1996:141) also reported a modified well, agricultural terraces, and small settlement mounds at the base of the hill where Actun Pech is located.

The entrance to the cave is a steep, narrow, and almost vertical descent (Figure 5.11) approximately 3 m into a large, open chamber. Room A is roughly 9 x 14 m. Healy et al. (1996:141) describes descending from this raised level to the floor of the chamber, which dropped in “terrace-fashion”. Room B is reached by descending into Room A and climbing a small platform on the eastern side of the room. Room B is 5.5 x 6 m with a 2 x 1 m alcove containing whole and partial vessels. The cave forks in two different directions, the left fork leading to Room D and the right to Room C. Room C is a small 2 x 2.5 m chamber that dead ends. Room D is located at the end of a narrow crawl space and is the only chamber in the cave that contains human remains and associated burial vessels.

When Actun Pech was explored in 1996 the cave contained the skeletal remains of an estimated 6 individuals (Healy et al. 1996), however these bones have been greatly disturbed in subsequent years and most are now missing (Figures 5.12 and 5.13). Healy et al. (1996) also inventoried ceramic vessels throughout the cave and performed an in situ analysis. At least 21 (or 23) whole or partial vessels were recorded ranging in date from 100 B.C. to A. D. 900, the majority being Late Classic period vessels (Healy et al. 1996:145-146), mostly plain and undecorated. While a systematic inventory of vessels has not been performed since, the cave no longer contains Late Preclassic period ceramics, likely as a result of looting (Powis 2010).

Powis (2010) returned to Actun Pech in 2009 as part of an effort to relocate and investigate previously described cave sites in Pacbitun's hinterlands. These investigations did not include excavations, but were instead limited to cursory observations. Looting had occurred in the cave since Healy et al.'s (1996) initial investigation (Powis 2010:30-32), however a gate had been erected over the entrance by the landowners to deter any further disturbances. Valdez et al. (2011) conducted preliminary excavations in Actun Pech during the 2010 field season and it was revisited in the 2012 field season for inclusion in the present study.

Healy et al. (1996) reported that Actun Pech was a very wet, actively forming cave and that water consistently dripped from the ceiling. However, when the cave was visited in later seasons (Powis 2010; Valdez et al. 2011) it was reported as being a dry cave. During the 2012 field season, the cave was again noted to be wet and highly active, suggesting that Actun Pech could be more sensitive to environmental conditions and may reflect climate change in the immediate region. Because of this, Actun Pech would be an ideal cave for collecting paleoenvironmental speleothem samples, which could provide detailed microenvironmental data for the surrounding area (see Moyes et al. 2009; Webster et al. 2007).

Formation harvesting throughout Actun Pech is extensive (Figures 5.14 and 5.15). This behavior has been documented at other sites in the past (Brady et al. 2005; Moyes 2001; Peterson et al. 2005; Prufer 2002; Rissolo 2001) and appears to have been a common practice. Brady et al. (2005) suggests that the removal of speleothems was associated with ideological practices related to fertility. Ethnographically, speleothems have been described as pieces of Mother Earth, regarded as sacred water solidified, and often incorporated into altars (Barrera Vásquez 1980:123, 946, 961). Cave formations, as well as crystals and cave pearls, have been found in excavations in the site core at Pacbitun (Powis 2013; Weber and Kieffer 2013).

Brady et al. (2005) were able to document the extent of speleothem breakage in Balam Na Cave, Guatemala and determined that 59% of all the stalactites had been broken. Due to the unsystematic pattern of harvesting, Brady et al. (2005:218) concluded that the formations had been removed for ritual purposes. Ethnographically, these cave formations were described as “alive, they grow and sweat water” (Brady et al. 2005:218) and are called *ch'ak xix* in Yucatec and were believed to be “coagulated water” (Barrera Vásquez 1980:123, 946, 961 in Brady et al. 2005:219). These studies in Balam Na Cave indicate that formation harvesting in caves was common and widespread (see also Brady and Rissolo 2006).

Formation harvesting has been noted at several other caves associated with Pacbitun (Healy et al. 1996; Spenard 2011:39; Valdez et al. 2011:29; Weber 2011a), however the scale of collecting at Actun Pech is more extensive than that detected in any of the other caves. Evidence of regrowth over broken formations throughout the cave indicates that the breakages were not recent. In addition, none of the breaks appeared to have been fresh, which may indicate that speleothem breakage does not occur in Actun Pech presently. During the 2012 field season, water dripped from the ceiling consistently throughout my fieldwork in the cave. It is possible that when Actun Pech was in a wet phase, the formations were valued for their symbolic connection to the actively forming cave and the sacred water.

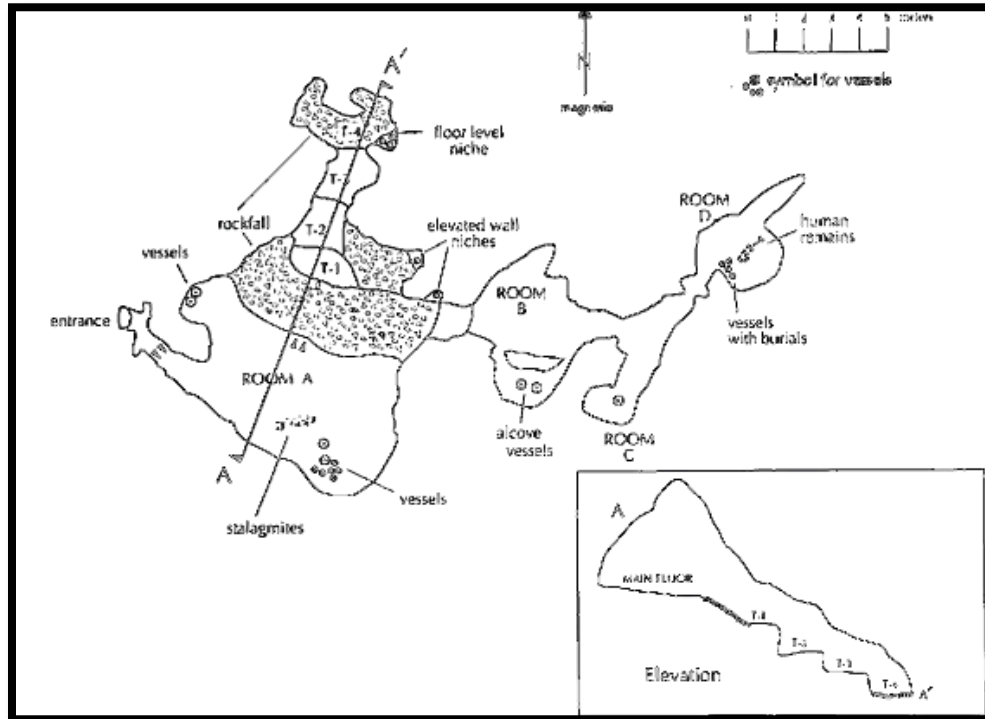


Figure 5.10: Map of Actun Pech (after Healy et al. 1996:Figure 2:2).



Figure 5.11: Entrance to Actun Pech.



Figure 5.12: Human remains in Chamber D of Actun Pech in 2009 (after Powis 2010:Figure 24:32).



Figure 5.13: Human remains in Chamber D in Actun Pech in 2012 showing severe disturbance and many missing bones.



Figure 5.14: Evidence of formation harvesting in Actun Pech (Room A).



Figure 5.15: Formation harvesting in Actun Pech showing regrowth over old breaks (Room C).

5.4.6 *Crystal Palace*

Crystal Palace is a large cave with evidence of extensive modification in the past. Investigations of a structure were previously conducted just outside of the cave (Weber 2011b). The structure was concluded to likely have been a house mound, however three obsidian blades and a ceremonial chert blade were recovered from excavations (Weber 2011b:46-47). Further excavations would be necessary to determine the exact function of the structure, however it is possible it was associated with the ceremonial use of Crystal Palace.

Of the caves investigated in 2012, Crystal Palace evidenced the most contemporary use for ritual activity, including ceramics having been moved around (Figure 5.16) (however, curiously not removed from the cave), footprints, pine torches, and copal. The botanical indications of ritual activity were determined to be of recent origin due to the fact that the torches were developing mold and the partially calcified copal resin was still fragrant (Figure 5.17 and Figure 5.18). My two guides, Joe Tzul and Antonio Mai, believed that the three of us encountered the Alux, or trickster spirit, that lives in Crystal Palace during excavations (see Spenard and Parker 2013), demonstrating rich supernatural and ritual associations still attributed to this particular cave. Contemporary ritual activity appeared to be concentrated around a natural cave formation “altar” in the back chamber of the cave, indicated by a scattering of pine torches around its base (Figure 5.19). Three or four large, broken columns appeared to have been arranged around the altar in a circular fashion, though not recently (Figure 5.20).

One other notable feature encountered during my visits to Crystal Palace was a small alcove in a side chamber close to the entrance across from a concentration of partial vessels and sherds. The alcove was deep and difficult to access. At its entrance was the curved portion of a ceramic vessel collecting drip water (Figure 5.21). Whether this ceramic fragment was in situ or

placed here more recently is unknown, however its placement indicates the collection of “virgin water” from cave contexts, which was often used in ritual activity (Thompson 1975).

Additionally, in the very back of the alcove rested a single obsidian blade, which could not be reached due to the depth of the alcove, which has likely grown more restricted over time due to cave formation.



Figure 5.16: Ceramics in Crystal Palace rearranged since it had last been visited.



Figure 5.17: Molding torches in the back chamber of Crystal Palace on a ledge near a natural "altar".



Figure 5.18: A modern offering of stacked sherds (left) and copal (right).



Figure 5.19: Natural "altar" in back chamber of the cave. Note burned wood fragments scattered around the base and on top.



Figure 5.20: Broken columns appear arranged in a circle around the "altar".



Figure 5.21: Portion of vessel placed at entrance of alcove collecting water. In the very back of the alcove was an obsidian blade.

5.4.7 *Actun Slate (Slate Cave)*

Actun Slate is a dry, flat tunnel that extends approximately 40 m east-west (Spenard 2011:33-34). The height and width of the cave varies throughout, sometimes being 6 m wide and tall enough to stand comfortably, while at other times the passage is quite restricted and can only accommodate a single person. A formation in the cave entrance is carved with eroded petroglyphs (Figure 5.22) and is the only cave in the periphery known to have rock art. A modern hearth and contemporary debris litter the entrance and artifacts in the cave are limited.



Figure 5.22: Petroglyphs in the entrance of Actun Slate.

The entrance to the cave is wide and open, but restricts drastically, allowing for entry only via crawling on one's stomach through a long and constrictive tunnel approximately 10 m in length. Additionally, the floor of the tunnel is strewn with a heavy layer of large, rough stones, cobbles, and slate that must be crawled over, making the passage painful and difficult. Artifacts such as a few ceramic sherds and possibly a mano fragment were seen throughout the debris, concentrated primarily against the walls of the tunnel. It is possible that past peoples may have intentionally restricted access to Actun Slate by scattering the stones and cobbles across the entrance tunnel.

The crawlspace tunnel eventually opens up into a series of rounded chambers with a surface noticeably clear of cobbles, stones, and debris (Figure 5.23). After these chambers, the rest of the cave can only be accessed by an even more restricted crawlspace. In 2012, investigators did not venture into the cave beyond the final open chamber and nothing beyond this tunnel was investigated, in part because additional caving experience was recommended for further exploration. The final open chamber investigated had a large, high ceiling shaped like a dome. In the center of the chamber with the domed ceiling was a burn feature next to a small boulder. Nearby I observed small ceramic sherds, including 2 polychrome pieces. On a large boulder against the wall were multiple large crystals that had originated from elsewhere in the cave. I was told that the crystals were "special" (Antonio Mai and Joe Tzul, personal communication, 2012) and did not disturb them.

Brady and Prufer (1999) address crystals in archaeological contexts and their ethnographic associations with shamans. Crystals, they argue, were tools used by ritual practitioners for divination and healing. Rock crystals "appear with some regularity in the archaeological record", primarily in caches and burials, and are likely underrepresented because

they are not generally recognized as artifacts (Brady and Pruffer 1999:137). However, ethnographically crystals play an important role in ritual activity throughout Mesoamerica and may represent the physical materialization of a person's spirit or soul (Brady and Pruffer 1999:132). Among the K'iche Maya (Tedlock 1992:59) and Huastec Maya (Alcorn 1984:240) novices achieve the status of shaman or curer when they receive crystals (cited in Brady and Pruffer 1999:130, 138). The Itzaj Maya believed crystals contained an animate force (Hofling and Tesucún 1997) and the Q'eqchi were reported to cure using stones taken from sacred caves that may have been crystals or speleothems (Brady and Pruffer 1999:131; Brady et al. 1997:733; Goubaud Carrera 1949:106). Ethnographically, crystals are regarded as objects with power associated with the sacred earth that granted special seeing or vision to the owner (Brady and Pruffer 1999:131-132) and in Yucatec the word for precious stone (*p'uk*) is the same used for rock crystal (Barrera Vásquez 1980:700).

A fist-sized crystal was found on the centerline of an excavated altar in Naj Tunich (Brady and Pruffer 1999:133-143; see also Brady et al. 1997). Crystals have also been reported in Cueva de los Quetzales in Guatemala and at several rockshelter sites in the Maya Mountains of Belize (Brady and Pruffer 1999:134-135). The Western Belize Regional Cave Project reported finding crystals in Actun Chechem Ha, Actun Tunichil Muknal, and Actun Uayazba Kab (Brady and Pruffer 1999:136). Crystals were recovered from cenotes at Chichén Itza and Dzilbilchultun (Brady and Pruffer 1999:138). However, it is difficult to discern the extent of human intervention when it comes to crystals found in caves themselves, unless it is clear that they are not local to the specific site. Conversely, the frequency of rock crystal in burials and caches at surface sites and the ethnographic record supports the possibility that crystals may have been important for ritual specialists among the Pre-Columbian Maya. Crystals have been found in caches at

Mayapan (Proskouriakoff 1962:354), Tikal (Coe 1990:703), Piedras Negras (Coe 1959:53), and Nebaj (Smith and Kidder 1951:44). They have been recovered from burial contexts at Uaxactún (Smith 1950), Tzimin Kax (Thompson 1931:314), Kaminalijuyú (Shook 1949:220), and La Lagunita (Ichon and Arnauld 1985:33). One quartz crystal was found in excavations of the Eastern Ballcourt at Cahal Pech (Ferguson et al. 1996 cited in Brady and Prufer 1999:137). Not all caves are conducive to the formation of crystals, however, and Brady and Prufer (1999:138) suggest that certain caves may have been sources of crystal and that crystals may have been traded to areas where they occurred only rarely in nature or not at all.



Figure 5.23: The transition from the rock-strewn crawlspace and the next chamber, the surface of which is mostly clear of debris.

5.4.8 *Tzul's Cave*

Tzul's Cave was included in PRAP's initial cave survey during the 2009 field season. The cave was surveyed, mapped, and photographed and artifacts were analyzed in situ (Powis 2010:33-35), however, no excavations occurred. It is a long, narrow cave with six rooms (Figures 5.24). The entrance is small and immediately drops several feet upon entering. This is the only currently known cave directly associated with Pacbitun via a causeway, which suggests that the cave's ideological, political, social, and/or economic significance was consciously emphasized by the ancient inhabitants of Pacbitun. It has been suggested that Tzul's Cave may have served as Pacbitun's mythical origin cave embodied in the sacred landscape (Jon Spenard, personal communication, 2012), as "many caves were thought to represent the cave of origin" (Brady 2003:88). Brady (2003) argues that caves focal to community activity or identity were likely origin caves for that particular group of people (Brady 2003:89). This supports the possibility that Tzul's Cave may have served as the people of Pacbiun's cave of origin.

In addition, Taube (2003) notes the dichotomy between light and dark imagery in relation to cultivated fields and wild forests. He notes the symbolic relationship between forests and caves, both representative of untamed, wild places inhabited by supernatural beings (Taube 2003:466-467). Taube draws upon the linguistic relationship between the Mayan word *ed' b'eh*, meaning "black road" or "narrow, uneven trail" and its association with dark, dense forests. In contrast to the concept of the black road (associated with forests and caves) is *sak b'eho' ob'* (*sacbeob*), "white roads", or raised causeways (Taube 2003:467).

A causeway extending across the landscape and to the mouth of a cave is potentially representative of a path through (and into) darkness. Some caves may have served as group pilgrimage sites (e.g., Brady 1989; Halperin 2005; Scott and Brady 2005), suggesting the

possibility that Tzul Causeway was constructed in part to facilitate pilgrimage from the site core to the cave. The *sacbe* could have symbolized the journey from light into darkness, from the everyday world into the sacred and wild realm of deities and supernatural beings. Additionally, the return journey from the cave back to the site core could have represented the return from the liminal realm back to the ordered human world.

Scott and Brady (2005:149) discuss how caves were “important landmarks around which communities formed”, and argue that the incorporation of caves into site core architecture has its roots during the Preclassic period. Significant caves were also likely sites for pilgrimages because of their associations with water and rain (Scott and Brady 2005:151). Pilgrimages would have been religiously, politically, and economically beneficial (Scott and Brady 2005:152). Tzul’s Cave does not fit the traits associated with pilgrimage caves, such as large entrances or hieroglyphic inscriptions. However, it does have large architectural modifications that would have required community participation and extensive modifications within the cave (Scott and Brady 2005:151).

The artifact assemblage of Tzul’s Cave consists primarily of ceramics, including whole and partial vessels, though overall does not appear unique or even that prestigious when compared to artifact assemblages from other caves at the site (i.e., Actun Lak or Actun Pech). However, this is similar to Actun Nak Beh, where artifacts associated with wealth are also not common (Halperin 2005:125) despite its direct association with the site core. The ceramic assemblage in Tzul’s Cave dates primarily to the Late Classic Period, although the restricted access to the cave has resulted in a so-far incomplete analysis. Very few botanical remains were recovered from soil samples taken from the cave (see chapter 6). However, the cave was modified throughout, including blocked passages, restricted tunnels, walls, and slate “plugs” or

caps. When the Tzul family discovered the cave over a decade ago, the entrance was sealed with a large slate slab. The Tzul's believe the slate slab indicates that the cave had remained sealed until its rediscovery, and they later placed a heavy metal gate over its entrance to prevent looting (Figure 5.25) (Joe Tzul, personal communication, 2012).

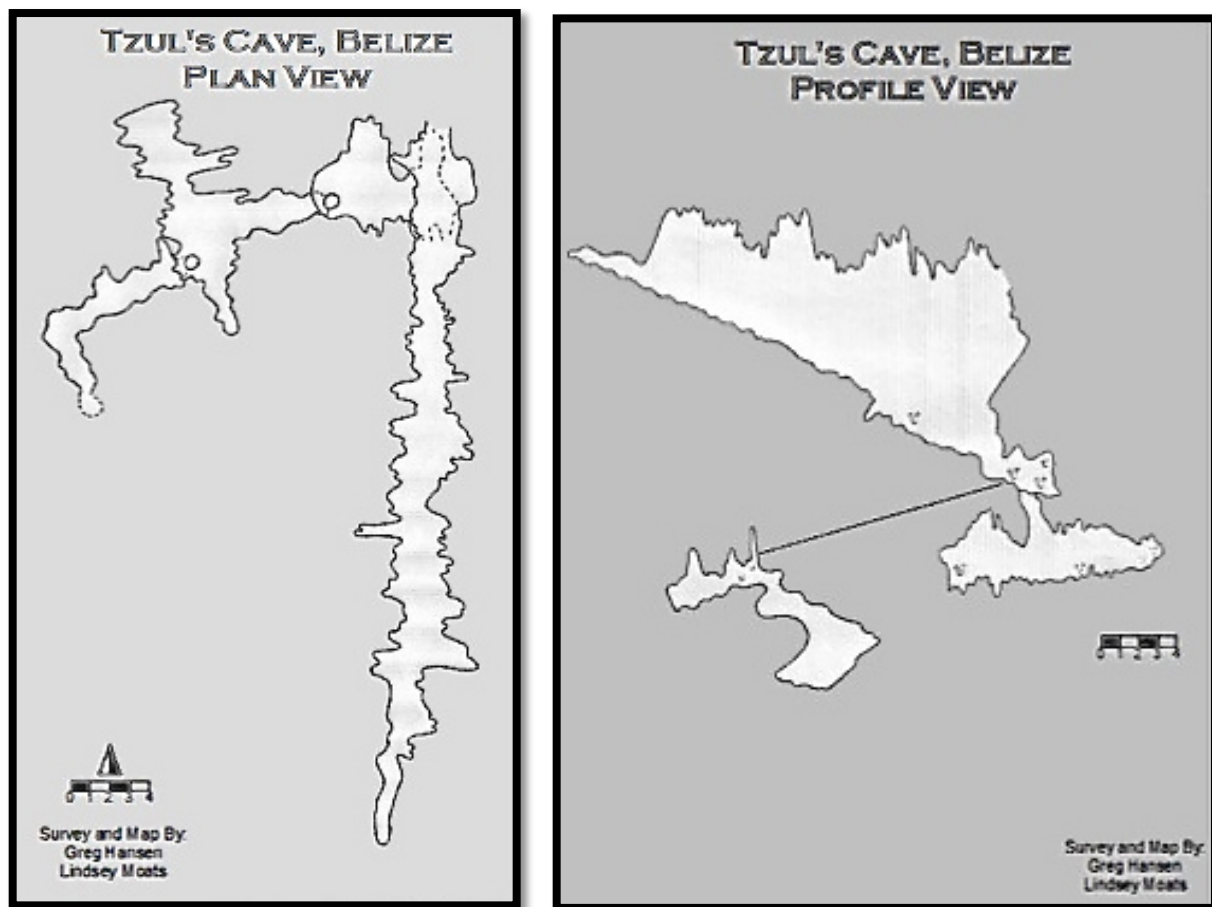


Figure 5.24: Plan and Profile view maps of Tzul's Cave (after Powis 2010:Figure 26:35 and Figure 27:35).



Figure 5.25: Entrance to Tzul's Cave.

