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Forests, Foodways, and Households of the Arenal Region, Costa Rica: An Archaeological and Paleoethnobotanical Investigation of Resilient Practices in a Volcanically Active Landscape

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Forests, Foodways, and Households of the Arenal Region, Costa Rica: An Archaeological and Paleoethnobotanical Investigation of Resilient Practices in a Volcanically Active Landscape

By

Venicia Martha Slotten

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Committee in charge:

Professor Christine Hastorf, Chair
Professor Rosemary Joyce
Professor Timothy Bowles

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Abstract

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For thousands of years, people have successfully and continually occupied the landscape of Arenal, Costa Rica despite the relatively frequent environmental catastrophes, especially volcanic eruptions of Arenal Volcano. By analyzing the experiences of the ancient Arenal populations when faced with environmental disasters, archaeology can assist in preparing and coping for similar threats we face on a worldwide scale today. Paleoethnobotanical data collected from domestic structures in the Arenal region demonstrate the plant-human interactions that occurred in this volcanically active landscape in northwestern Costa Rica. These data provides a diachronic perspective, with a view of the plant resources used by residents in the Tronadora phase house structure at G-995 La Chiripa (1616-1108 BCE) as well as the Late Arenal phase village at G164 Sitio Bolívar (430-540 CE). The macrobotanical data (seeds, fruits, geophytes, and wood charcoal) reveal a subsistence strategy that was dominated by a diverse assemblage of forest-based products as well as root crops supplemented by minimal agricultural foods such as maize, beans, and squash. Notable fruit trees in both of the assemblages include avocado (*Persea*), cacao (*Theobroma*), cashew (*Anacardium occidentale*), cherry or plum (*Prunus*), coyol (*Acrocomia aculeata*), guanabana or cherimoya (*Annona*), guava (*Psidium*), jocote (*Spondias mombin*), nance (*Byrsonima*), ramón (*Brosimum*), sapodilla (*Manilkara*), pejibaye (*Bactris*), and mamey (*Pouteria*). A diet which primarily relied on agroforestry practices and root-crop agriculture may have aided these ancient inhabitants in navigating their ever-changing landscape. This is because low-lying vegetation, especially agricultural fields would not have survived depositions of volcanic ash and tephra, whereas underground root crops and stands of forests with fruit trees would have remained available, providing a bank of food either within their local surroundings or neighboring regions. Such a subsistence regime provided these ancient peoples with the ability to maintain their daily routines with a sense of resilience to their environmental setting that often experiences extreme conditions.

For Zinnia

Table of Contents

LIST OF FIGURES

List of Tables

Acknowledgements

While pursuing these archaeological investigations and writing this dissertation I have been fortunate to receive support from colleagues, friends, family, mentors, and a variety of funding sources. It would be inaccurate to portray this body of work as purely a product of my own, due to the great amount of energy put into this research by the support of others.

I would like to express my deepest gratitude for the mentorship of my committee members throughout my time at Berkeley including Christine Hastorf, Rosemary Joyce, Junko Habu, and Timothy Bowles. They have all provided feedback on my research throughout the process, greatly improving my methodologies and written work. My advisor, Christine Hastorf, has been an invaluable mentor who always made sure to devote time towards meeting with me, training and encouraging me to improve my paleoethnobotanical methodologies and writing. Her deep commitment to employing a strong methodological framework in archaeology and paleoethnobotany inspired me to pursue this degree and to always strive for improvements in my scholarship. She has also influenced me to go further with my interpretations of past people and their foodways in a way that brings the data to life, illustrating and imagining past lived experiences and engagements with plants. This endeavor would not have been possible without her support, strong drive, and guidance.

My other committee members helped to expand my perspectives academically and generously offered advice not just regarding my research and writing, but also my career goals. Rosemary Joyce encouraged a critical perspective of Mesoamerican and Central American archaeology and has always been very supportive of my research efforts and goals, as well as offering incredibly insightful advice in times of need. Timothy Bowles taught an agroecology course that encouraged me to engage further with disciplines outside of anthropology, reconsider my research endeavors with a new perspective, and make my research relevant to greater audiences. I must also thank Junko Habu, although not on my committee, she taught my environmental archaeology course, pushing me to consider a variety of theoretical frameworks in my research and was a superb advocate of me during my time at Berkeley.

I am incredibly grateful for the opportunity to participate in archaeological projects in Central America, which began with Payson Sheets generously welcoming me to join the excavations at Joya de Cerén in El Salvador during my master's research. Payson has been very supportive of my research goals throughout my graduate career and trusted in me to pursue paleoethnobotanical investigations in Arenal when his project discovered one of the oldest domestic structures found thus far in Costa Rica at the La Chiripa site. His continued support and enthusiastic demeanor while in the field inspired me to pursue additional funding for the Sitio Bolívar excavations, thus providing a suitable comparison of another domestic setting in the Arenal region.

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I would like to thank the directors of the Proyecto Prehistórico Arenal, Payson Sheets and Ricardo Vazquez Leiva, for allowing me to join the important project at La Chiripa and collect botanical samples that could greatly contribute towards our understanding of this settlement. I am grateful to the entire excavation crew for being patient with the collection process and helping to transfer the heavy soil samples back to Tilarán, even in less than ideal weather conditions. Other members of the La Chiripa project whose help made this dissertation possible during the 2016, 2018, and 2019 field seasons include Luis Barba, Andres Mejia Ramon, Tatiana Hidalgo, Rachel Egan, and Christine Dixon-Hundredmark. Local excavators hired during the fieldwork at La Chiripa include Mario Enrique Chevez, José Alfaro, Jose Andres Murillo Gonzalez, Jaison Antonio Amador Lopez, and Greyvin Jesus Amador Lopez. Andres Mejia Ramon helped manage collection of the paleoethnobotanical samples at La Chiripa, for which I am very grateful even though he may have repeatedly expressed his dislike for the amount of samples being collected, transported, and processed.

Excavations and laboratory work at Sitio Bolívar were completed by a combination of hired local excavators and volunteers. Local excavators hired during the fieldwork at Sitio Bolívar included Mario Enrique Chevez, David Barria Cubillo, Ricky Jarlen Warner Carillo, Jose Andres Murillo Gonzalez, Jaison Antonio Amador Lopez, and Greyvin Jesus Amador Lopez. Volunteers included Will Pennington (California State University, Long Beach) as well as many students associated with the University of Costa Rica including Maria Lopez Rojas, Anthony Azofeifa, Nicole Quinteros, Johanna Ferber, Fiorella Zumbado, Andrea Morales, and Maria Fernanda Obando Sanchez. Volunteers participated in both the field and laboratory components of the project. Additionally, advice regarding project decisions at Sitio Bolívar was given generously by members of the Proyecto Prehistórico Arenal including Payson Sheets (University of Colorado, Boulder), Ricardo Vazquez (Museo Nacional de Costa Rica), and Tatiana Hidalgo Orozco (Consultora).

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Lastly, I would be remiss in not mentioning my family, especially my parents, siblings, spouse, and daughter. My family has given me unwavering support as I pursued a doctorate in anthropology, rooting for me throughout this long journey, and making sure to keep in contact during my frequent travels. I could not have undertaken this journey without my partner in life, Eric Stetz, who never questioned moving our lives across