5.4.9 Actun Lak (Pottery Cave)

Actun Lak's (Figure 5.26) entrance was documented by the Mendip Caving Group (Flavell et al. 1994:5) and relocated by PRAP in 2010 (Spenard 2011). The cave is approximately 43 m long and consists of three chambers, five ledges, the entrance area, and has been modified with artificial terraces and platforms (Spenard 2012:148-151). Thousands of sherds are piled throughout Actun Lak. Though they are no longer in situ, as the landowner has moved many of them out of the way to allow for cave tours, the sheer quantity of ceramics is astounding. Piles of ceramics occupy ledges, are stacked against the walls, and concentrated around cave formations and altars (Figure 5.27). The assemblage has not been completely analyzed (see Spenard 2013b for representative samples) but a cursory examination indicates that

it consists of a diverse array of ceramic types, including polychromes, red slipped, black slipped, plain, fluted, incised, and unslipped sherds dating primarily to the Terminal Classic period.

The cave's interior chambers and dark zone indicate that it served the personal supernatural needs of Pacbitun's elite. Actun Lak is the only cave from which jade and other greenstone artifacts have been recovered. However, caution should be taken when comparing Actun Lak's assemblage to that of other caves, primarily because it has been the most extensively excavated of any of Pacbitun's karst features. One of the most significant features of Actun Lak is Chamber 2, in which a portion of the walls behind a speleothem altar are entirely blackened from at least one, but likely multiple, large burning episodes (Figure 5.28). Spenard (2012) placed multiple excavation units in Chamber 2 not only because this seemed to be the location of intense and repeated ritual activity, but also with the intention of recovering archaeobotanical materials. He noted that the majority of the matrix consisted of only charcoal, and several soil samples were removed for flotation.



Figure 5.26: Map of Actun Lak showing location of 2011 excavation units (after Spenard 2012:Figure 2:149).



Figure 5.27: Example of sherds stacked at the base of a cave formation in Actun Lak.



Figure 5.28: Actun Lak, Chamber 2, fire-blackened walls. The cave formation altar is in the front. Part of the cave wall at the bottom has spalled off, possibly as a result of intense heat (photograph courtesy of Jon Spenard).

5.5 Chapter Summary

Three rockshelters and six caves from the Pacbitun periphery have been included in the present study. Each has been investigated to various degrees in the past, though none specifically for paleoethnobotanical research. The caves share similarities and differences, which can aid in the interpretation of ritual patterns between sites. Tzul's Cave appears to have been a significant public cave, potentially serving as a small pilgrimage site within a circuit of sacred places. Actun Pech likely served as the location of sacred water, where cave formations were routinely harvested, potentially as tokens of fertility. Additionally, it was the final resting place of at least six individuals. Actun Slate is the only known cave site with petroglyphs associated with Pacbitun. Actun Lak appears to have been a cave primarily used for public and/or elite rituals. Few artifacts were present in Actun Merech, and therefore a more nuanced understanding of its function and significance must await future investigations. Crystal Palace is a large cave that continues to retain spiritual significance among the Maya. Understanding the social significance of various sites and features will enrich our interpretations of the ancient Maya and how they interacted with the sacred landscape.

6 METHODS AND DATA

This chapter presents the methods and results of paleoethnobotanical investigations utilized for the nine sites included in this study. Methods are described for field, laboratory, and archaeobotanical analysis procedures. Descriptions of wood structure are given to explain how identifications are made, and some scanning electron microscopy photographs are provided to illustrate some of these characteristics.

My dataset consists of 67 samples excavated from six cave sites and three rockshelters in the Pacbitun periphery, however most of the samples from Crystal Palace and Actun Merech were sterile. The overwhelming majority of paleoethnobotanical remains recovered consist of carbonized wood charcoal. Very few food remains were present in any of the assemblages. Macrobotanical remains were collected from flotation samples and analyzed for identification. Sampling strategies were not consistent between sites due to restrictions in the field; however, meaningful information can be extrapolated from the data regardless. The results of the archaeobotanical analysis follow, including intrasite and intersite comparisons of the archaeobotanical assemblages.

The analysis of pollen extracted from sediment cores can reveal a great deal about the ancient environment, however the extent of human involvement in paleoecological changes can only be inferred, as well as the extent and impact of those changes. Using macrobotanical remains deposited during ritual activity can provide some insights into environmental interactions at Pacbitun. Because of the ritual context of the data, ideological preferences in plant selection limit the ability to use the recovered wood charcoal for this purpose, however the data can be used to analyze human behavior in response to the environment. Studying climate change and cultural responses to change on a microscale, particular to Pacbitun's locality,

prevents overgeneralized descriptions of paleoecological conditions in the entire Maya area and recognizes the distinctive environmental histories of particular sites and regions. By doing so, archaeologists are better able to reconstruct human reaction and adaptation to environmental change.

The occurrence of these samples in ritual contexts demands the acknowledgement of the social interactions and circumstances that resulted in their deposition (Morehart et al. 2005). Because paleoethnobotanical remains were for the most part the only archaeological material recovered during this study, the perception of the samples must progress beyond understanding them merely as ecofacts (Morehart and Morell-Hart 2013). By shifting focus to the social dimensions of paleoethnobotany, archaeologists can address dimensions of ritual activity among the Maya that may have otherwise been inaccessible (Morehart and Morell-Hart 2013).

6.1 Methods

This portion of the chapter outlines the methods utilized during the course of the project. I first discuss my field methodology, followed by the methods utilized in the laboratory. Archaeobotanical materials were analyzed at Georgia State University under the supervision of Dr. Christopher Morehart. Scanning Electron Microscopy was conducted on some of the wood charcoal samples, primarily angiosperm dicot species, to aid in identifications. The details of the analysis are discussed below.

6.1.1 Field Methods

The collection of soil samples and excavations took place during the 2011 and 2012 field seasons. Recovery of archaeobotanical remains was not consistent between sites. The various

recovery methods place limitations on the data and have been taken into consideration during the analysis and interpretation process. Soil samples from one cave (Actun Lak) and all three rockshelters were recovered during excavations in the 2011 field seasons by Spenard (see Spenard 2011, 2012, 2013a). These samples were recovered when features were encountered during excavation or taken from vessels. During the 2012 field season, three or four 1-liter soil samples were taken from four of the cave sites (Actun Merech, Actun Pech, Tzul's Cave, and Crystal Palace). This was followed by multiple, systematic excavations of 0.25 x 0.25m soil columns in Crystal Palace, Actun Pech and Actun Slate. Units were excavated in arbitrary 10 cm levels unless cultural or natural strata were identified, in which case these more meaningful stratigraphic units were excavated separately. All soil was bagged by level and removed for flotation in the lab. No subsurface artifacts were recovered, however carbonized wood charcoal was abundant in a majority of soil samples and excavations.

All of the recovered soil was subjected to a manual flotation procedure (see Pearsall 2010). This was done using two 5 gallon buckets fitted with 1/16-inch nylon window screen and filled with water from a rain-catchment cistern. The water was allowed to settle between samples and was changed every 2 samples to avoid contamination. Samples would be slowly poured into the buckets and manually agitated. The light fraction was removed using a fine mesh sieve and placed onto squares of cheesecloth. These were tied on a line and allowed to dry. Heavy fraction materials caught in the mesh were placed in the sun to dry before being sorted. Botanical remains recovered from the heavy fraction were collected and added to their respective light fractions. Additional archaeological materials were recorded, and stored in the lab. Once dry, light fractions were bagged and then stored in the lab for exportation. The samples were

exported to Georgia State University for analysis with the permission of the Institute of Archaeology of Belize.

6.1.2 Lab Methods

Archaeobotanical samples were exported to the Environmental Anthropology laboratory at Georgia State University. Each sample was assigned a five-digit identification number beginning at 10001. All of the samples were initially sorted under light microscopy using a boom-mounted microscope. Different taxonomic groups were given a distinct number in addition to the original sample number. For example, sample 10023 contains botanical remains from 11 different species. These distinct specimens are given sequential identification numbers 10023-001, 10023-002, 10023-003, and so on.

Carbonized wood charcoal was analyzed using a snap method, in which the charcoal is broken in order to reveal a clean cross (or transverse) section. From the transverse section, several cellular characteristics can be analyzed, including the size, distribution, and density of vessels, types of axial parenchyma, rays, and the presence or absence of resin ducts. These characteristics are unique between families, taxa, and species, however the diversity of angiosperm species native to the Maya Lowlands makes identifications beyond family difficult and sometimes impossible. Poor preservation also affects the ability to identify angiosperm charcoal. The rays of wood charcoal are used to determine the maturity of the specimen when it was harvested.

Vessels are continuous columns or tubes in the xylem of angiosperms and are primary water conductors throughout the plant (Hoadly 1990:31; Mauseth 1988:109; Raven et al. 2005:516). They can be distributed in a variety of patterns. Ring porous wood is when the

vessels are arranged in distinct rings associated with growth rings with spaces void of vessels in between. Semi-ring porous wood has vessels throughout, except there is a size distinction between early wood vessels and late wood vessels, which alternate between seasons. Diffuse porous wood has vessels distributed relatively uniform throughout (Hoadly 1990:10; see also Pearsall 2010). The density of vessels is usually described as dense, moderate, and sparse. Vessels can also be arranged in particular patterns. Some species have primarily solitary vessels, paired vessels (Figure 6.1), or clustered vessels. Some vessels occur in radial (vertical) chains of two, three, four (Figure 6.1), five, etc. Tangential chains are similar, except manifest horizontally. Vessels can also be in oblique or diagonal chains (Figure 6.2). The vessels of some species have angular edges. Most wood species, however, have a combination of many of these vessel forms. For example, *Persea* sp. (avocado) has vessels that are solitary and in radial chains of two to three.

Axial parenchyma are non-lignified cells in the body of stems that have distinct patterns (Hoadly 1990:39). Apotracheal axial parenchyma are not directly associated with vessel elements. Paratracheal axial parenchyma are adjacent to and associated with vessel elements. Aliform axial parenchyma can be either apotracheal or paratracheal and form tangential wings. Confluent axial parenchyma are paratracheal and form long bands that are sometimes wavy. Diffuse axial parenchyma are apotracheal and manifest as single strands. Scanty axial parenchyma are paratracheal and do not form a complete sheath around vessel elements. Terminal axial parenchyma are apotracheal and concentrate at the boundary of growth rings. Unilateral axial parenchyma are paratracheal, but do not form a complete sheath around vessels, rather they form a hood over one side of a vessel. Vasicentric axial parenchyma forms a complete sheath around vessel elements. Axial parenchyma can also be banded, forming

horizontal lines, and can be various widths and be either apotracheal or paratracheal (Figure 6.3). Axial parenchyma can also form a reticulate pattern, in which they form bands that are the same width as rays and manifest in a basket-like pattern (see Hoadly 1990; Mauseth 1988; Raven et al. 2005). Like with the vessels, wood can have multiple forms of axial parenchyma. For example, some species of Legumes have paratracheal axial parenchyma that is aliform to confluent, in which case the axial parenchyma cells are associated with the vessels and form tangential wings that converge into confluent bands.

Rays are parenchyma cells distributed in radial, vertical patterns when examining wood in cross section (Hoadly 1990:8). In mature specimens, they tend to form parallel vertical lines (Figure 6.4). In immature specimens/small branches, they appear as if radiating outward from a central point (Figure 6.5). Another easy way to identify immature wood is whether or not a pith is present. A pith is the spongy core of young branches (Mauseth 1988) (Figure 6.6). Rays can be exclusively uni-seriate (one cell wide), bi-seriate (two cells wide) (Figure 6.3), multi-seriate (one to three cells wide, four to six cells wide, or six to ten cells wide). Alternatively, rays can also be aggregated in groups of two or more. The spacing between rays and relative abundance can also be informative in identifications. Additionally, sometimes charred wood will split and fissure along its rays, depending on the temperature and moisture content of the wood (Pearsall 2010) (Figure 6.6).

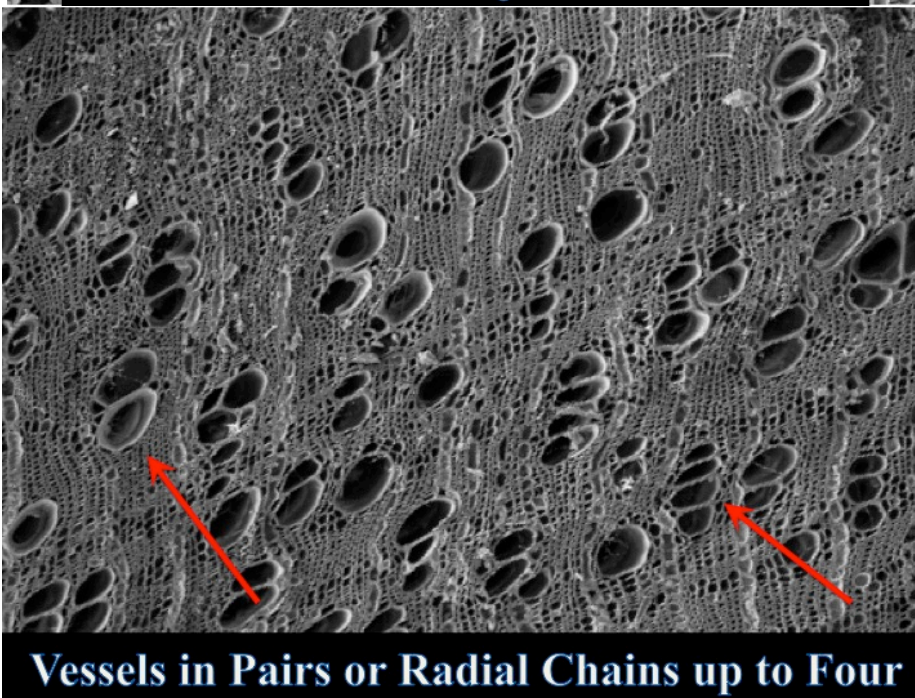
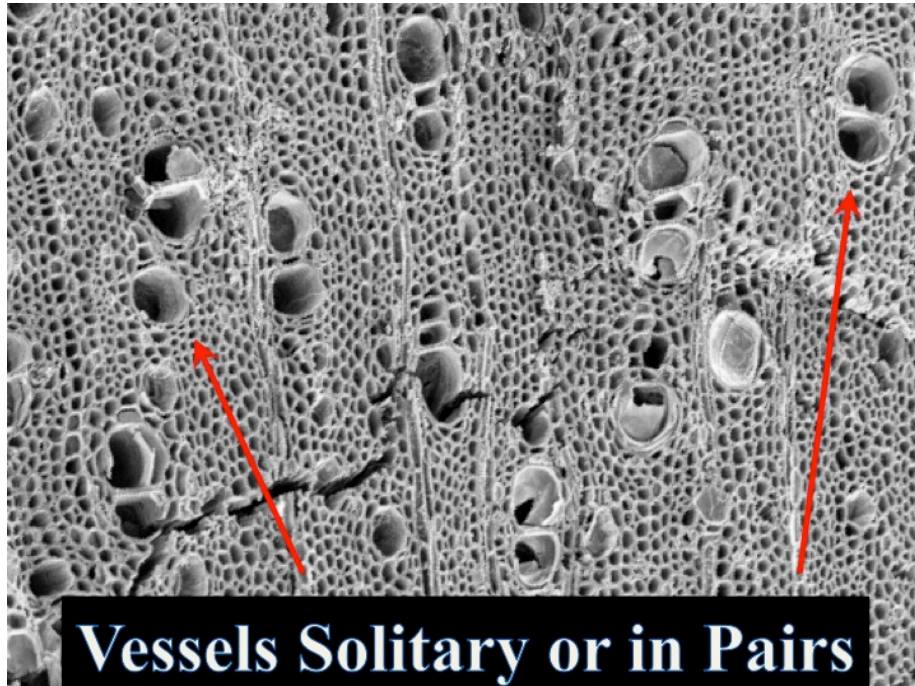


Figure 6.1: Types of vessels.

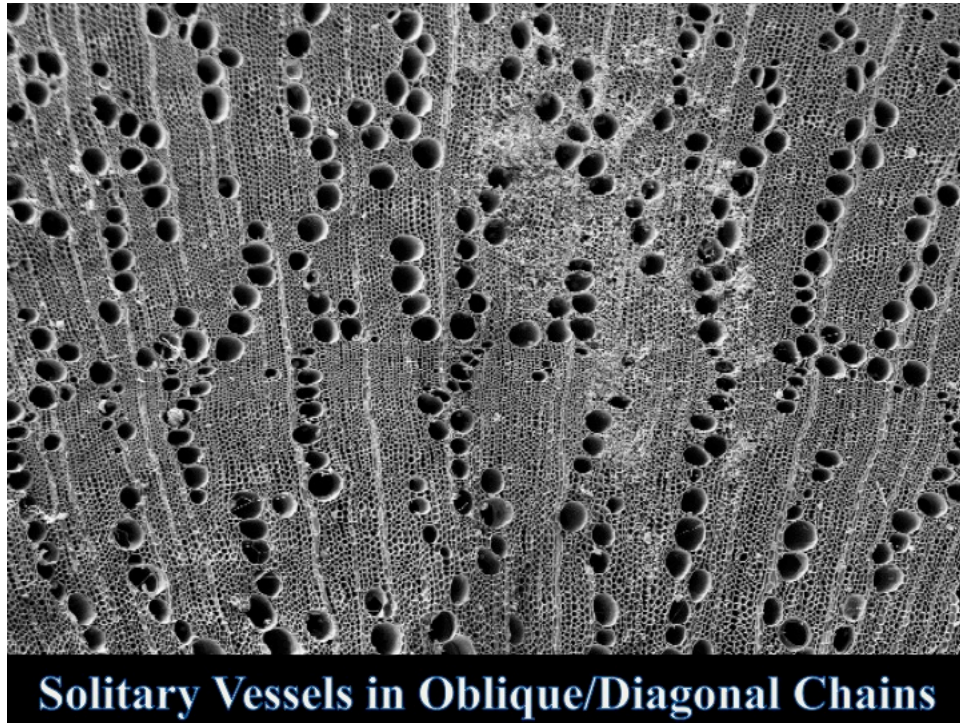


Figure 6.2: Oblique radial chains.

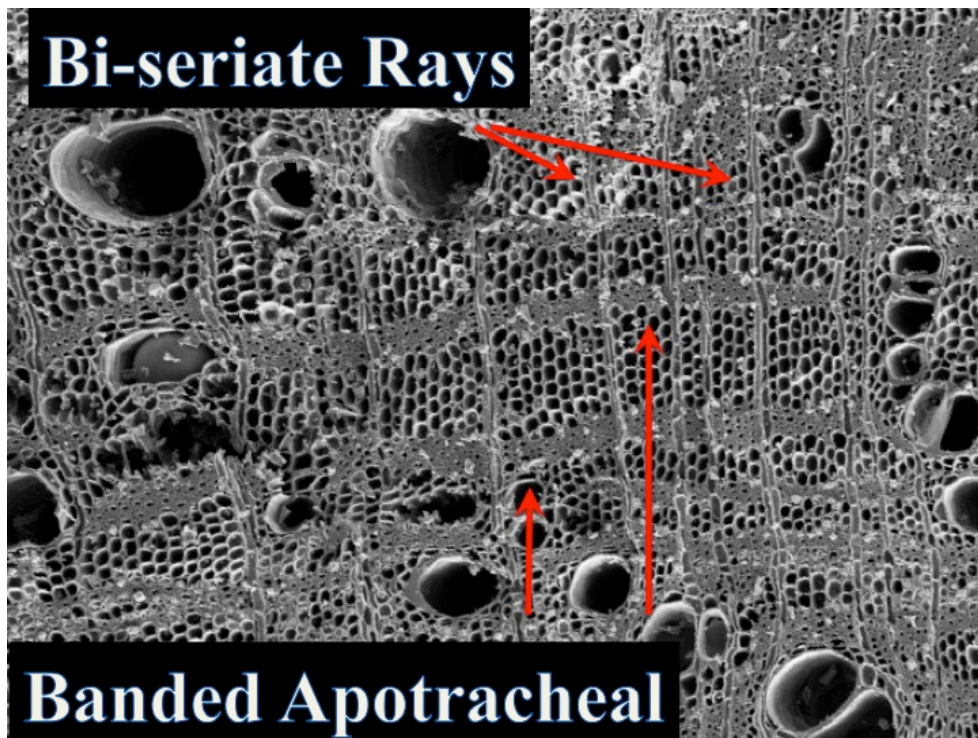


Figure 6.3: Example of axial parenchyma and rays.

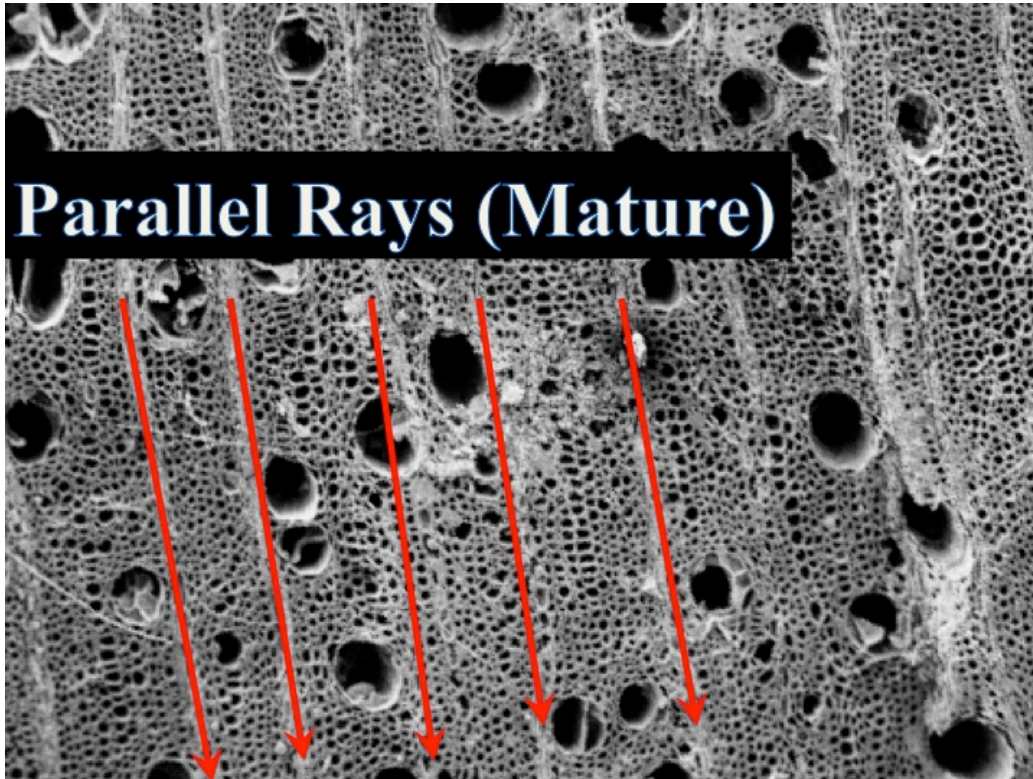


Figure 6.4: Rays from a mature wood specimen.

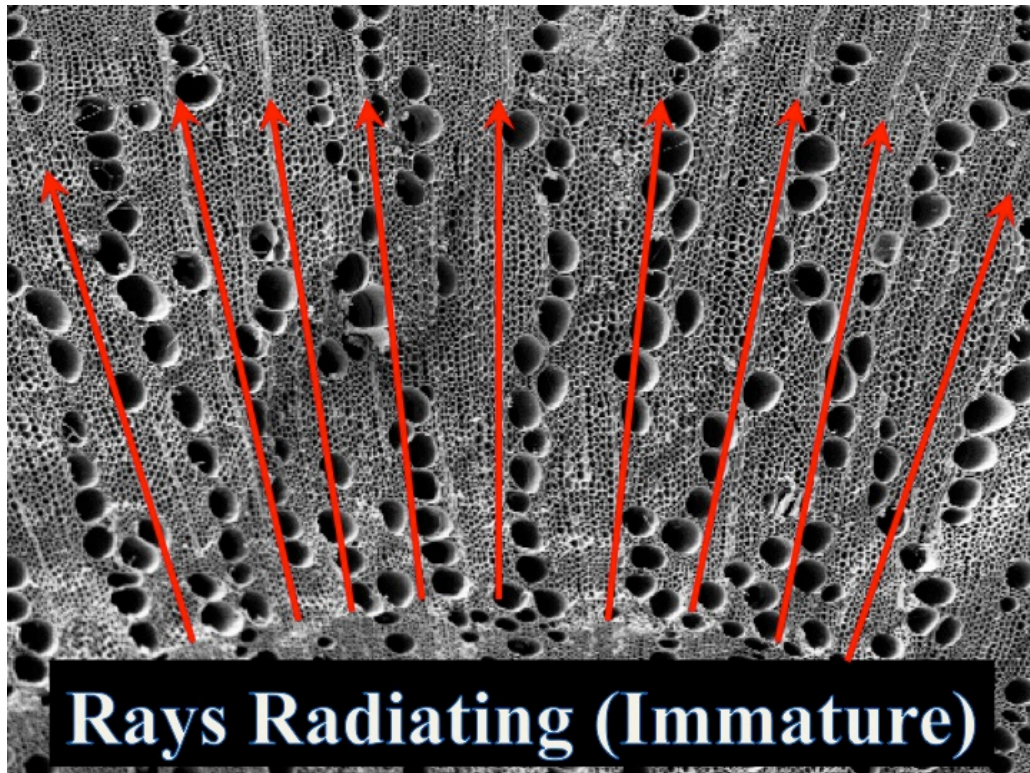


Figure 6.5: Rays of an immature branch.

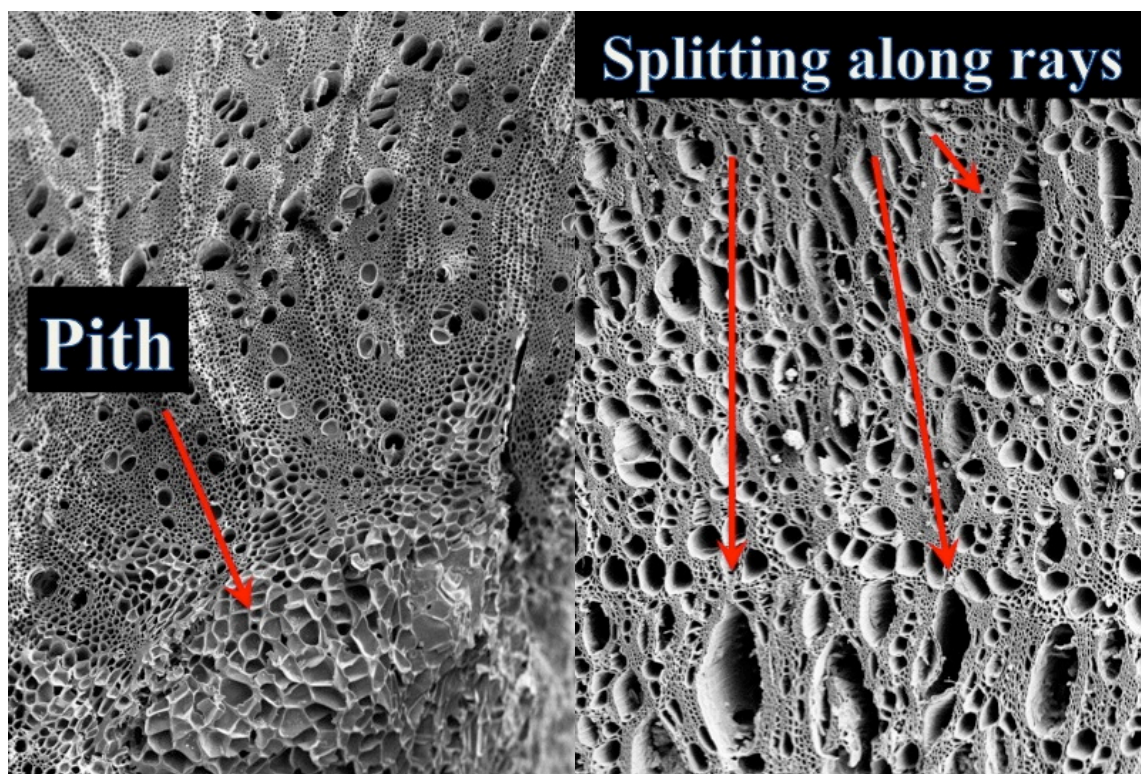


Figure 6.6: Left: Branch with pith. Right: Charred wood that has fissured along the rays.

Other characteristics can help identify wood species, such as tyloses. Tyloses are parenchyma cells that have infiltrated vessels and formed a seal and have a distinctive iridescence or sparkle (Hoadly 1990) (Figure 6.7). Some species have more pronounced tyloses, while they are more common in others. Charcoal can also be examined in three different sections: transverse, tangential, and radial. Transverse section is cross-section, and is the most common method for examining and identifying wood. Tangential and radial sections are used mainly for studying ray length and depth and require higher levels of magnification.

Gymnosperms were identified by a lack of vessels and the presence of resin ducts (Figure 6.8); since there are only two species of gymnosperm native to the Maya area, both being species of Pine, all gymnosperms are identified as *Pinus* sp. Due to a high biodiversity and the variability of angiosperms in the Maya area, these can often only be identified to genus, family,

or often just as either monocotyledon or dicotyledon. Identification of specific species was made when possible. Only carbonized specimens were included in the archaeological assemblage and non-carbonized seeds were determined to be a result of animal deposition.

In addition to low intensity microscopy, 40 of the 67 total samples were subjected to high-powered scanning electron microscopy to aid in identification. The SEM was performed by Dr. Robert Simmons in the Biology Department at Georgia State University and was funded by a Sigma Xi Grants-in-aid-of-Research grant. Each of the 40 samples was scanned in transverse, tangential, and longitudinal sections and photographed at varying degrees of magnification (between 75 and 250 magnification).

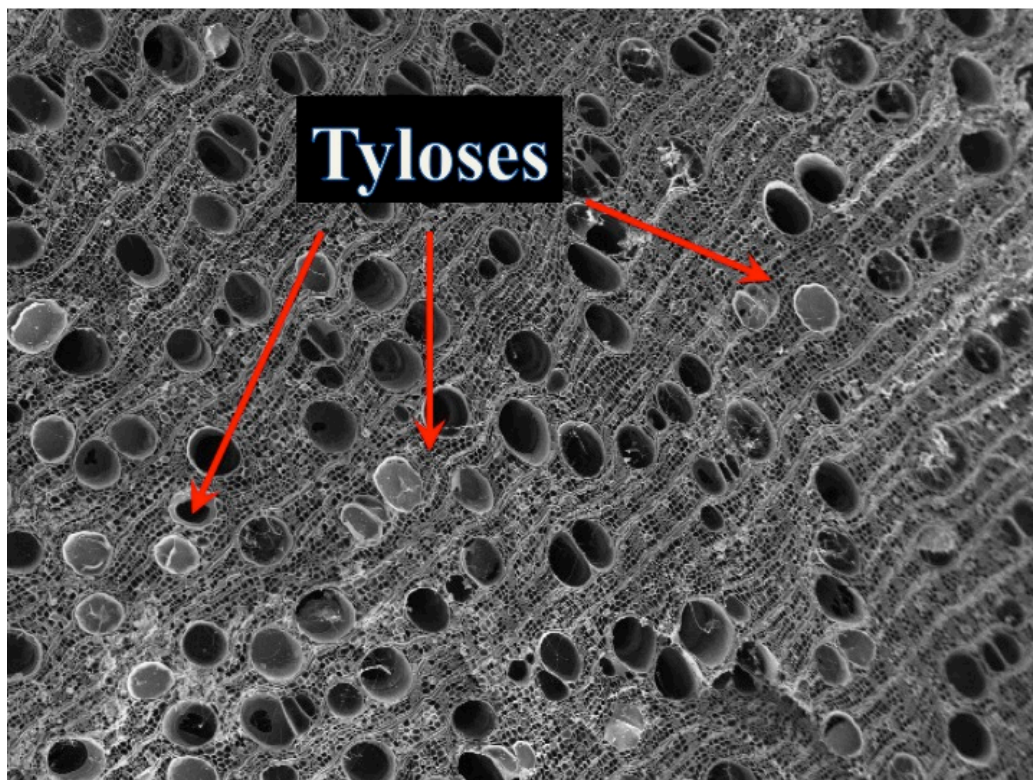


Figure 6.7: Example of tyloses.



Figure 6.8: *Pinus* sp. specimen x75 (10003-002) showing a lack of vessels and the presence of resin ducts.

Wood charcoal specimens were identified using a variety of reference materials (see Hoadly 1990; Jacquet 1983; Kribs 1968; Miles 1978) and the online database Inside Wood, which is managed by North Carolina State University (Inside Wood 2004; Wheeler 2011). Inside Wood is a valuable database that is free and open to the public that provides researchers with high quality images of wood micrographs. Wood is searchable by the cellular characteristics discussed above, in addition to more detailed characteristics. Images are also searchable by genus, family, or species. While images cannot replace the value of a comparative collection, it is nonetheless a very useful tool for individuals who may not have access to physical collections, and emphasizes the utility in digitizing these collections for public access.

During analysis, the possible maturity of specimens was determined by examining the density and distribution of the rays. Specimens were ranked in one of three categories: 1) Mature, 2) Immature/Small Branch, or 3) Indeterminate. Maturity estimates were made conservatively and samples were classified as immature only if they could be identified positively as a small branch, displaying characteristics such as rays fanning out from a central point and/or the existence of a pith. Mature wood was classified based on relatively parallel rays and specimens that could not be clearly identified as a branch. Samples were deemed Indeterminate if they had undergone extensive warping or were poorly preserved, and no definitive age estimate could be made.

6.2 Data

A lack of chronological data and a lack of subsurface artifacts limits the analysis to the Late Classic period, which is the most representative period of activity based upon ceramic assemblages in the caves. Most wood specimens were identified to genus or botanical family and very few were identified to species. Some wood specimens were too poorly preserved or too fragmentary to identify beyond angiosperm dicot. Due to the different methods of sampling from each site, a variety of analyses were applied to the data. The archaeobotanical assemblages are compared using ubiquity analyses and standardized weight measurements. Some sites yielded so little charcoal that weight analyses would not have been informative. Additionally, some sites were only sampled once, and therefore were not compared based on ubiquity.

Pine versus angiosperm charcoal, mature versus immature charcoal, and the distribution of genera were the primary standards of comparison. Since pine is a socially and geographically restricted resource, its distribution in archaeobotanical assemblages can provide insights into

social, economic, and political networks of the upper Belize River valley. By grouping angiosperms into one category of comparison as local species, it allows for comparisons to be made even with charcoal that was not identified. The level of development of specimens may be useful for determining resource availability or function in a cultural capacity. Individual genera can be used to discern culturally meaningful patterns in plant use (Morehart 2011:44).

Ubiquity analyses look at the number of samples that a taxon is present in out of all samples and are given as the percentage of samples that a taxon is present in (Popper 1988:61). The number of samples taken and/or units excavated are used as a unit of analysis. Weight measurements compare the weight in grams of the total carbonized wood charcoal in a sample versus that of a particular taxon. Only flotation samples were used and macrofossils (recovered during excavation) were excluded from the weight analyses. Analyses of the weight and ubiquity distribution of mature, immature, and indeterminate maturity specimens were made to infer behavioral data. Ubiquity analyses were also employed, to determine whether or not there was a detectable spatial distribution to mature and immature wood. Indeterminate maturity wood was included in these analyses because of the significant amount of charcoal that could not be positively identified.

Soil samples collected during the 2012 field season were standardized at one-liter. However, they are compared with excavated units to analyze charcoal distributions across the entire site. Additionally, samples from Actun Lak, Nohoch Tunich, Xtuyul, and Subuul were taken by Jon Spenard during the 2011 season. These samples were not standardized, as the majority of ash or burn features encountered during excavation was collected. The differential sampling strategies and quantities limit the interpretations of the data, but I feel as if the archaeobotanical assemblage can still provide useful insights into patterns of plant use across

sites. This is why multiple analyses have been conducted and are considered. Inferences are made tentatively, and further archaeological investigations are recommended, especially considering the limited sample size. However, it is my hope that the knowledge gained from this project can still provide useful insights and comparisons that can contribute to future studies.

6.2.1 *Intrasite Analysis*

The archaeobotanical analysis from each individual site is discussed below. This section discusses the results from each site separate from the others. This allows an analysis of each botanical assemblage and single site. The analysis and results of all nine sites as a whole are discussed in the next section.

6.2.1.1 *Nohoch Tunich*

During the 2011 field season, five 1 x 1m units and two 0.5 x 1 m extension units were excavated in Nohoch Tunich Rockshelter (Spenard 2012). Excavations indicated that only the southern section of the rockshelter was heavily utilized. Ceramics, chert flakes, and jute shells were frequently encountered as well as slate, clam shells, two bi-face fragments, and ashy features containing charcoal and resin that were collected for flotation. Two areas of the rockshelter appeared to have been focal points of ritual activity: a bedrock bench and an alcove in the southern section of the rockshelter (Spenard 2012:162-164). In total, six samples were analyzed from these excavations, the results of which are presented in Table 6.1.

Wood charcoal was the most abundant macrobotanical remain recovered from the rockshelter. One pit fragment from a member of the cashew family, Anacardiaceae, was also recovered (*Spondias* sp.), as well as a small amount of carbonized resin. Pine (*Pinus* sp.) was the

most ubiquitous wood recovered, present 100% of the samples (Figure 6.11). However, when compared by weight (in grams) with angiosperms, there is a relatively even distribution between the two types (Figure 6.10).

Angiosperms in the sample included one specimen identified as a member of the Rubiaceae family, Caribbean Princewood (*Exostema caribaeum*) (Figure 6.9). The specimen is diffuse-porous with small vessels between 20 and 40 μm . Vessels are mostly solitary with some radial chains of two to four. Growth ring boundaries are indistinct or absent. Rays are multi-seriate and two to four cells wide. Axial parenchyma is scanty paratracheal. A majority of angiosperms were very small and fragmentary and could not be identified further.

A majority of the pine wood was classified as mature wood, and some specimens were indeterminate. Angiosperms were more heterogeneous in the distribution of mature and immature wood. Overall, mature wood specimens were the most represented in the sample (Figure 6.12). Mature wood charcoal was also present in 100% of the samples, while immature wood charcoal or branches were present in less than 20% of the samples (Figure 6.13). However, 50% of samples contained wood charcoal of indeterminate maturity.



Figure 6.9: *Exostema caribaeum* x215 from Actun Nohoch Tunich (10035-001).

Table 6.1: Archaeobotanical remains from Nohoch Tunich Rockshelter. U = Unit, L = Level, F = Feature, S = Sample, * = uncarbonized.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
U3 L2	<i>Pinus</i> sp.	Charcoal	1	-	Mature	10033
	Dicot	Charcoal	>.1	-	Indet.	
	Indet.	Charcoal	>.1	-	Indet.	
	Unknown	Resin	>.1	-	-	
U3 L3	<i>Pinus</i> sp.	Charcoal	.15	-	Mature	10034
U3/5 L1 F1	<i>Exostema caribaeum</i>	Charcoal	.1	-	Immature	10035
	<i>Pinus</i> sp.	Charcoal	.15	-	Mature	
	Dicot	Charcoal	.06	-	Indet.	
	Unknown*	Seed		1	-	
	Indet.	Charcoal	>.1	-	Indet.	
U3/5 L4 F2 S1	Dicot	Charcoal	.2	-	Mature	10036
	<i>Pinus</i> sp.	Charcoal	.22	-	Mature	
U3/5 L4 F2 S2	<i>Pinus</i> sp.	Charcoal	.5	-	Mature	10037
U7 L1	Dicot	Charcoal	1.45	-	Mature	10038
	<i>Pinus</i> sp.	Charcoal	.001	-	Indet.	
	Unknown	Stem		1	-	
	<i>Spondias</i> sp.	Pit Fragment		1	-	
	Indet.	Charcoal	.02	-	Indet.	

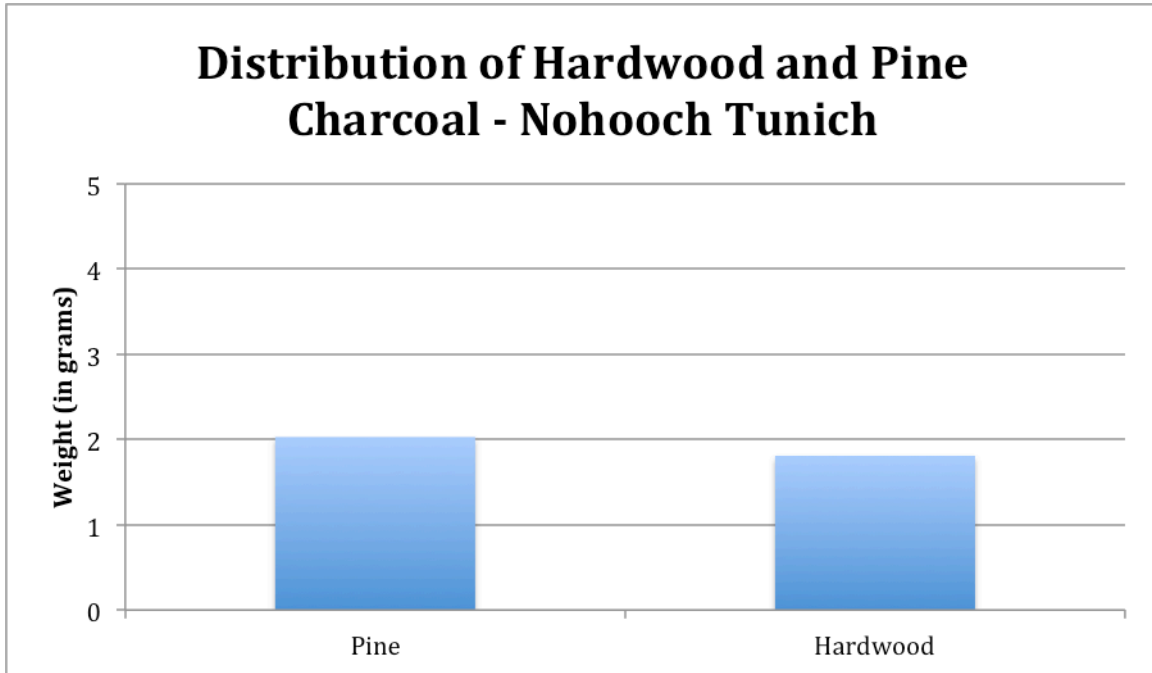


Figure 6.10: Distribution of Pine and angiosperms (hardwoods) based on weight.

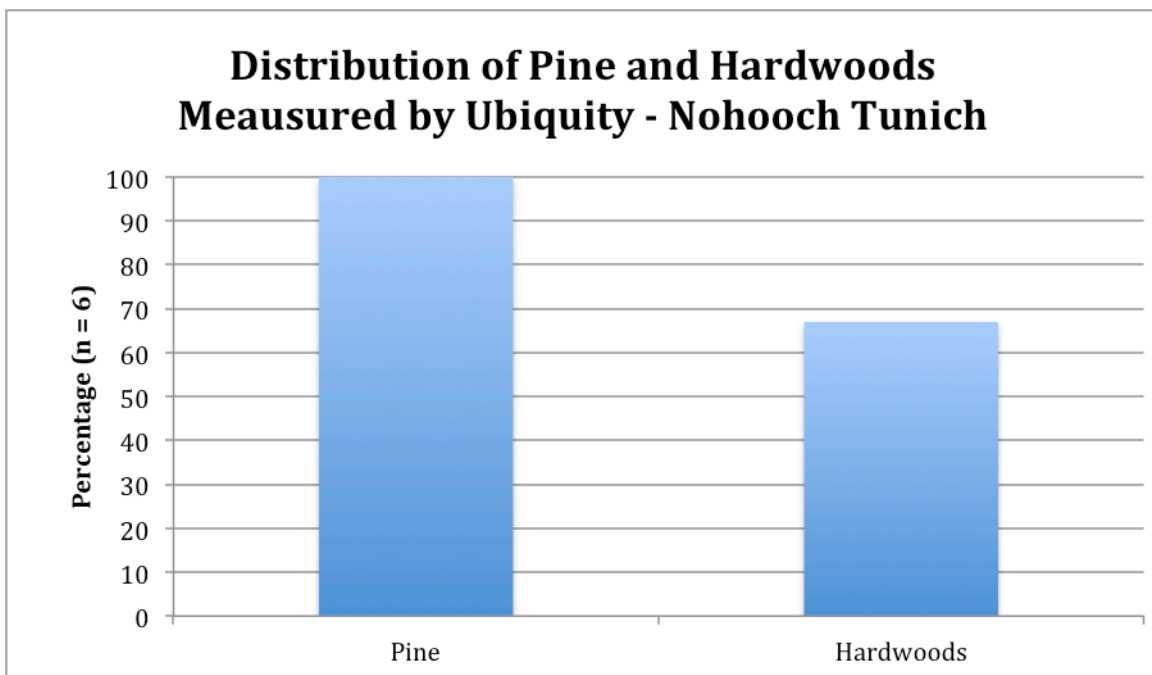


Figure 6.11: Distribution of pine and angiosperms based on ubiquity.

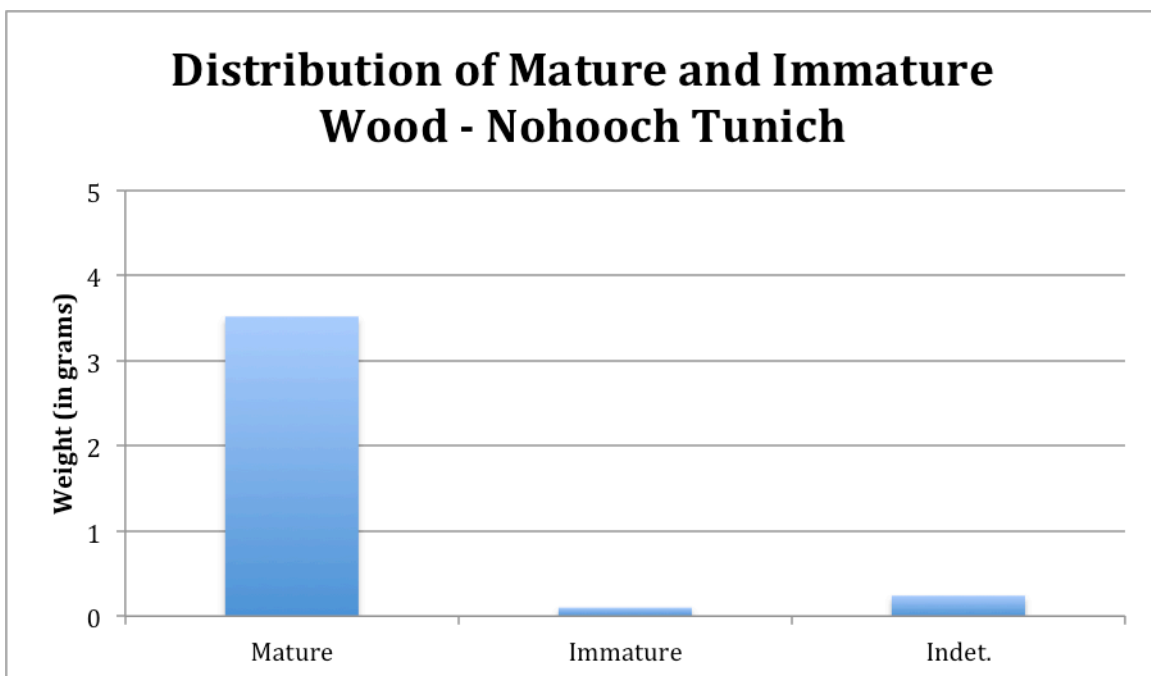


Figure 6.12: Distribution of mature, immature, and indeterminate maturity wood measured by weight.

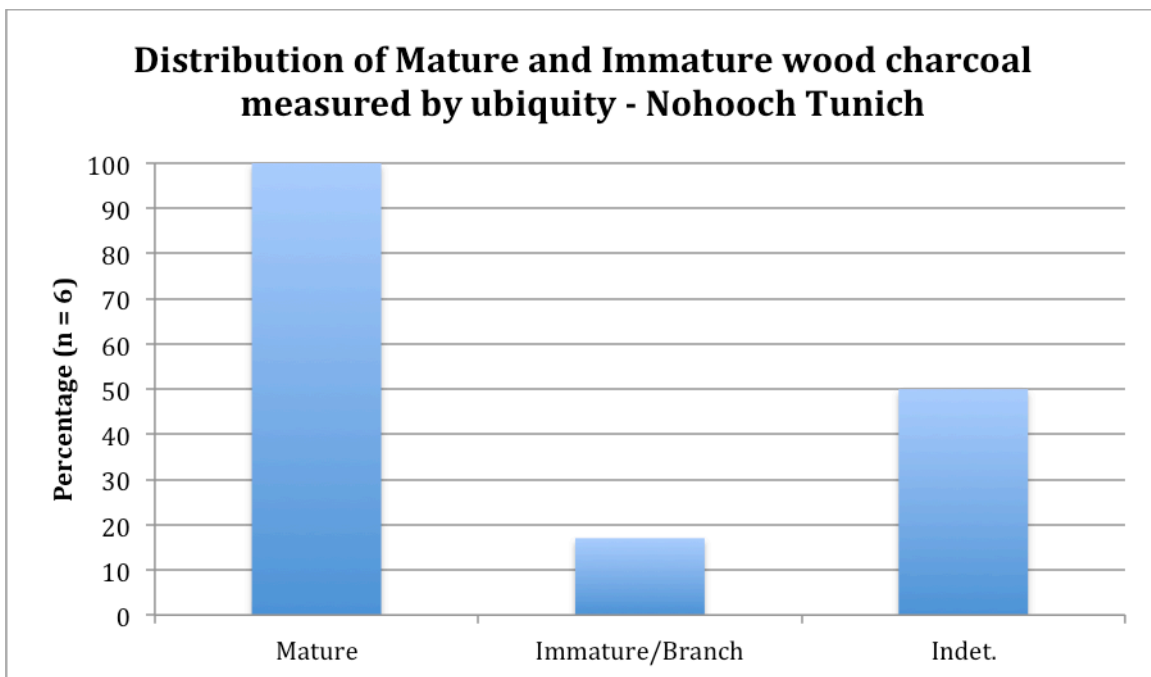


Figure 6.13: Ubiquity analysis of wood maturity.

6.2.1.2 *Actun Subuul*

In 2011, two 1 x 1 m excavation units were placed in the undercut of Actun Subuul, one partially outside of the drip line (Spenard 2012:167-168). Artifacts recovered included ceramics, jute, slate, and one mano. In the northern portion of Unit 1, an ashy deposit rested above a dense concentration of ceramics and jute. A single flotation sample was taken from this matrix.

Evidence of activity at Actun Subuul indicates that the Maya ascribed ideological significance to a wide range of karst features.

The flotation sample from Actun Subuul recovered only a single, small piece of charcoal. This charcoal fragment was identified as an angiosperm dicot, but no further identifications could be made due to the size. This likely indicates that while certain karst features, such as the boulder that makes up Actun Subuul, were utilized at various points in time, they were not as heavily used as other karst features. These features may also have been treated as small forest shrines. Given Actun Subuul's location next to a walking path, though, it is probable that the context was highly disturbed.

Unfortunately, further investigations are no longer feasible, as during the 2012 field season it was discovered that the landowner had bulldozed much of the area surrounding the Nohoch Tunich Rockshelter Complex, and the Actun Subuul overhang was completely destroyed (see Spenard 2013a). Several other karst features were severely damaged or buried under rubble. This action was taken with good intentions, as the landowner was intending to clear the area to build a guard station to protect Actun Lak, which is located further down the trail, and did not understand the cultural and archaeological significance of the rockshelters, believing them to be nothing more than ancient hunting camps (Spenard 2013a:49). This incident will serve as a

future reminder to PRAP staff of the necessity for open communication between the project and the public.

6.2.1.3 *Actun Xtuyul*

Spenard (see Spenard 2012) placed two excavation units into Actun Xtuyul rockshelter. Unit 1 was located against the back wall in the hopes of recovering other fragments of the previously discussed pottery mold, and Unit 2 at the southeast corner of Unit 1. A feature of ash and charcoal was collected from Unit 1, Level 1 for flotation. Very few other artifacts were recovered during excavation, but included small amounts of sherds and a possible chert flake (Spenard 2012:165).

The results of the analysis of the ash feature are presented in Table 6.2. Wood charcoal was the most ubiquitous archaeobotanical remain recovered. Angiosperms outweighed pine in weight by grams (Figure 6.15). However, some of the wood charcoal displayed severe warping and poor preservation, which made identification difficult or impossible with some specimens. Some small angiosperm dicot branches were well preserved, as well as a pine branch. Some species identified in the botanical assemblage were, a member of the Sapindaceae family (*Allophylus* sp.), Mexican Alvaradoa (*Alvaradoa amorphoides*), fig (*Ficus* sp.), and *Bertiera guianensis* (Rubiaceae family) (Figure 6.14). Additionally, a single *Oxalis* sp. seed was recovered, as well as three unidentified seeds of the same species. All of the seeds were carbonized, suggesting that they were included in the burning event that produced the wood charcoal, though they may have been deposited naturally prior to the burning even (see Morehart 2011). The Oxalidaceae family contains several herbaceous shrubs, including wood sorrels, which can be used for food or medicine (Javier Mai, personal communication, 2010).

The *Alvaradoa amorphoides* wood is diffuse porous. Growth rings are absent, however the wood appears divided due to the presence of terminal parenchyma. Vessels are dense, between 30 and 60 μm wide, and in long diagonal and radial patterns. Rays are multi-seriate and one to three cells wide. Axial parenchyma are apotracheal and diffuse. The *Ficus* sp. specimen is diffuse porous with large vessels (between 150 and 220 μm) that are distributed unevenly. Vessels are primarily solitary, with infrequent pairs and clusters. Rays are exclusively uniseriate. The axial parenchyma are paratracheal banded. The *Allophylus* sp. specimen is diffuse porous with some solitary vessels, but mostly radial chains between two and three. Vessels are small, between 50 and 100 μm and moderately distributed. Rays are uniseriate and axial parenchyma are apotracheal banded. The *Berberia guianensis* wood has mostly singular vessels and some pairs. The vessel walls have angular edges and the wood is diffuse porous. The vessels are between 20 and 40 μm and the rays are one to three cells wide. Tyloses are present but not common and the axial parenchyma are diffuse.

The distribution of mature and immature wood in Actun Xtuyul (Figure 6.16) demonstrates an abundance of immature wood when compared with mature. However, identifications of immature wood charcoal were facilitated by the presence of well-preserved branch fragments in the sample. Additionally, some specimen ages were indeterminate due to poor preservation. Because only a single sample was taken from the rockshelter, no ubiquity analyses were necessary.

Table 6.2: Archaeobotanical remains from Actun Xtuyul. U - Unit, L = Level

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
U1 L1	<i>Allophylus</i> sp.	Charcoal	.42	-	Immature	10023
	<i>Pinus</i> sp.	Charcoal	1	-	Immature	
	<i>Pinus</i> sp.	Charcoal	.31	-	Mature	
	Dicot	Charcoal	.2	-	Indet.	
	<i>Bertiera guianensis</i>	Charcoal	>.1	-	Immature	
	Dicot	Charcoal	.82	-	Indet.	
	<i>Alvaradoa amorphoides</i>	Charcoal	.67	-	Immature	
	<i>Ficus</i> sp.	Charcoal	.3	-	Immature	
	Indet.	Charcoal	.1	-	Mature	
	Unknown	Seed	-	3	Indet.	
	<i>Oxalis</i> sp.	Seed	-	1	-	

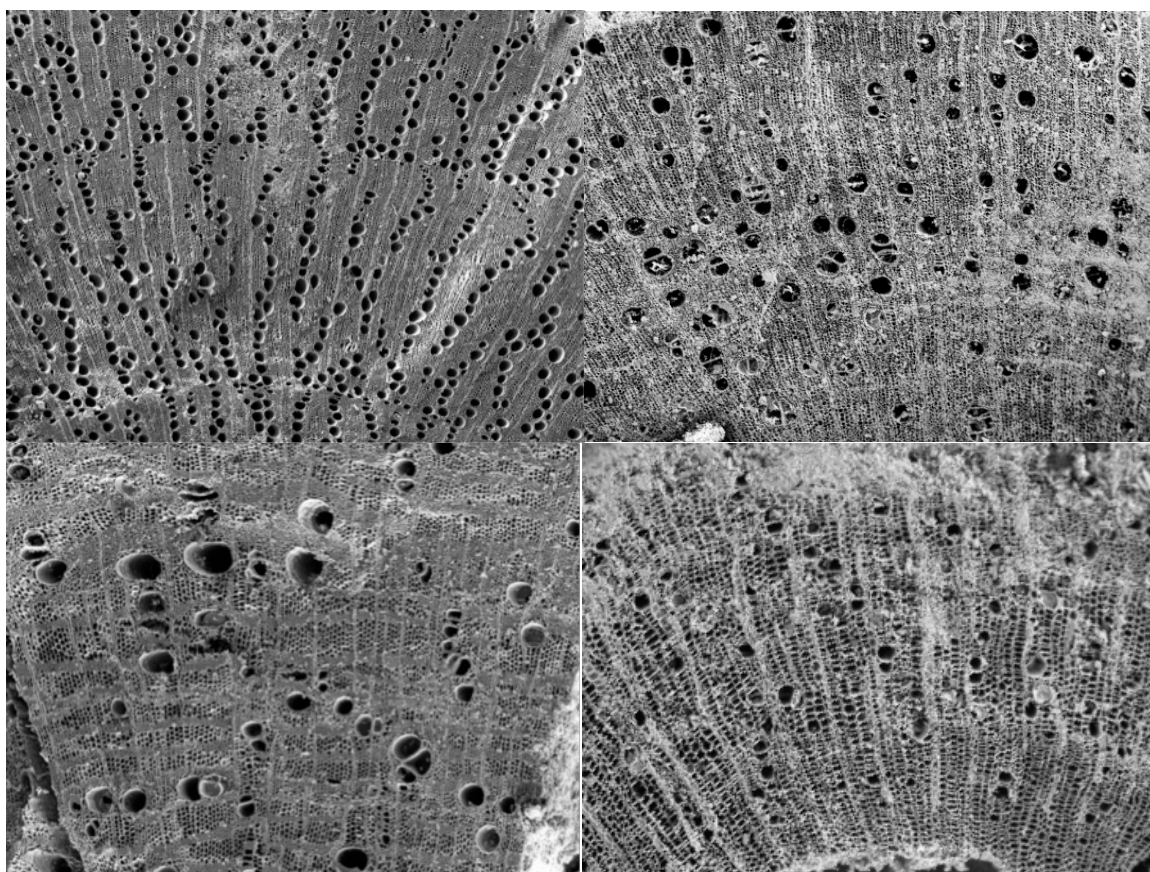


Figure 6.14: Wood charcoal from Actun Xtuyul. *Alvaradoa amorphoides* x100 (top left; 10023-007), *Allophylus* sp. x100 (top right; 10023-001), *Ficus* sp. (bottom left; 10023-009), *Bertiera guianensis* x100 (bottom right, 10023-005).

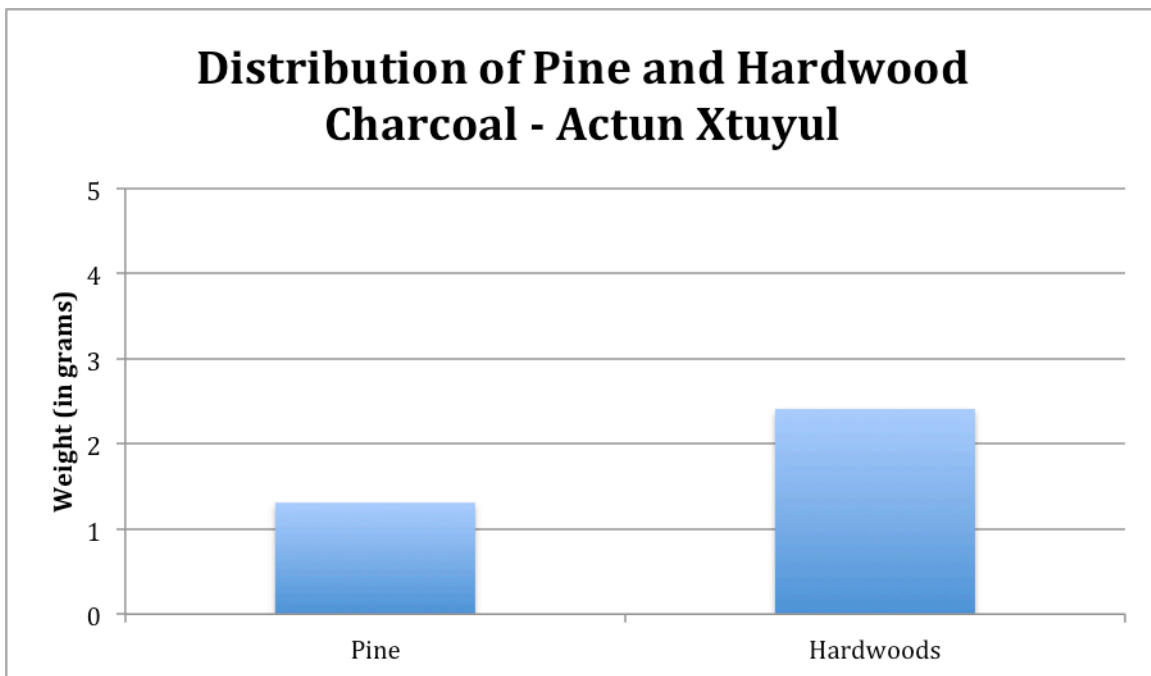


Figure 6.15: Distribution of pine and angiosperm charcoal.

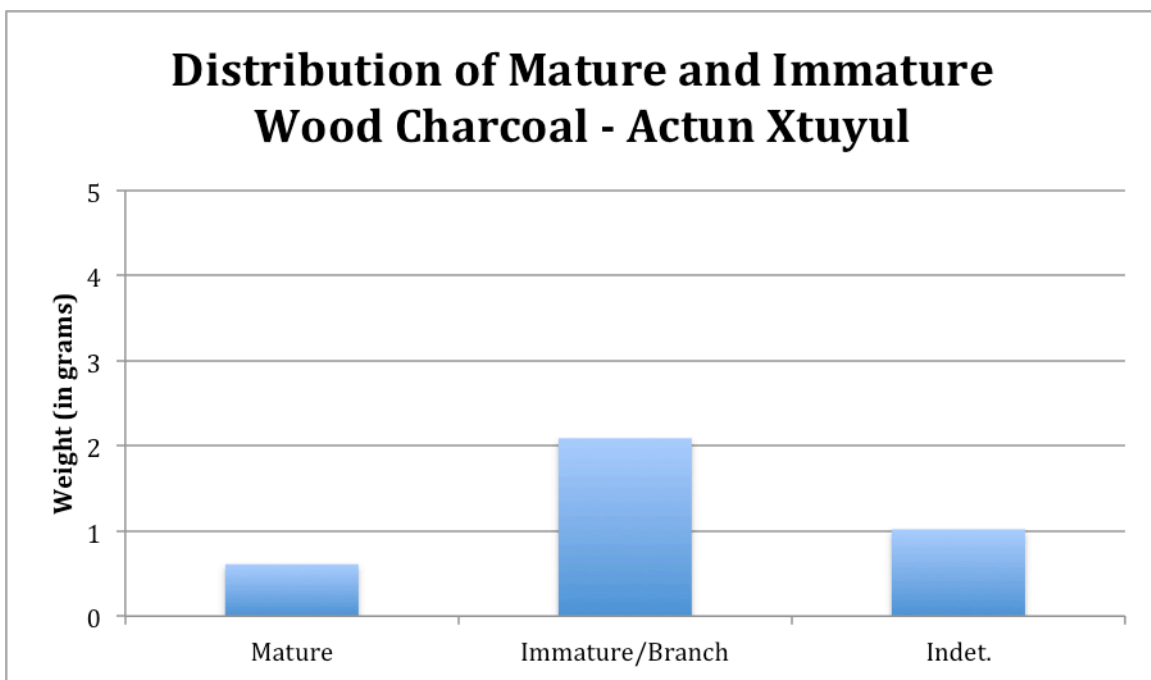


Figure 6.16: Maturity distribution of charcoal specimens from Actun Xtuyul.

6.2.1.4 *Actun Merech*

During the 2010 investigations Valdez et al. (2011) placed two 0.5m x 0.5m units in Actun Merech, one at the entrance and one in the rear room of the cave. All of the soil was removed from the cave and wet screened using 1/8-inch mesh screen. Unit 1, placed in the entrance, yielded ceramic sherds, jute, and lithic flakes (Valdez et al. 2011:27). Unit 2, in the rear chamber, yielded ceramic sherds and a single human incisor (Valdez et al. 2011:28); however no other human remains have been recovered from the cave to date. Spenard (2012) revisited Actun Merech in 2011 in order to explore the two chutes at the back of the cave and record artifacts and other cultural features, but no further excavations occurred.

During the 2012 field season, the cave site was chosen for soil sampling in the hopes of recovering paleoethnobotanical data (Parker 2013). Four 1-litre soil samples (labeled A-D) were taken for flotation (Figure 6.17). No further excavations or sampling took place because three of the four samples were sterile. Only Soil Sample D yielded a limited quantity of archaeobotanical remains, the results of which are presented in Table 6.3. Uncarbonized Trumpet tree (*Cecropia peltata*) seeds and one unidentified seed were recovered, indicating faunal activity.

Very small fragments of Pine (*Pinus* sp.) were recovered, as well as one species of angiosperm dicot (Sapotaceae family). The pine specimens were mature specimens, while the angiosperm was harvested from a younger tree. All three sterile samples were taken from the very back chamber of Actun Merech, while Soil Sample D was taken from an alcove in Room D. Room D is the chamber with horizontal ledges along the walls and the two vertical chutes in the back. Because only one sample contained archaeobotanical remains and only very small amounts of charcoal, ubiquity and weight analyses were not conducted. The Sapotaceae wood is diffuse porous in cross-section. Vessels are mostly singular with some radial chains of two to

four. Vessels are between 50 and 100 μm . Rays are multi-seriate, one to three cells wide. Axial parenchyma are apotracheal diffuse.

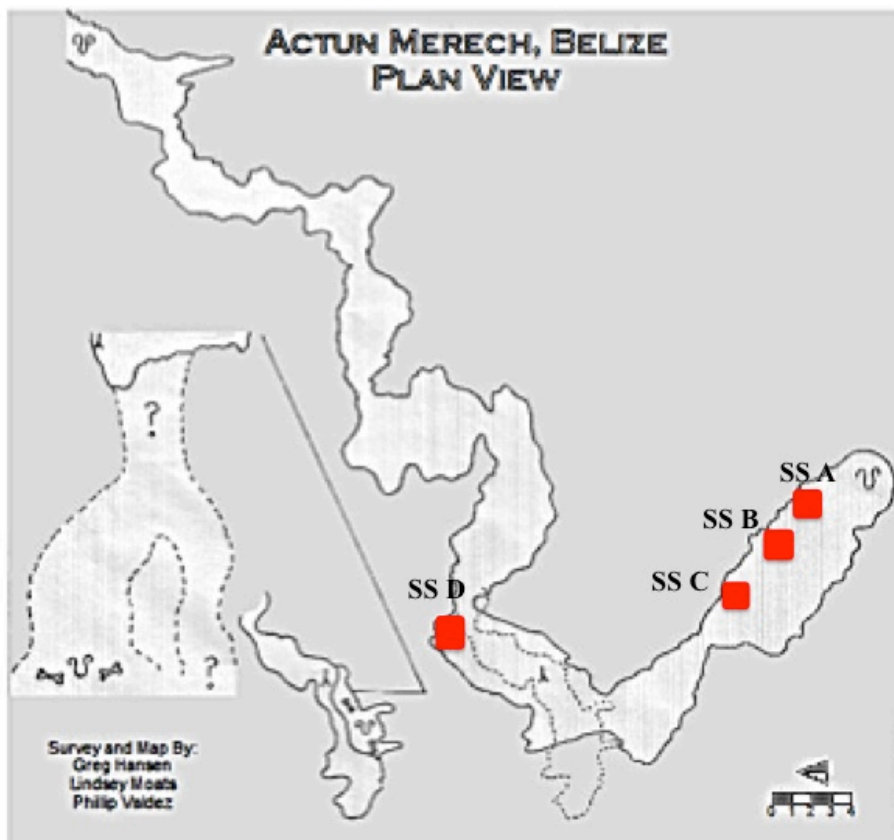


Figure 6.17: Location of soil samples taken from Actun Merech (after Powis 2010:Figure 20:29)

Table 6.3: Archaeobotanical remains from Actun Merech. SS = Soil Sample, * = uncarbonized.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
SS A	Sterile	-	-	-	-	10018
SS B	Sterile	-	-	-	-	10019
SS C	Sterile	-	-	-	-	10020
SS D	<i>Pinus</i> sp.	Charcoal	.16	-	Mature	10021
	<i>Cecropia peltata</i> *	Seed	-	18	-	
	Unknown*	Seed	-	1	-	
	Sapotaceae	Charcoal	>.1	-	Immature	

6.2.1.5 Actun Pech

Four 1-litre soil samples were taken from Actun Pech in order to determine promising locations for excavation (Figure 6.18). Afterwards, two 0.25m x 0.25m units were excavated and the soil was removed for flotation. No subsurface artifacts were recovered, however charcoal was frequently encountered. Soil samples and excavations yielded archaeobotanical remains, primarily wood charcoal, the analysis of which is presented in Table 6.4.

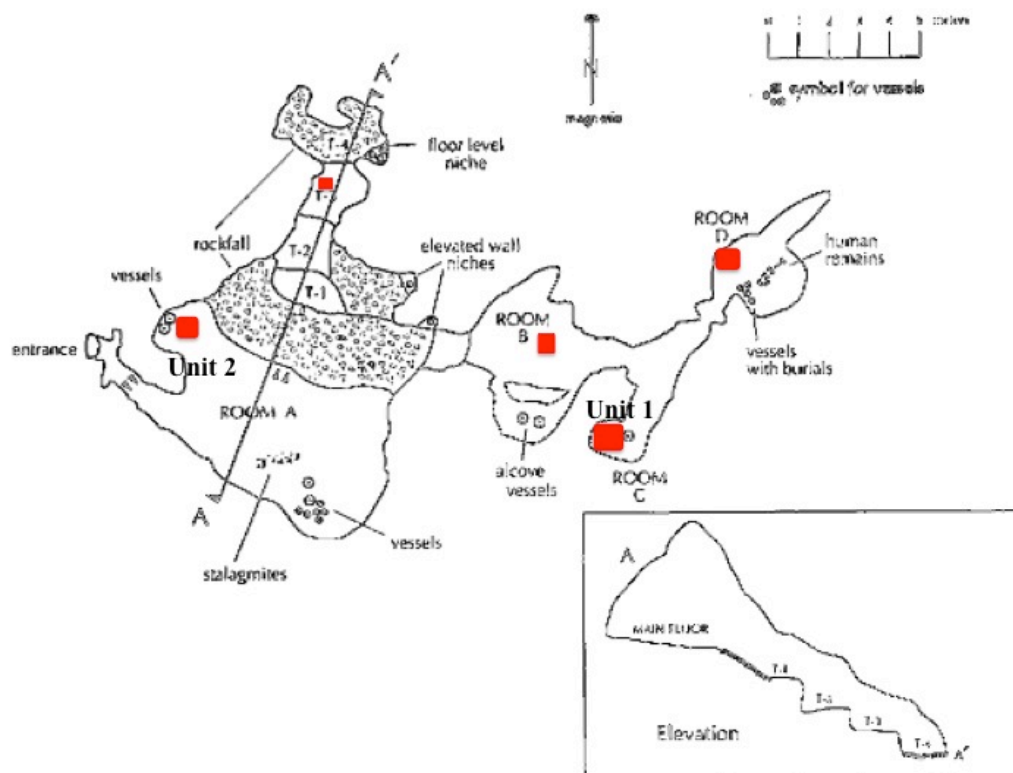


Figure 6.18: Location of soil samples and units in Actun Pech (after Healy et al. 1996:Figure 2:2).

Because wood charcoal quantities were so small in terms of weight, distribution of pine and angiosperms was determined based on ubiquity (Figure 6.19). A majority of the small, fragmentary charcoal samples could only be identified as angiosperm dicots based on the presence of vessel elements. However, more detailed identifications could not be made of many of the specimens. While pine charcoal is the most ubiquitous species present, in five of the nine

samples, angiosperm charcoal outweighs pine charcoal in grams. Specimens were either mature or of indeterminate maturity and no immature branches were recovered from any of the nine samples.

One charcoal specimen was identified as a member of the Burseraceae family (*Protium* sp.) and may represent the copal tree. Another specimen was tentatively identified as Prickly Ash (*Zanthoxylum* sp.) (Figure 6.20). *Protium* sp. is diffuse porous with mostly solitary vessels and some pairs. Vessels are between 40 and 100 μm , moderately dense, with angular outlines. Rays are uni-seriate and bi-seriate. Axial parenchyma are diffuse to scanty. The *Zanthoxylum* sp. specimen is diffuse porous with solitary vessels, however radial chains of two and three are common. Vessels are small, between 30 and 80 μm . Rays are almost exclusively uni-seriate. Axial parenchyma are both apotracheal diffuse and paratracheal scanty. There are some tyloses present as well, though not many.

Table 6.4: Archaeobotanical remains from Actun Pech. SS = Soil Sample, U = Unit, L = Level, * = uncarbonized.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
SS A	<i>Pinus</i> sp.	Charcoal	>.1	-	Mature	10024
SS B	<i>Pinus</i> sp.	Charcoal	.36	-	Mature	10025
SS C	Unknown*	Seed	-	1	-	10026
SS D	Sterile	-	-	-	-	10027
U1 L1	<i>Pinus</i> sp.	Charcoal	>.1	-	Mature	10028
	<i>Cecropia peltata</i> *	Seed	-	13	-	
	Unknown*	Seed	-	7	-	
U1 L2	<i>Pinus</i> sp.	Charcoal	>.1	-	Indet.	10029
	Unknown*	Seed		1	-	
U2 L1	<i>Protium</i> sp.	Charcoal	.5	-	Mature	10030
	cf <i>Zanthoxylum</i> sp.	Charcoal	.08	-	Indet.	
	Dicot	Charcoal	.06	-	Indet.	
U2 L2	Dicot	Charcoal	>.1	-	Indet.	10031
U2 L3	Dicot	Charcoal	>.1	-	Indet.	10032
	Dicot	Charcoal	>.1	-	Mature	
	<i>Pinus</i> sp.	Charcoal	>.1	-	Indet.	
	Indet.	Charcoal	>.1	-	Indet.	

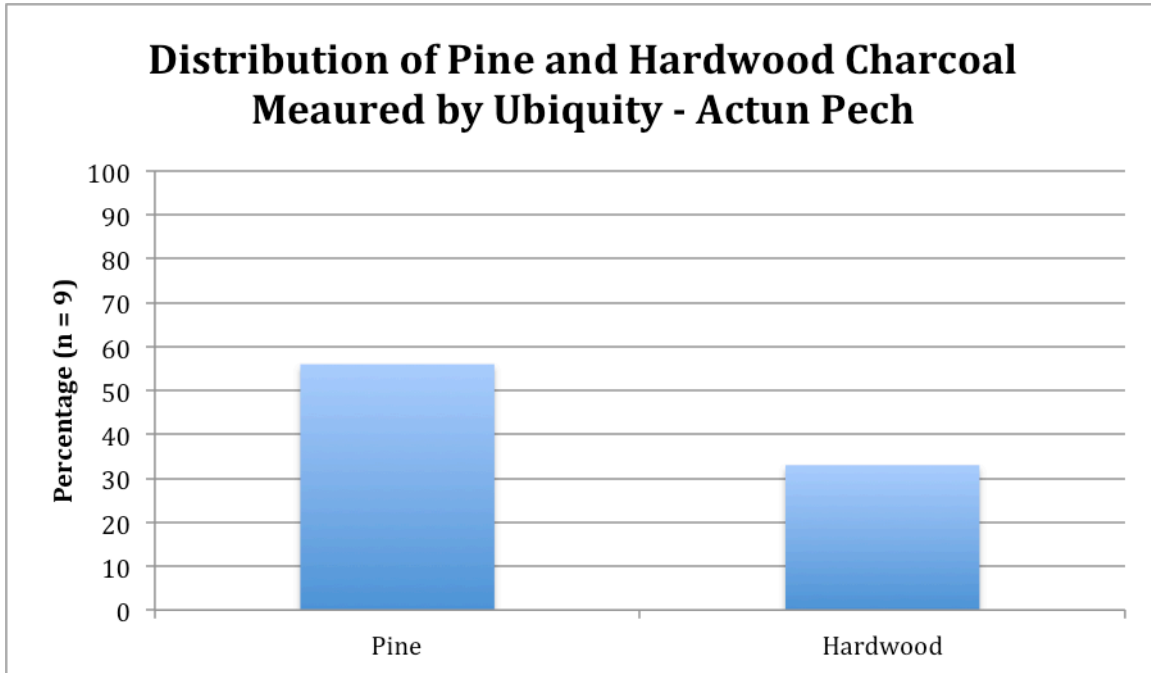


Figure 6.19: Ubiquity of pine and angiosperms

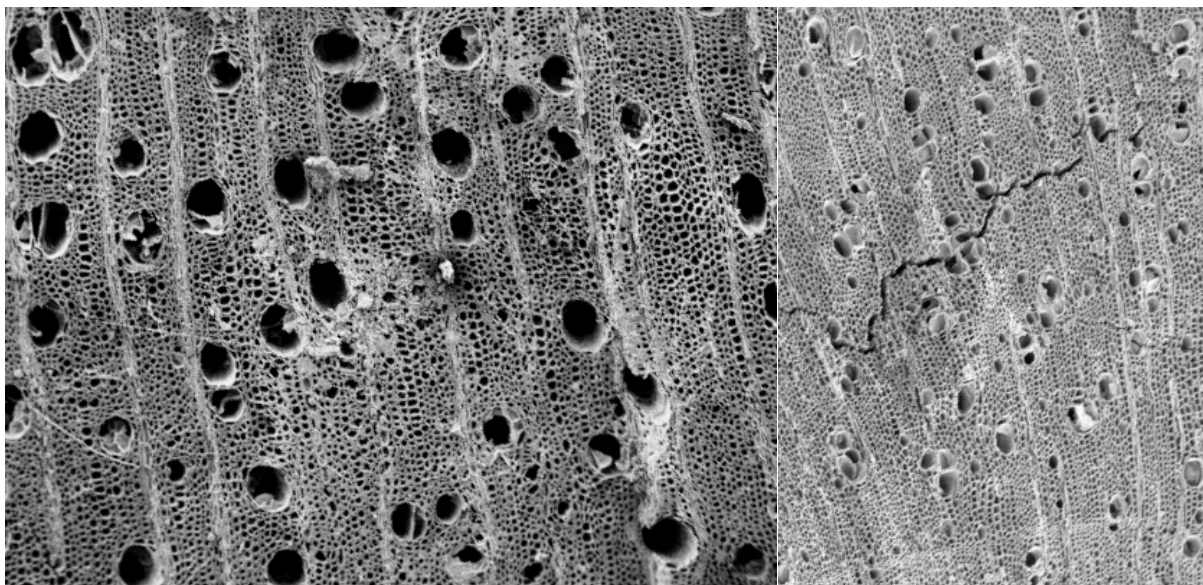


Figure 6.20: Wood charcoal samples from Actun Pech. *Protium* sp. x100 (left, 10030-001), cf *Zanthoxylum* sp. x100 (right, 10030-002).

6.2.1.6 *Crystal Palace*

During my initial visit to Crystal Palace in 2012, I collected three soil samples from small alcoves in the cave where scatters of charcoal were visible. Due to the likelihood that any surface charcoal would be modern, three 0.25m x 0.25m soil columns were excavated as well. The results of the archaeobotanical analysis are presented in Table 6.5, however the table excludes samples 10056-10067 because they were all sterile. All but one subsurface sample was sterile. Because of the small quantity of archaeobotanical remains recovered, ubiquity and weight analyses were not conducted.

Unit 1 was located in a side chamber in the back of the cave, accessed by following a path behind a series of flowstone “window” columns overlooking the main chamber, beside a scatter of large ceramic sherds. Unit 2 was located between the altar and one of the broken columns in the circular arrangement. Unit 3 was placed further back in the same chamber close to the back wall. No subsurface artifacts were recovered during excavations and flotation of the soil yielded minimal archaeobotanical remains, the majority of the samples being sterile (samples 10056-10067). Pine was the only species of wood recovered from Crystal Palace.

Table 6.5: Archaeobotanical remains from Crystal Palace. SS = Soil Sample, U = Unit, L = Level, and * = uncarbonized.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
SS A	cf Malvaceae*	Seed	-	1	-	10050
SS B	<i>Pinus</i> sp.	Charcoal	2.4	-	Mature	10051
SS C	Sterile	-	-	-	-	10052
U1 L1	<i>Pinus</i> sp.	Charcoal	.04	-	Indet.	10053
U1 L2	Sterile	-	-	-	-	10054
U1 L3	<i>Pinus</i> sp.	Charcoal	.02	-	Indet.	10055

6.2.1.7 Actun Slate

Three 0.25m x 0.25m soil sample columns were placed in Actun Slate. The results of the archaeobotanical analysis are presented in Table 6.6 below. The units in Actun Slate contained a diversity of wood varieties. Unit 1, located in the domed-ceiling chamber in the back of the cave, demonstrated a series of burning episodes (Figure 6.21). Unfortunately, a lab mishap resulted in levels 1 and 3 being mixed together, making stratigraphic analysis of the unit impossible. However, the majority of angiosperm species (Figure 6.22) were not present in the hearth area where Unit 1 was located, but in Unit 2, located in the transitional chamber between the rock-strewn entrance tunnel and the domed-ceiling chamber. Pine was the most abundant wood charcoal recovered from the hearth in the domed chamber.

Angiosperm charcoal was more abundant than pine charcoal overall (Figure 6.23), but *Pinus* sp. was the most ubiquitous species represented (Figure 6.24). Poor preservation made identifying many of the hardwoods difficult. A large portion of the wood charcoal was of indeterminate maturity, however from the samples that could be comfortably identified, a majority of them belonged to mature specimens. Mature wood was also the most ubiquitous (Figures 6.25 and 6.26). Some of the hardwood species tentatively identified include a member of the Lauraceae family that may be *Persea* sp. (possibly avocado), fig (*Ficus* sp.), a member of the Moraceae family, three types of legume, and possibly *Miconia* sp., and *Trichilia* sp.

The wood specimen identified tentatively as *Persea* sp. is diffuse porous in cross section. Vessels are singular as well as in clusters and radial chains between two and four. Vessels are between 70 and 120 μm wide and rays are three to five cells wide. The axial parenchyma are scanty to vasicentric. The wood charcoal from the Moraceae family may be a species of *Castilla* sp., which includes trees that produce rubber. The specimen is diffuse porous in cross-section

with large vessels between 100 and 200 μm . The vessels are mostly solitary, with some radial chains of three. Axial parenchyma are aliform and rays are one to three cells wide.

The *Miconia* sp. specimen is diffuse porous. Vessels are solitary and in radial chains of two to four with angular edges. The vessels are moderately distributed and between 60 and 100 μm in size. Tyloses are common and present throughout. Rays are uni-seriate and bi-seriate and the axial parenchyma are apotracheal diffuse. The *Trichilia* sp. specimen is diffuse porous with vessels arranged in chains of three to four. Axial parenchyma are apotracheal aliform and rays are one to three cells wide. Wood from Leguminosae are diffuse porous with medium to large vessels. Rays from the specimens recovered from Actun Slate are uni-seriate, though they tend to be multi-seriate among most of the Legumes. Legumes have distinctive paratracheal axial parenchyma that form broad aliform to confluent bands.

Table 6.6: Archaeobotanical remains from Actun Slate. U = Unit, L = Level, * = uncarbonized.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
U1 L1/3	<i>Pinus</i> sp. cf <i>Miconia</i> sp. cf Solanaceae*	Charcoal	1.8	-	Mature	10039/10040
		Charcoal	1.5	-	Immature	
		Perianth	-	1	-	
U1 L2	<i>Pinus</i> sp.	Charcoal	.6	-	Mature	10041
U1 L4	<i>Pinus</i> sp.	Charcoal	.08	-	Mature	10042
U1 L5	<i>Pinus</i> sp. Unknown	Charcoal	.15	-	Mature	10043
		Resin	>.1	-	-	
U2 L1	cf <i>Persea</i> sp. <i>Pinus</i> sp. cf Moraceae Dicot Leguminosae cf <i>Trichilia</i> sp.	Charcoal	.04	-	Mature	10044
		Charcoal	.22	-	Mature	
		Charcoal	.01	-	Mature	
		Charcoal	.01	-	Indet.	
		Charcoal	.7	-	Indet.	
		Charcoal	.7	-	Indet.	
U2 L2	Dicot <i>Ficus</i> sp. <i>Pinus</i> sp. Dicot Dicot	Charcoal	.1	-	Indet.	10045
		Charcoal	.2	-	Indet.	
		Charcoal	.25	-	Mature	
		Charcoal	.1	-	Indet.	
		Charcoal	.7	-	Indet.	

	Dicot Indet. <i>Cecropia peltata*</i>	Charcoal Charcoal Seed	.15 .8 -	- - 25	Indet. Indet. -	
U2 L3	Dicot <i>Pinus sp.</i>	Charcoal Charcoal	.5 .5	- -	Indet. Mature	10046
U2 L4	Dicot Indet.	Charcoal Charcoal	.5 >.1	- -	Indet. Indet.	10047
U3 L1	<i>Pinus sp.</i> Indet. <i>Cecropia peltata*</i>	Charcoal Charcoal Seed	.02 .01 -	- - 5	Mature Indet. -	10048
U3 L2	<i>Pinus sp.</i> Leguminoseae Dicot Dicot Leguminoseae Dicot	Charcoal Charcoal Charcoal Charcoal Charcoal Charcoal	.44 .4 .08 .04 .5 .07	- - - - - -	Mature Mature Indet. Mature Mature Indet.	10049



Figure 6.21: Unit 1 stratigraphy in Actun Slate showing a series of burning events.

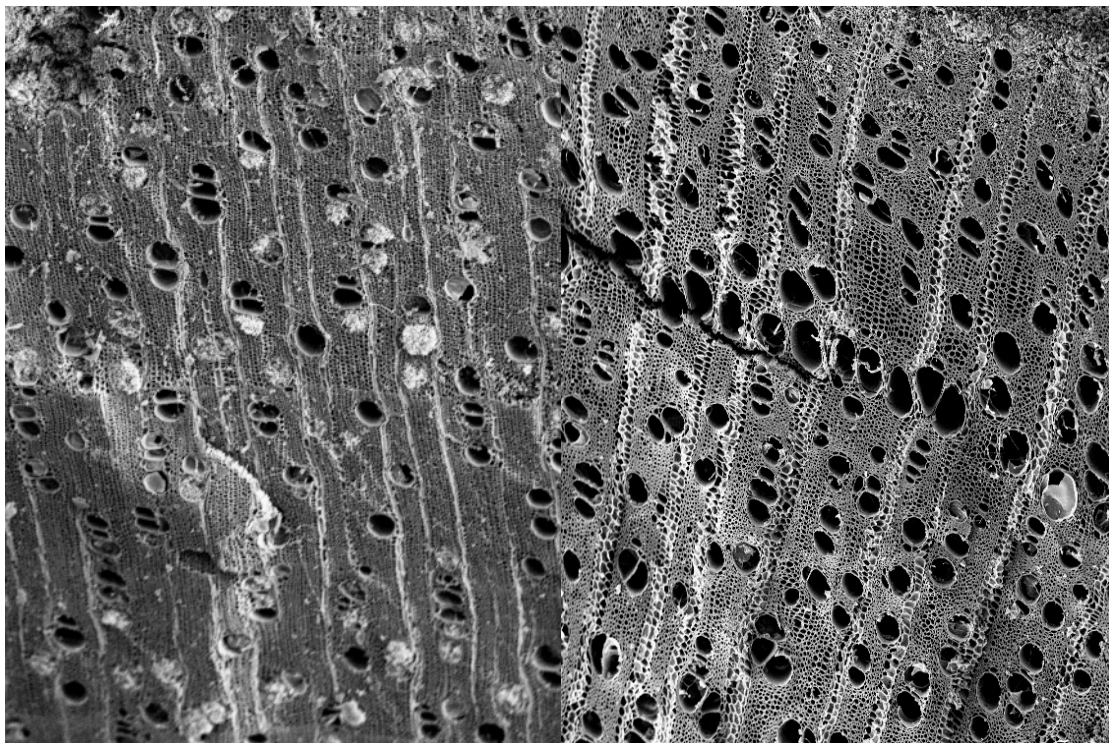


Figure 6.22: Wood charcoal from Actun Slate. cf *Miconia* sp. x100 (left, 10039-002), cf *Persea* sp. x150 (right, 10044-001).

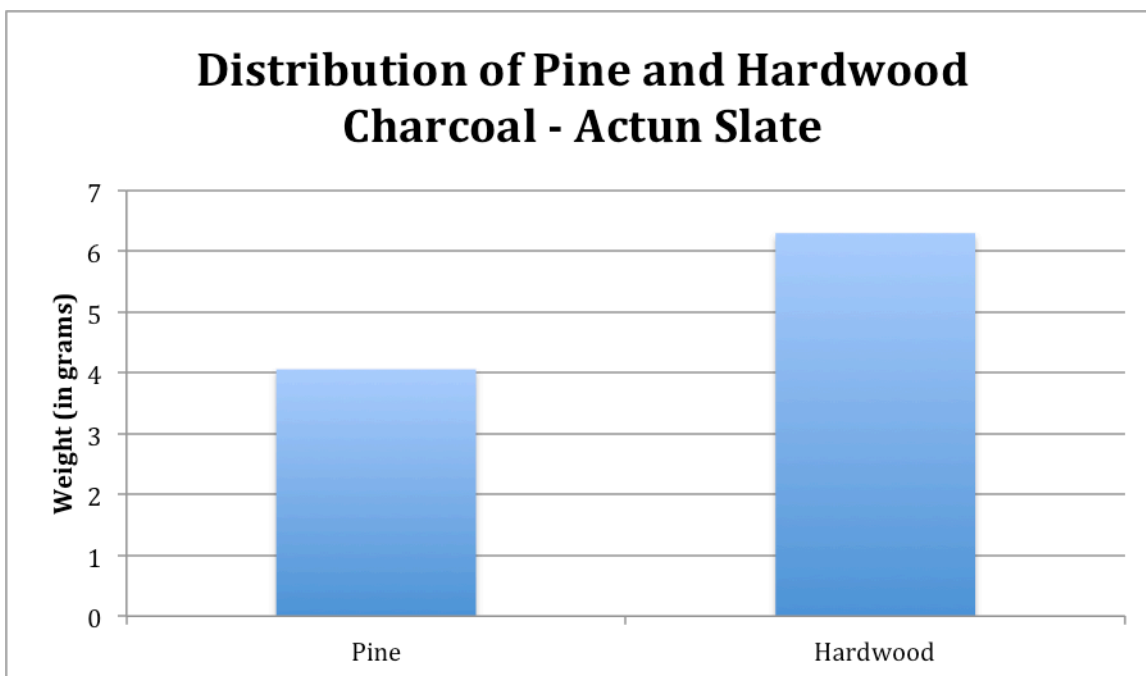


Figure 6.23: Distribution of pine and angiosperm charcoal.

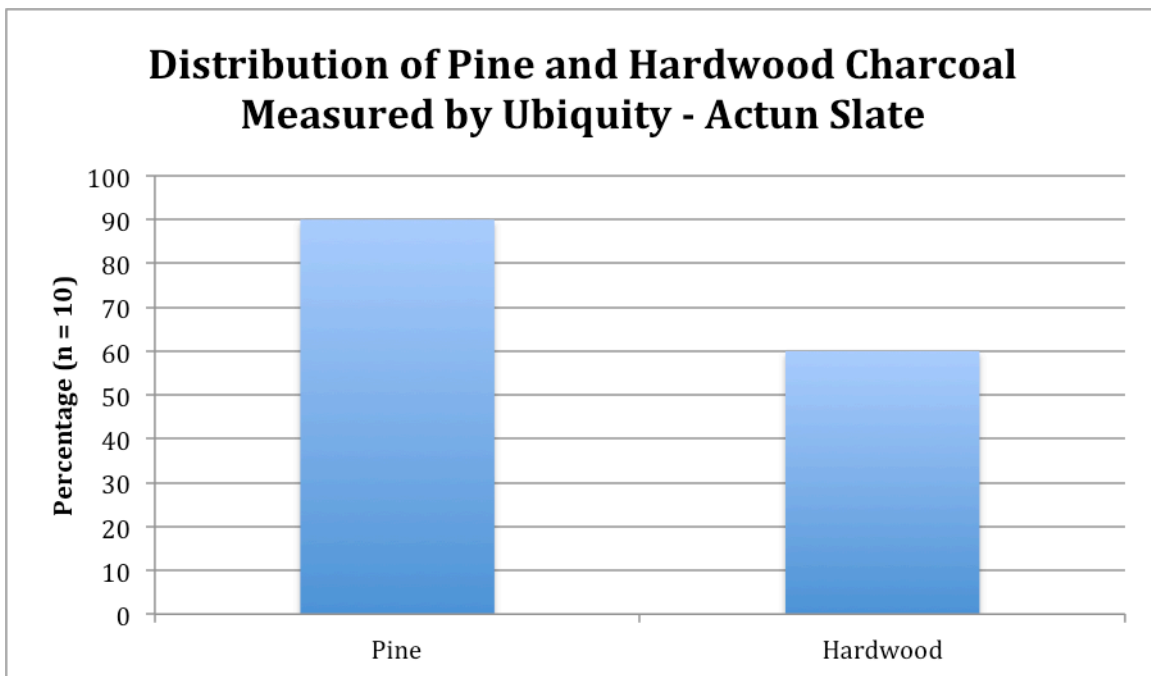


Figure 6.24: Ubiquity of pine and angiosperm charcoal.

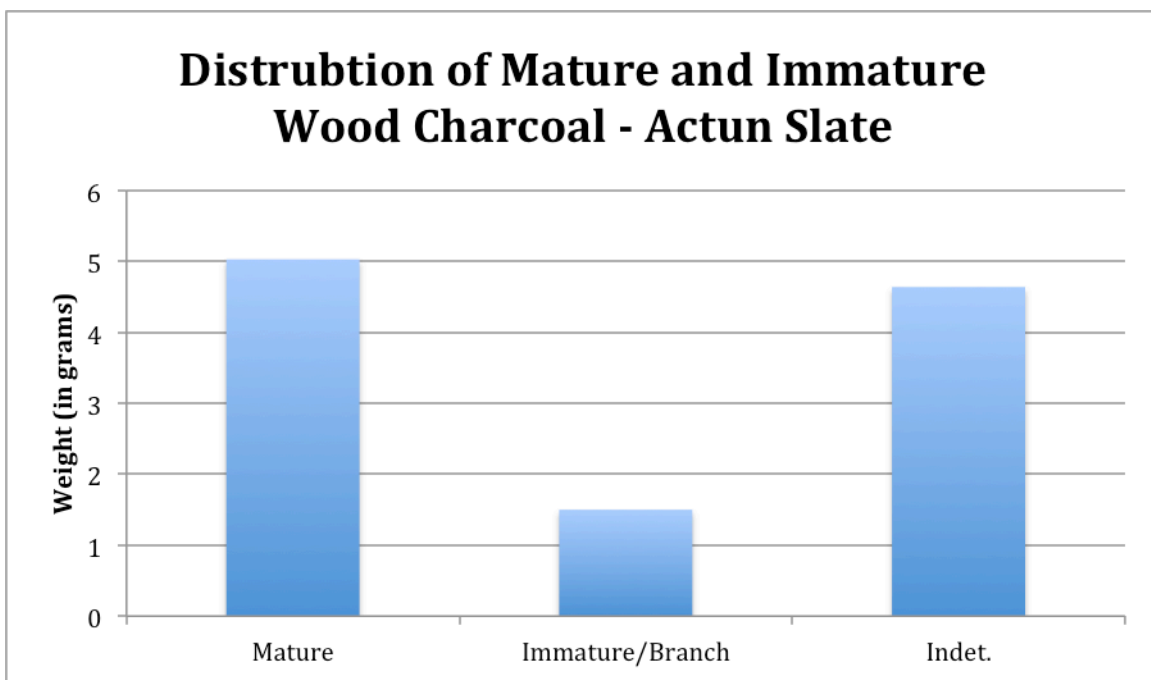


Figure 6.25: Distribution of mature, immature, and indeterminate maturity wood.

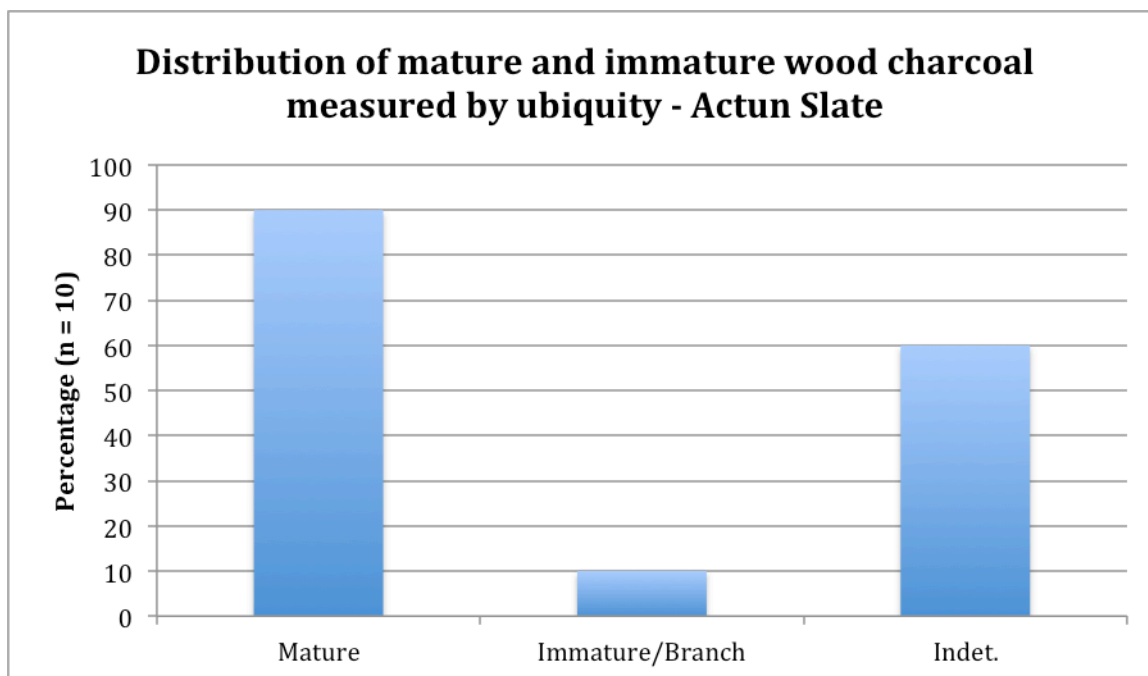


Figure 6.26: Maturity analysis based on ubiquity.

6.2.1.8 Tzul's Cave

Three soil samples were taken from Tzul's Cave, but yielded only small amounts of very fragmentary charcoal (Figure 6.27). The results of the archaeobotanical analysis are presented in Table 6.7. Small fragments of an angiosperm dicot species were present in all three samples. However, the specimens are extremely small, and while it is difficult to determine with certainty, it appears to be the same species in each sample. Soil Sample A was taken from an alcove in the chamber where the slate plug is located. Soil Sample B was taken from below the constructed wall beneath the slate plug. Soil Sample C was taken from the deepest chamber, near the whole ceramic vessels. Only Sample C contained pine charcoal in very small amounts. Given Tzul's Cave's direct association with the Pacbitun site core, it is interesting that there was very little pine wood present in the samples. However, this may in part be due to the limited sampling that

took place in the cave. Additionally, Tzul's Cave is the only site where the same angiosperm dicot species appears to have been in every sample.

Table 6.7: Archaeobotanical remains from Tzul's Cave. SS = Soil Sample.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
SS A	Dicot	Charcoal	.002	-	Indet.	10015
SS B	Dicot	Charcoal	.03	-	Indet.	10016
SS C	Dicot	Charcoal	.02	-	Indet.	10017
	<i>Pinus</i> sp.	Charcoal	.01	-	Indet.	

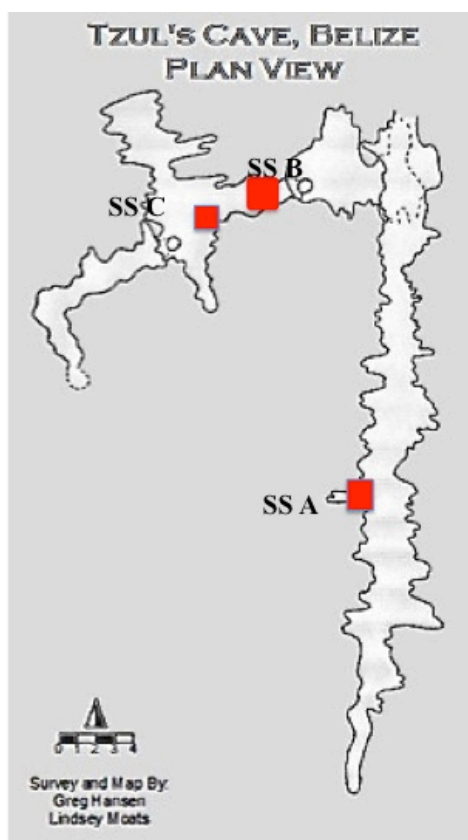


Figure 6.27: Locations of soil samples in Tzul's Cave (after Powis 2010:Figure 26:35).

6.2.1.9 Actun Lak

Since Actun Lak was more extensively excavated than any of the other karst sites included in the present study, there is significantly more archaeobotanical data present for analysis. One of the primary motivations for the extensive work in Actun Lak was the fire-blackened walls of Chamber 2, which prompted inquiries regarding plant use in the cave. Spenard (see 2011, 2012, 2013) recovered soil samples and macrobotanical remains during excavations inside and outside the entrance of the cave during the 2011 and 2012 field seasons. The results of the archaeobotanical analysis are presented in Table 6.8.

As with all of the sites described so far, wood charcoal was the most abundant type of archaeobotanical remains recovered. The amount of *Pinus* sp. wood, in comparison with angiosperms, recovered from the cave is astonishing (Figure 6.29, 6.30, and 6.31). Figure 6.29 represents the distribution between all of the units, including one located outside the entrance of the cave. Figure 6.30 represents only the charcoal recovered from the interior of the cave. Figure 6.30 is the distribution of pine and angiosperm wood based on ubiquity. These measurements are excluding 2 large, partially carbonized pine fragments (Figure 6.28) collected during excavation. Other species represented in the sample (Figure 6.43) include one fragment belonging to the Chrysobalanaceae family (tentatively identified as *Licania arborea*), *Piscidia* sp. *Protium* sp., and a 1.5 cm long carbonized thorn likely belonging to a tree in the Moraceae family. However, given the ubiquity of plant species in Mesoamerica with thorns, it is difficult to make an accurate identification. Additionally, a charred *Attalea cohune* nut was recovered and several unknown carbonized seeds.

The *Piscidia* sp. charcoal is diffuse porous with large vessels between 150 and 200 μm that are completely filled with pronounced tyloses. Rays are exclusively uni-seriate and

paratracheal axial parenchyma are aliform to confluent. The Chrysobalanaceae (cf *Licania Licania arboria*) charcoal is diffuse with a high density of vessels. The vessels are solitary and solitary and range between 100 and 200 μm . Tyloses are common and the rays are uni-seriate. The *Protium* sp. is diffuse porous with primarily solitary vessels. The vessels are between 40 and 100 μm and the rays are uni-seriate and bi-seriate. Axial parenchyma are diffuse to scanty.

Since pine charcoal tended to belong to mature trees, there is a clear distinction between mature and immature wood in Actun Lak, favoring mature wood (Figure 6.32 and Figure 6.33). One of the large, partially carbonized pine fragments was subjected to ^{14}C dating and processed by Beta Analytic. It returned a date between A.D. 770 and 940 (Spenard 2012:153). While the A.D. 940 date is late, this date falls almost within the range of the Late Classic Period at Pacbitun. These pine fragments were recovered from Unit 2, Level 1, and the deposition in the uppermost level suggests that the cave was used possibly until the site's abandonment. This is the only radiocarbon date that has been obtained for any of the samples so far.

Samples 10013 and 10014 were each recovered from a cache of two ceramic vessels located against the cave wall. The contents of the bowls were floated and each sample contained small amounts of pine charcoal and resin. These were very small and fragmentary pieces of charcoal and each sample weighed less than 0.1 grams. However, they indicate that small quantities of pine and incense were burned in both bowls, likely as an offering, before they were cached.

Given the amount of pine found in Actun Lak and its concentration in Chamber 2, questions arise regarding the ritual event(s) that resulted in its deposition into the archaeological record. While there is sufficient ethnographic evidence to suggest that pine was converted into charcoal before transportation, large partially carbonized pine fragments from Actun Lak

indicate that not all of the pine in the cave entered in the form of charcoal. Given the cave's proximity to the Mountain Pine Ridge, transporting pine wood to Actun Lak, rather than charcoal, would not have been as arduous. However, pine smokes profusely when burned, another reason why it is believed to have been converted to charcoal, which burns cleaner. If pine was burned in Actun Lak in quantities as large as the blackened cave walls and excavations suggest, than an incredible amount of smoke would have been produced in the process, which was likely the intent.

Table 6.8: Archaeobotanical remains from Actun Lak. U = Unit, L = Level, V = Vessel, F = Feature, * = uncarbonized.

Provenience	Plant	Part	Weight (g)	#	Maturity	ID Number
U1 L1	<i>Pinus</i> sp.	Charcoal	6.13	-	Primary	10001
	<i>Cecropia peltata</i> *	Seed	-	300	-	
	Unknown	Seed	-	2	-	
	Unknown	Resin	>.1	-	-	
U1 L4	<i>Pinus</i> sp.	Charcoal	.72	-	Primary	10002
	Indet.	Charcoal	.5	-	Indet.	
	<i>Piscidia</i> sp.	Charcoal	.21	-	Primary	
U2 L1	<i>Pinus</i> sp.	Charcoal	9.1	-	Primary	10003
	<i>Pinus</i> sp.	Charcoal	1.82	-	Secondary	
	Unknown	Seed	-	1	-	
	Unknown	Seed	-	1	-	
	<i>Cecropia peltata</i> *	Seed	-	25	-	
	<i>Pinus</i> sp.	Wood	20.9	2	Primary	
U4 L1	<i>Attalea cohune</i>	Endocarp	-	1	-	10004
	<i>Pinus</i> sp.	Charcoal	1	-	Indet.	
	<i>Cecropia peltata</i> *	Seed	-	11	-	
	Indet.	Charcoal	.5	-	Indet.	
U4 L1	Unknown	Resin	.3	-	-	10005
	<i>Pinus</i> sp.	Charcoal	.5	-	Indet.	
	Unknown	Seed	-	1	-	
U4 L1	Unknown	Resin	.5	-	-	10006
	<i>Pinus</i> sp.	Charcoal	.4	-	Indet.	
U4 L3	Unknown	Resin	.1	-	-	10007
	<i>Pinus</i> sp.	Charcoal	13.13	-	Primary	
U6 L1	<i>Pinus</i> sp.	Charcoal	1.03	-	Secondary	10007
	<i>Pinus</i> sp.	Charcoal	1.03	-	Secondary	
	Unknown	Resin	-	-	-	

	Unknown	Seed	-	1	-	
U6 L2	<i>Pinus</i> sp.	Charcoal	6	-	Primary	10008
	<i>Pinus</i> sp.	Charcoal	.2	-	Secondary	
	Unknown	Resin	.18	-	-	
	Dicot	Charcoal	.46	-	Primary	
	<i>Licania arboria</i>	Charcoal	.12	-	Primary	
	Fabaceae	Thorn	-	1	-	
	Unknown	Seed	-	1	-	
	Indet.	Charcoal	1	-	-	
U7 L1	<i>Pinus</i> sp.	Charcoal	49	-	Primary	10009
	Unknown	Resin	.4	-		
U7 L2	<i>Pinus</i> sp.	Charcoal	10.83	-	Primary	10010
	<i>Pinus</i> sp.	Charcoal	.2	-	Secondary	
	Unknown	Resin	.15	-	-	
	Indet.	Charcoal	.5	-	Indet.	
U7 L3	<i>Pinus</i> sp.	Charcoal	7.9	-	Primary	10011
	Unknown	Resin	1	-	-	
	<i>Pinus</i> sp.	Charcoal	.15	-	Secondary	
	<i>Protium</i> sp.	Charcoal	.3	-	Primary	
U8/9 L2 V1	<i>Pinus</i> sp.	Charcoal	>.1	-	Indet.	10013
	Unknown	Resin	>.1	-	-	
U8/9 L2 V2	<i>Pinus</i> sp.	Charcoal	>.1	-	Indet.	10014
	Unknown	Resin	>.1	-	-	
U10 L3 F1	Monocot	Charcoal	.37	-	Indet.	10014
	Dicot	Charcoal	.4	-	Secondary	
	Unknown	Stem	-	1	-	
	Unknown	Stem	-	2	-	



Figure 6.28: Partially carbonized pine fragments recovered from Actun Lak.

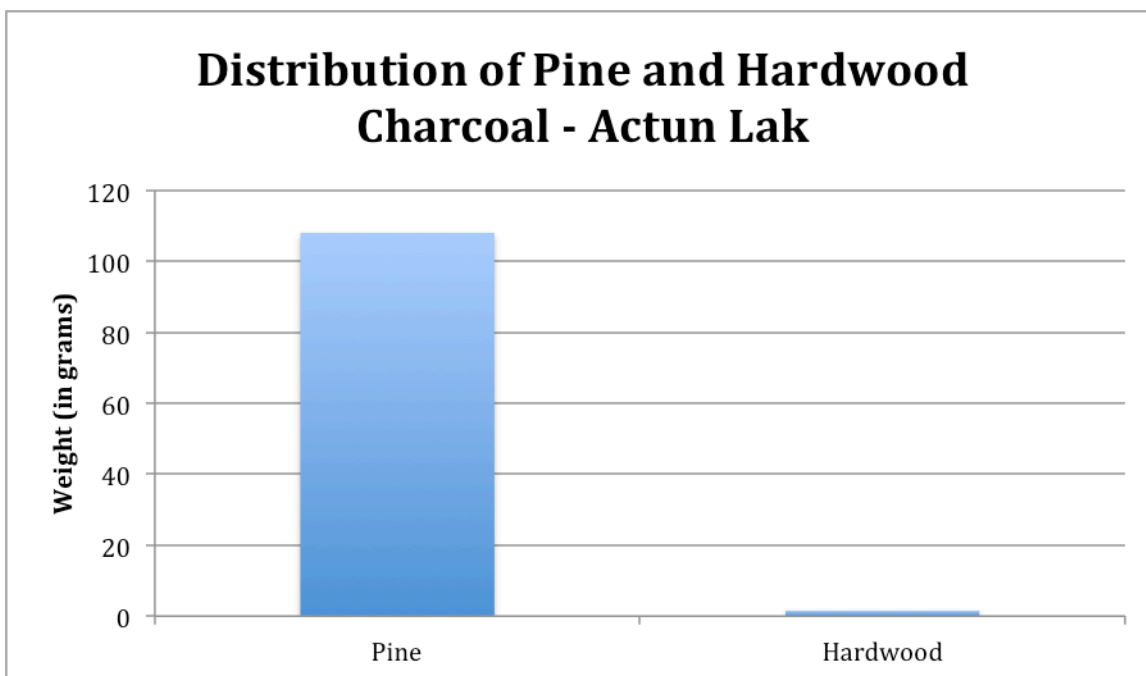


Figure 6.29: Distribution of pine and angiosperm charcoal in Actun Lak, including Unit 14, located outside the cave entrance. Also excluding the two large pine fragments (sample 10003-006).

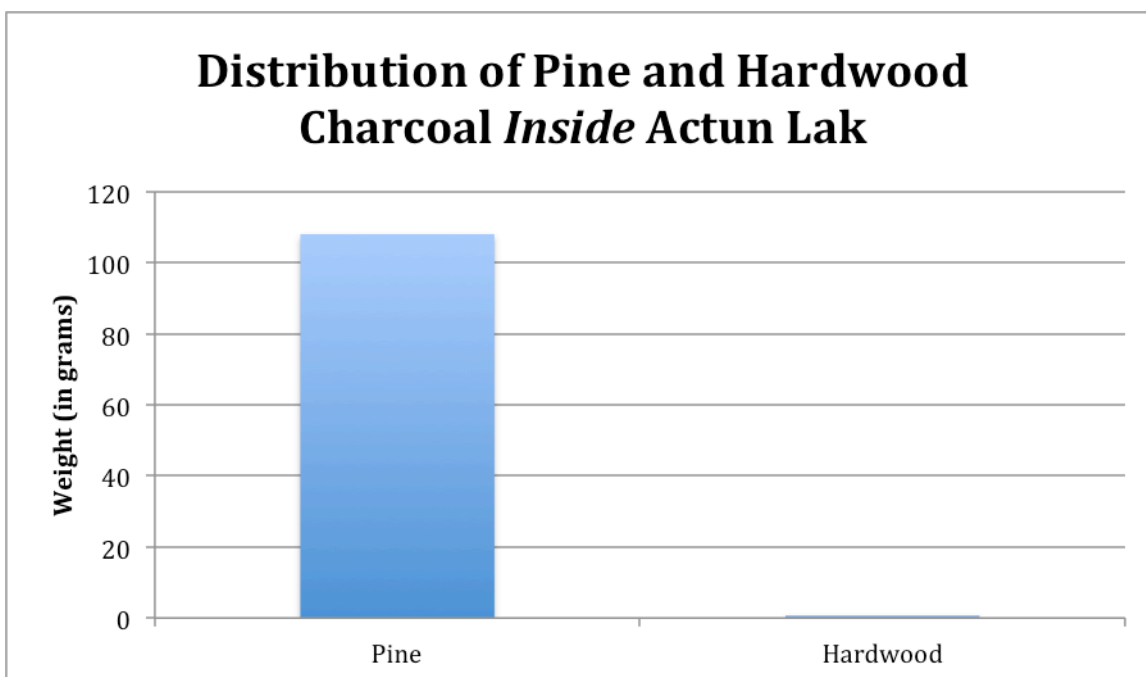


Figure 6.30: Distribution of pine and angiosperm charcoal inside Actun Lak, excluding Unit 14 and sample 10003-006.

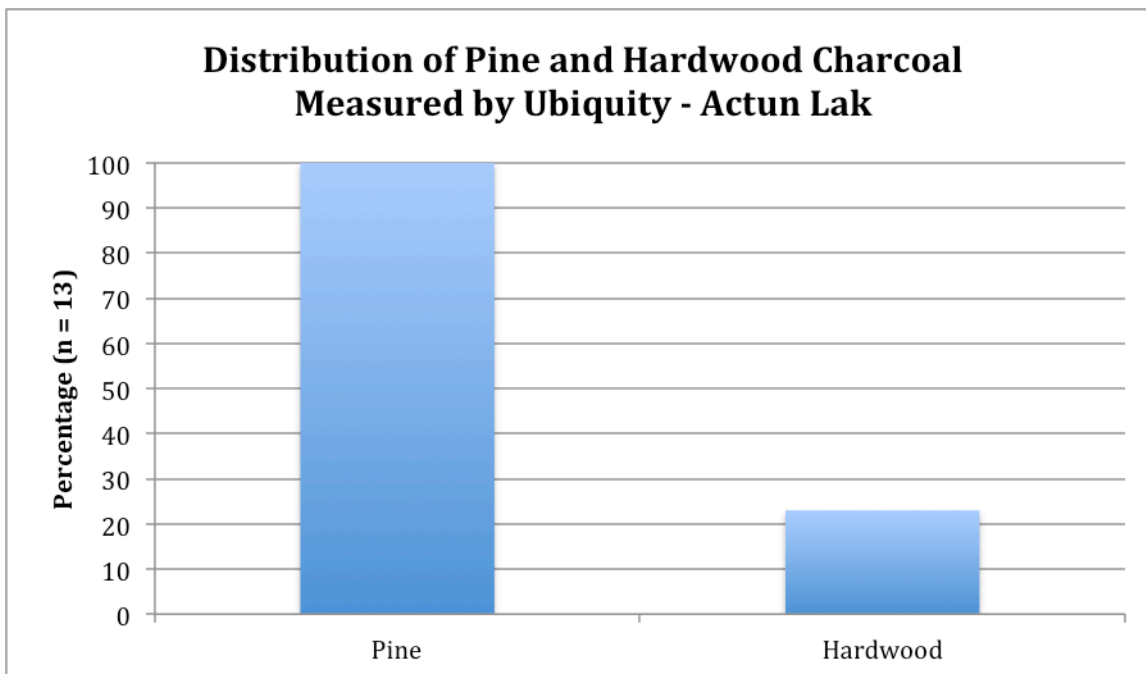


Figure 6.31: Distribution of pine and angiosperm charcoal in Actun Lak measured by ubiquity, excluding Unit 14.

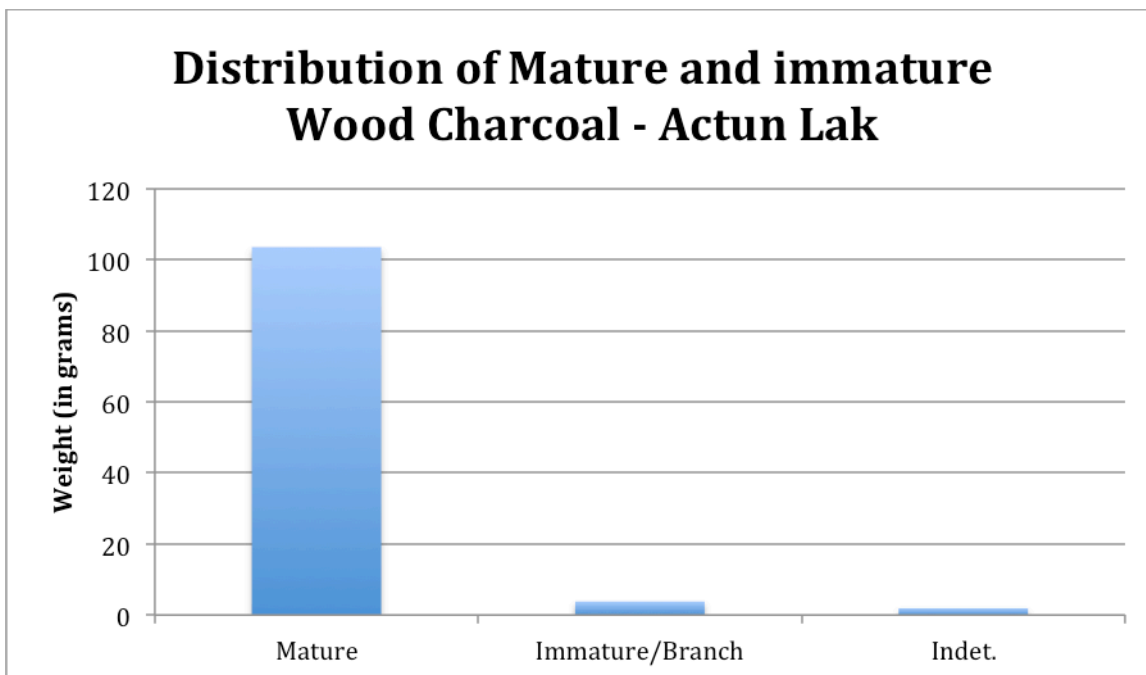


Figure 6.32: Distribution of mature, immature, and indeterminate maturity wood specimens based on weight.

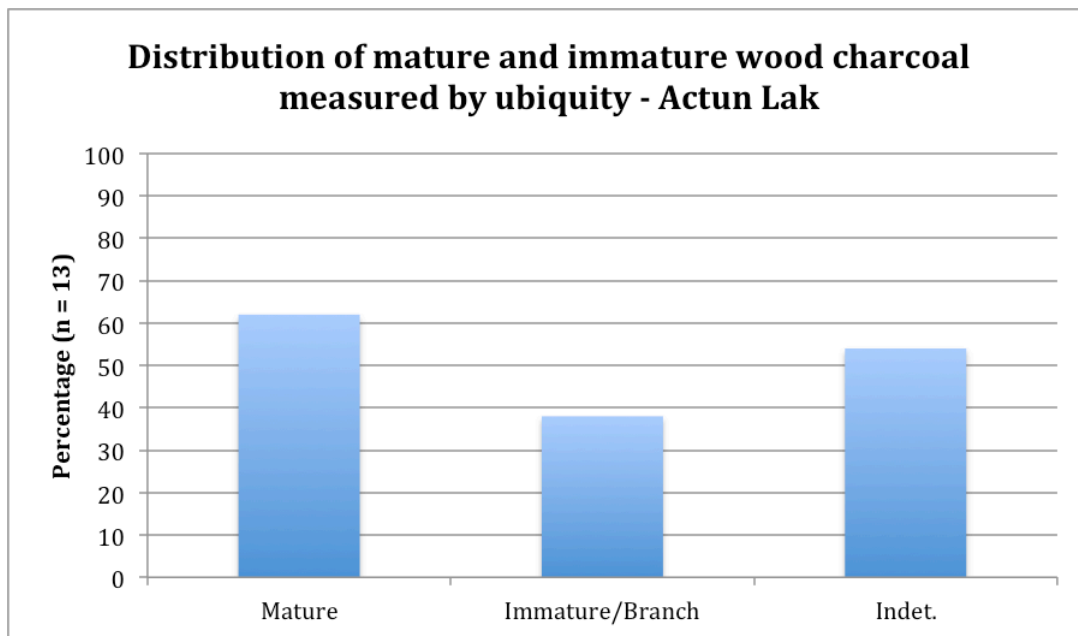


Figure 6.33: Ubiquity of mature, immature, and indeterminate maturity wood.

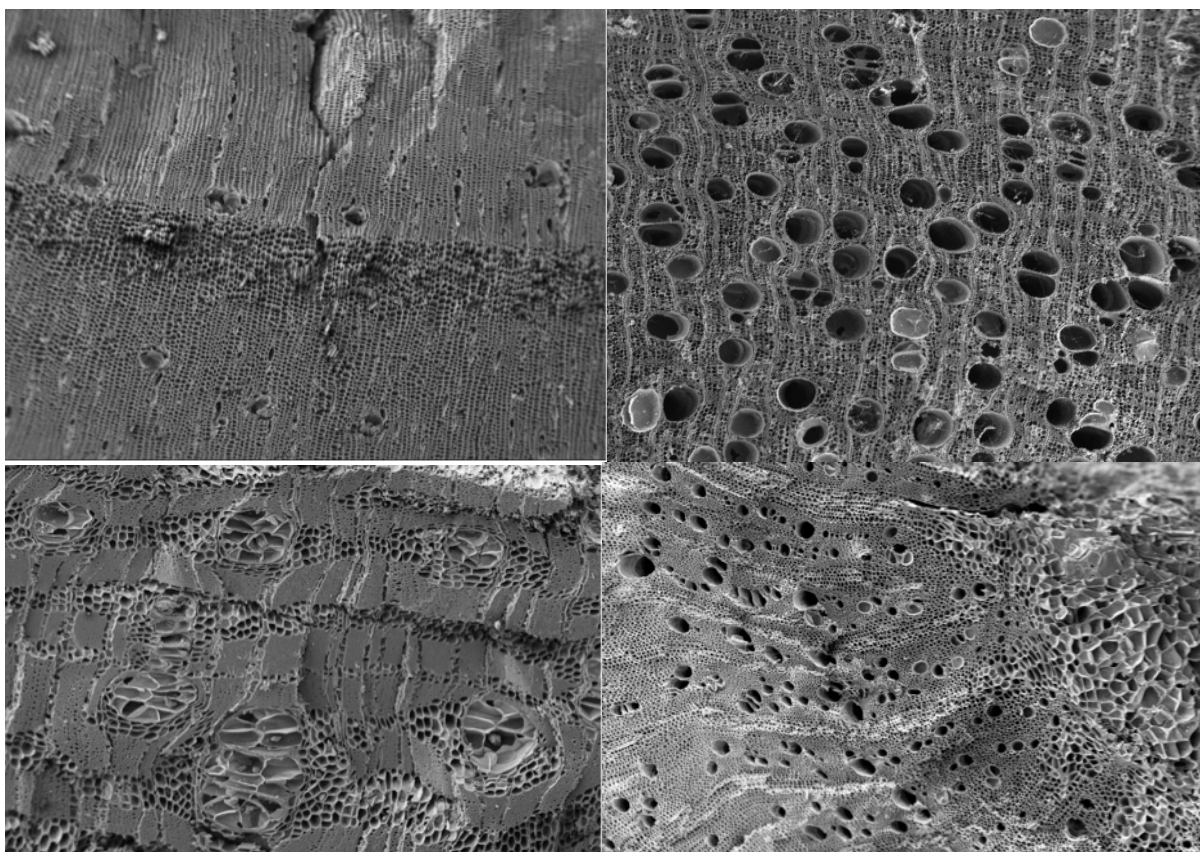


Figure 6.34: Sample of wood charcoal recovered from Actun Lak. *Pinus* sp. x100 (10003-002, top left), *Licania arboria* x100 (10011-004, top right), *Piscidia* sp. x200 (10002-003, bottom left), Unidentified branch with pith x150 (10014-002, bottom right).

6.2.2 *Intersite Analysis*

There are similarities and differences between the assemblages from each of the nine sites. Wood charcoal was the dominant archaeobotanical remain recovered across all nine sites. In fact, very little else in the way of botanical remains was recovered. The only exceptions were a pit fragment and stem from Actun Nohoch Tunich, four seeds from two different species from Actun Xtuyul, and from Actun Lak some unidentified seeds, a cohune endocarp, and a thorn. Resin was also found at several of the sites. Other than this, however, the entire archaeobotanical assemblage consisted of carbonized wood charcoal.

Addressing the distributions between pine and angiosperm charcoal can provide valuable information about the botanical assemblage. Since pine is geographically restricted, it may be considered a non-local resource, though individuals at Pacbitun would have had greater access to this resource than people at many other sites. Therefore understanding the distribution between these two wood types allows for a general pattern of forest resource use. Additionally, since pine appears to have been a prestige good and part of a political-economic system of exchange (Lentz et al. 2005; Morehart et al. 2005) its spatial distribution between Pacbitun's caves can allow for questions regarding social differentiation to be explored. Finally, by analyzing angiosperm charcoal together, it allows for comparisons to be made using specimens that could not be identified to the taxonomic level or at all.

Pine wood was recovered from eight of the nine sites, excluding Actun Subuul. Because of Actun Subuul's location next to a footpath, the integrity of its context is questionable, and the lack of pine charcoal may reflect this disturbance. Because only one small charcoal fragment was recovered, I hesitate to make claims regarding ritual plant use at the site. However, the presence of charcoal and other cultural artifacts such as ceramics indicates the diversity of karst

features utilized by the ancient Maya. The distribution of pine across the sites indicates that pine was a crucial element of a ritual toolkit (Morehart et al. 2005) (Figure 6.35).

Figure 6.35 is the ubiquity analysis of pine and angiosperm charcoal across seven of the nine sites. Actun Xtuyul and Actun Subuul are excluded because only one sample was taken from each. Figure 6.36 is the percentage of pine versus angiosperm charcoal based on weight. Actun Subuul is excluded because it only yielded one small fragment of charcoal. These analyses demonstrate the variability of wood types across the cave sites. Pine is the most ubiquitous charcoal recovered from all but two of the represented sites. One site has an equal ubiquity between pine and angiosperms. Only Tzul's Cave has a greater distribution of angiosperm charcoal than pine.

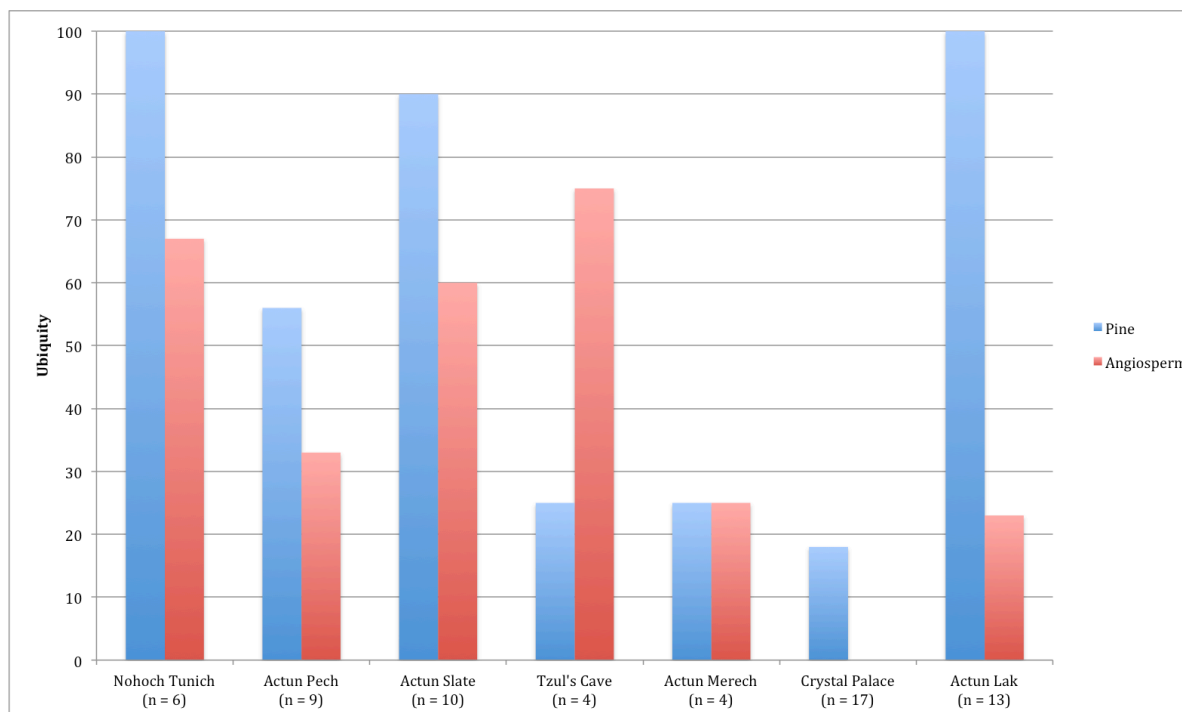


Figure 6.35: Ubiquity of pine and angiosperm charcoal across sites. Actun Xtuyul and Actun Subuul are excluded because only one sample was taken from each site.

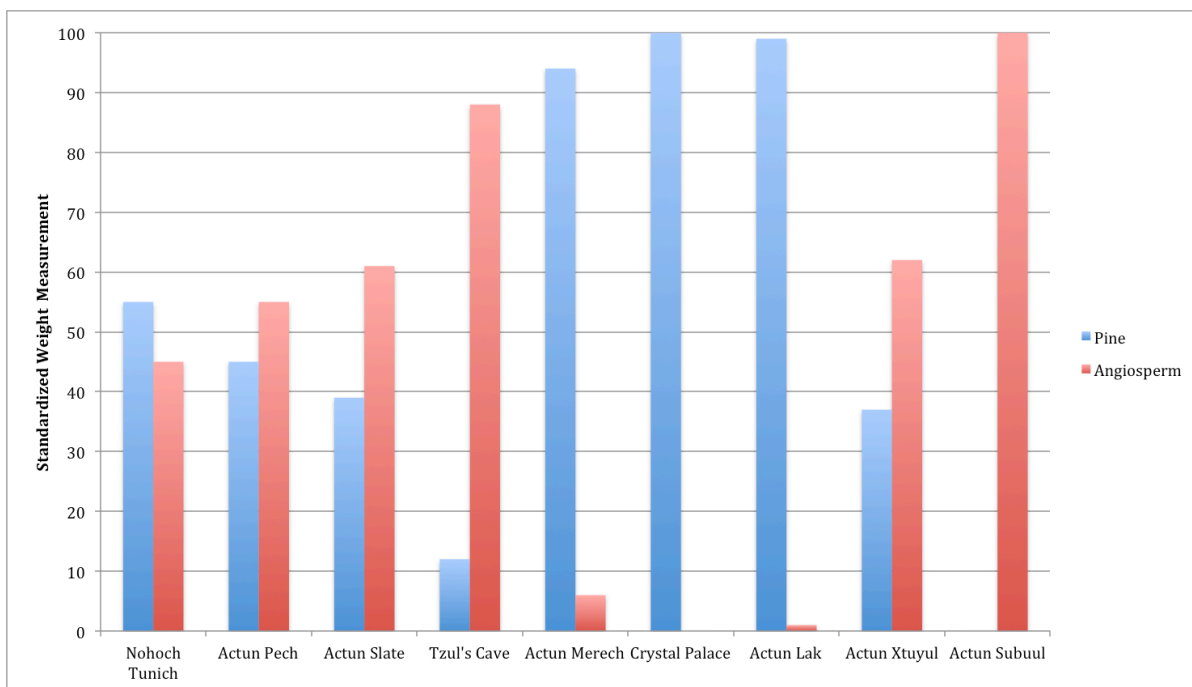


Figure 6.36: Standardized weight measurements between pine and angiosperm charcoal at cave sites.

Actun Lak by far yielded the greatest amount of pine, particularly in comparison with angiosperms. Actun Lak contains the greatest amount of prestige goods when compared with the other sites. However, it has also been the most extensively investigated archaeologically in comparison with the other karst sites. It was the evidence of extensive burning in the cave and the thousands of ceramic sherds that drew attention to it in the first place.

Actun Nohoch Tunich, Actun Xtuyul, Actun Pech, and Actun Slate had a more balanced distribution of pine and hardwood charcoal than the other sites, even though pine only outweighed angiosperm charcoal in Nohoch Tunich. One hundred percent of Crystal Palace's archaeobotanical assemblage consisted of pine, however a majority of samples recovered from the cave were sterile. There is evidence of modern ritual use of pine in Crystal Palace also, and therefore it is highly likely that any charcoal recovered near the surface is modern. Considering

that the vast majority of sub-surface excavations were sterile, it is difficult to assess Late Classic ritual use of the cave.

Figure 6.37 is the comparison of identified genera between all nine cave sites measured by ubiquity. The data indicates a wide variability between sites in the species being used in rituals, with the exception of pine. Of 13 identified genera, only fig (*Ficus* sp.), copal (*Protium* sp.), and pine (*Pinus* sp.) were present at more than one site. Pine was present at eight of the nine sites. Fig and copal was present at two sites and the other ten genera at only one. This analysis not only emphasizes the significance of pine in ritual assemblages, but the cultural variability evident in the archaeological record. Morehart's (2011:100) paleoethnobotanical analysis also indicated significant variety of tree species used in cave rituals between sub-regions. Indeed, the diversity of species at caves all associated with the same urban center indicate that even within the same community there was extreme flexibility in culturally acceptable forms of ritual paraphernalia. Alternatively, cave sites may have functioned for different ritual purposes, and the diversity present in the archaeological record may be the recording of distinct ritual patterns being conducted for various motivations.

Scott's (2009) documentation of the requisite use of candles in Kaqchikel rituals may provide an ethnographic comparison of such variability in materials. Among many modern Maya groups, pine is reported to be analogous to candles used in ceremonies (Morehart 2011:108-109; Oakes 1951; Redfield and Villa Rojas 1934; Tedlock 1992; Vogt 1976). Scott (2009:42-48) recorded various candles used in Kaqchikel ritual. Ten different colors are used and each has unique symbolic attributes. It is possible that the different wood types used in Late Classic cave ritual have corresponding symbolic attributes with the different colored candles used in modern Maya rituals, just as pine has symbolic parallels with candles. Morehart

(2011:121) interpreted the ritual burning of wood in cave contexts as the release of the spiritual essence of the tree so that it could be transformed into appropriate sustenance for the gods.

Many candle colors, such as black, white, or yellow, are symbolic representations of sacred maize (Scott 2009:42-44), and can be interpreted as food offerings to the gods. *Cebo* candles, made from animal fat, are offered among the Kaqchikel specifically to feed ancestral spirits, among other uses, and are often burned with black candles (Scott 2009:44-45). Additionally, Scott (2009:42, 45) describes the use of different types of candles depending on how long the Kaqchikel wish for a ceremony to last, using longer burning candles for longer rituals.

Therefore, a promising future avenue of research would be determining the length of time specific varieties of wood burn, which may provide insights into how or why specific wood species were chosen.

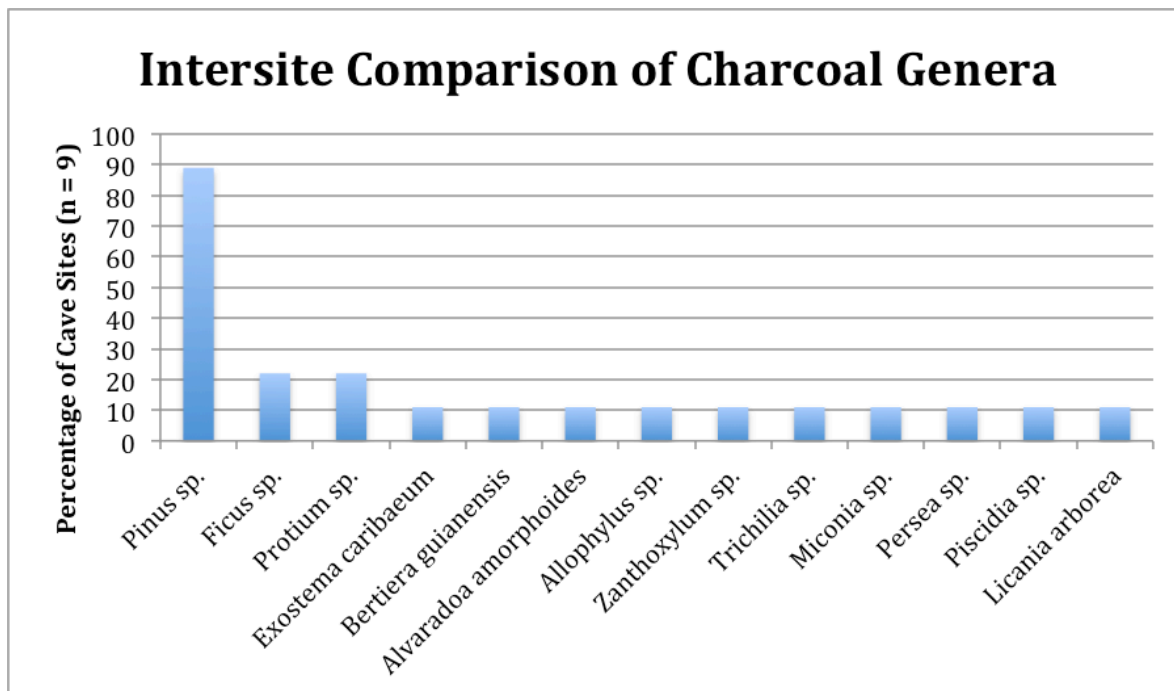


Figure 6.37: Comparisons of identified charcoal genera between sites.

Since another objective of this research is to determine whether or not macrobotanical remains from ritual contexts can aid in the reconstruction of Pacbitun's surrounding environment, the same analyses were performed to understand the distribution of mature, immature/branch, and indeterminate maturity wood charcoal across the site. Figure 6.38 is the ubiquity analysis. Actun Subuul and Actun Xtuyul are excluded because only one sample was taken from each, and Tzul's Cave is excluded because all of the wood charcoal was of indeterminate maturity. Figure 6.39 measures the percentage of each category of wood maturity that makes up the overall assemblage based on weight. Actun Subuul and Tzul's Cave are excluded from the analysis for the same reasons they were excluded from the first chart. Actun Xtuyul is included, though.

Out of the seven sites included in Figure 6.38, mature wood was more ubiquitous than either immature or indeterminate maturity wood. Figure 6.39 shows that mature wood charcoal specimens made up the majority of archaeobotanical assemblages across all sites except for Actun Xtuyul. The sample from Actun Xtuyul also had the most distinguishable examples of immature wood because of the preservation of small branches, some still containing their piths. While the wood could not always be identified due to poor preservation of some of the cellular characteristics, maturity estimates could still be made because small branches were intact. It also seems as if pine wood generally tends to be mature and angiosperms are more likely to belong to immature specimens across all sites.

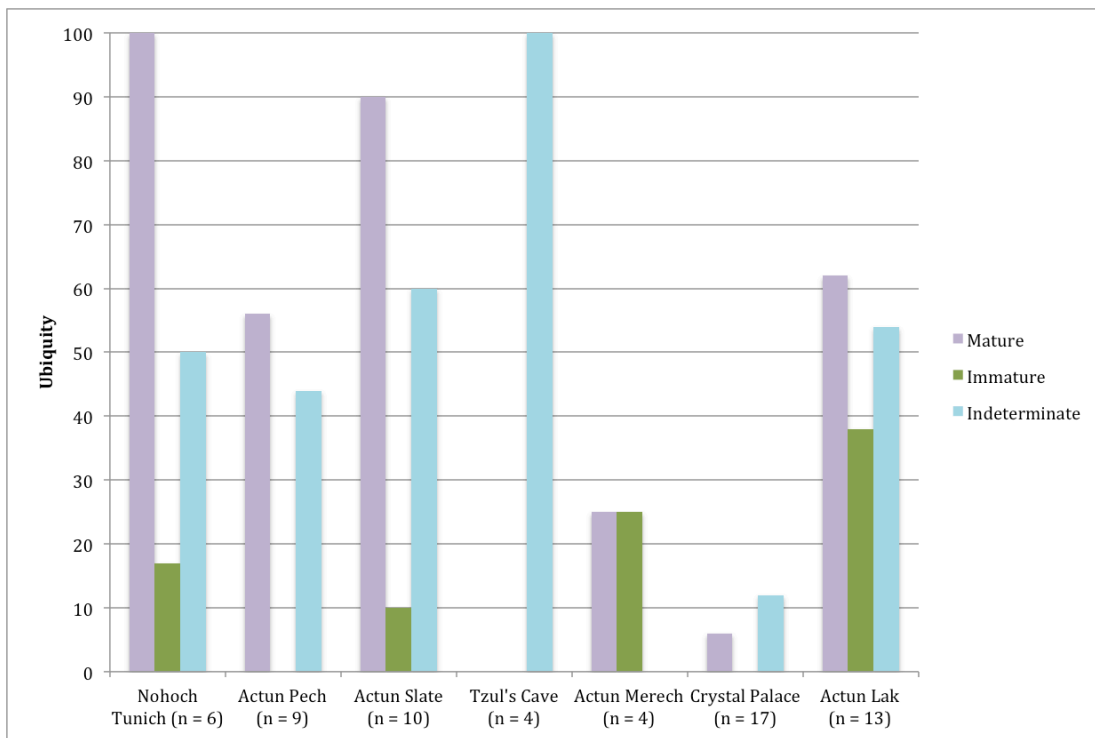


Figure 6.38: Ubiquity of mature, immature, and indeterminate maturity wood across sites.

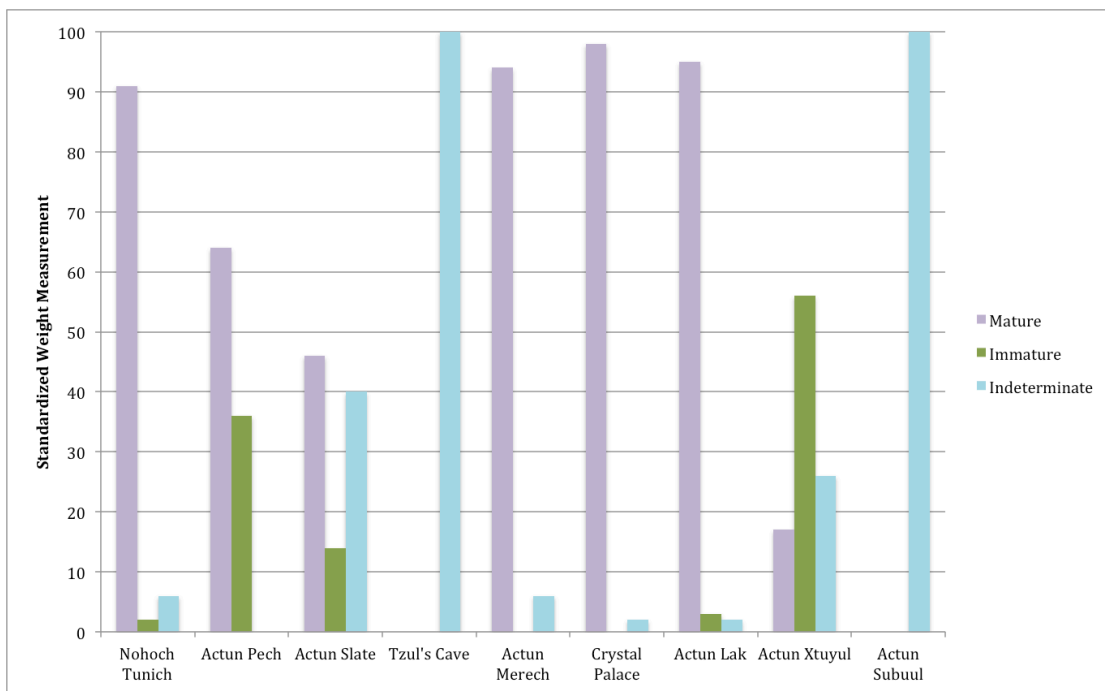


Figure 6.39: Percentage of total assemblage across sites of mature, immature, and indeterminate maturity wood based on weight.

6.3 Ethnographic Comparisons

Protium sp. belongs to the Burseraceae family, from which copal or *pom* is frequently collected. The resin from *Protium* sp. can be used as an incense, which has been an important component of Maya ritual since at least European contact and likely earlier (Breedlove and Laughlin 2000; Morehart 2011; Oakes 1951; Redfield and Villa Rojas 1934; Tozzer 1941; Vogt 1969). Ethnographically, copal smoke is regarded as a “symbolic sacrifice or “food” offering that is consumed by the deities” (Morehart 2011:111). The Tzotzil Maya consider copal to be cigarettes for deities (Vogt 1976:49). Charred residues believed to be copal was found at Cerros in Belize (Cliff and Crane 1989). Brady (1989:212-213) reported copal residue on ceramics from Naj Tunich in Guatemala. *Piscida* sp. is *habín*, which is used in *ch’a chaak* rain ceremonies ethnographically (Flores and Balam 1997). *Habín* is used in earth ovens for first fruit ceremonies (Redfield and Villa Rojas 1934). It is also used to construct the *ch’a chaak* altar (Flores and Balam 1997:105). *Piscidia* sp. is associated with rain and water (Morehart 2011:114). The significance of pine ethnographically and in archaeological contexts has been discussed in detail in previous chapters.

6.4 Comparing the Data to the Models

The data can be compared to the two models outlined in Chapter 2 in order to determine how the ancient Maya at Pacbitun reacted ritually to their changing environment. The first model based on behavioral ecology predicts that people will respond to regional climate change by using plants that are non-local, immature, and grow in disturbed, open areas. The second model based on cognitive anthropology predicts that people will continue using the same or

similar resources, use plants from primary forests, use local resources, and there would be no notable difference in wood maturity.

In Actun Nohoch Tunich, Actun Pech, Actun Slate, Actun Merech, and Actun Xtuyul local angiosperms and non-local pine is distributed relatively evenly. In Tzul's Cave, local angiosperms dominate the charcoal assemblage. Only in Crystal Palace and Actun Lak does pine significantly outweigh angiosperm charcoal based on standardized weight measurements. This would suggest that in terms of local versus non-local resources only Crystal Palace and Actun Lak conform to the behavioral ecology model, while the rest fit the model derived from cognitive anthropology.

Mature wood dominates the botanical assemblages of Actun Nohoch Tunich, Actun Pech, Actun Merech, Crystal Palace, and Actun Lak. In Actun Slate there is a relatively even distribution between mature and immature wood. In Actun Xtuyul immature wood specimens dominate the assemblage. Therefore, in terms of mature versus immature wood, only Actun Xtuyul conforms to the behavioral ecology model.

Of the species identified from the sites, *Ficus* sp., *Protium* sp., *Miconia* sp., *Piscidia* sp., and *Allophylus* sp., are found in wet environments or forests. *Alvaradoa amorphoides*, *Zanthoxylum* sp., and *Persea* sp. are generally found in disturbed habitats. *Zanthoxylum* sp. is also drought tolerant. This suggests that there is no clear distribution between habitats, but a relatively even split between species found in forests and those found in disturbed areas between all the cave sites. This would seem to support the model of cultural logics rather than the behavioral ecology model.

There is no temporal data available due to a lack of subsurface materials and no discernable stratigraphy. However, in each of the soil columns excavated from Actun Pech and

Actun Slate, there is little change in archaeobotanical remains throughout. The expanse of time encompassed cannot be safely determined, however excavations from both caves suggests continuity in the use of plant remains.

What these data demonstrate is that there is extreme variability between sites, however the paleoethnobotanical assemblages of a majority of cave sites seems to indicate that ritual practitioners were operating primarily based on cultural logics, rather than fitness-related behavioral trade-offs. No cave conforms perfectly to a single model. Indeed, some conform to each model in different aspects. During a time of resource scarcity, when the valley would have been the most heavily populated, only at Actun Xtuyul were immature plants primarily used. And only in Crystal Palace and Actun Lak were non-local resources primarily utilized. Actun Nohoch Tunich, Actun Pech, Actun Merech, Actun Slate, and Tzul's Cave all fall safely within the predictions of the model of cultural logics. This would suggest that environmental changes in the local ecosystem can be masked by the cultural rational of ritual practice and behavior.

6.4 Chapter Summary

Archaeobotanical analyses from nine karst features in the Pacbitun hinterlands suggest that tree resources were important components to Maya cave ritual. A general lack of food or subsistence related plant materials is rather surprising. It is possible that food offerings were carried into the cave via ceramic vessels and were not left in hearths. However, Morehart's (2011) study indicated that burned wood was the most common offering in caves, being symbolic food offerings for the gods transformed through fire. It is possible that more intensive archaeological investigations of these cave sites would provide greater insights into food offerings at Pacbitun. The paleoethnobotanical analysis also indicates that ritual practitioners

behaved based on cultural logics of ritual practice, rather than cost-benefit analyses of available resources, calling into question the applicability of behavioral ecology models to understand all forms of human behavior.

7 FUTURE DIRECTIONS AND CONCLUSIONS

7.1 Future Directions

The paleoethnobotanical research conducted for the purposes of this thesis were limited in scope. While nine karst sites were sampled, many received only minimal excavations. More thorough paleoethnobotanical investigations would provide a more complete understanding of ritual plant use at Pacbitun. Additionally, sampling caves with clear stratigraphic and temporal data would greatly benefit our understanding of changing patterns of ritual plant use through time. Doing so would provide significant data for understanding how the ancient Maya were responding to a changing landscape.

Obtaining multi-proxy paleoenvironmental data for the Belize Valley would provide a more accurate interpretation of the archaeobotanical remains recovered from cave sites in the region. Understanding the extent and degree of environmental pressure will provide a more nuanced picture of how people responded to a changing ecosystem. Additionally, systematizing the sampling strategy would allow for better comparisons between sites. Since some sites were only sampled when burn features were encountered, the volume of soil and the number of samples is not consistent between sites. The next logical step for this research would be to resample some sites in order to standardize the samples both in soil volume and quantity of samples. More thorough excavations should be conducted, especially at sites that were only minimally sampled. In addition, gathering other forms of paleoethnobotanical data, such as microbotanical or residue analyses, would contribute significantly to the current research.

7.2 Conclusions

Analysis of archaeobotanical remains recovered from nine karst features located throughout Pacbitun's hinterlands supports previous archaeobotanical surveys (see Morehart 2011) indicating that plants played an integral role in Maya cave ritual during the Late Classic period. Pine (*Pinus* sp.) was the most ubiquitous species encountered, present at eight of the nine sites. It also comprised a greater percentage of the archaeobotanical assemblages at half of the sites. Actun Lak's preponderance of pine charcoal correlates with its rich prestigious offerings. Additionally, given Pacbitun's dietary reliance on maize, it seems unusual that no maize was recovered from any of the cave sites included in the study. Admittedly, this may be due to random sampling error, and further and more extensive excavations would be beneficial. However, very few food remains were recovered from any of the sites. Of the few food remains that were in the archaeobotanical assemblage, none of them were common cultigens. Although cultigens and even textile fragments were excavated from a hearth feature in Barton Creek Cave (Morehart 2011:82-83), there is the potential that food offerings were left in vessels. Indeed, uncarbonized maize cobs were recovered from jars in Actun Chapat in 1998 (Morehart 2011:63). Some vessels in Actun Pech were preliminarily inspected during the 2012 season, but no macrobotanical remains were present in any of them. Residue analyses would be a beneficial future step in determining whether or not cave vessels had contained food offerings. However, the significance of symbolic food offerings, such as burned wood, should not be understated. The citizens at Pacbitun were supplicating their deities, but in a less overt manner.

Using the two models discussed previously, we can see where each site falls within the predicted outcomes. Three karst sites (Actun Xtuyul, Actun Lak, and Crystal Palace) exhibit characteristics of both behavioral models, while five sites (Actun Pech, Actun Merech, Actun

Slate, Actun Nohoch Tunich, Tzul's Cave) demonstrate patterns consistent with the model of cultural logic. Though the sites lack temporal data, there are still inferences to be drawn from spatial distributions. In addition, these ritual behaviors can be regarded as having been embedded in a context of macro-regional environmental change. By testing the paleoethnobotanical data against behavioral models, it becomes clear that environmental change may be obscured in the cultural miasma that governed everyday life among the Late Classic Maya. It is clear from paleoenvironmental data that at least some parts of the Maya Lowlands were experiencing dramatic climate change and ecological stress. However, the plant remains recovered from these nine karst sites suggest that people were primarily behaving in ways that conformed to social rules of logic, and not necessarily biologically driven to respond to resource scarcity.

It is my hope that this research contributes to Maya archaeology in various ways. It provides data regarding ritual plant use among the Maya at Pacbitun that can be compared to sub-regional data from the surrounding river valleys. It also contributes valuable insights into the ways that people respond to broad regional climate change. Social institutions such as ritual practice mediate the way that the Maya responded to the environment more than biological logics of resource scarcity. Understanding how people respond to the environment and are prevented from responding may help elucidate future questions regarding environmental change. Future research in the Maya area will further elucidate many of the questions addressed in this work.

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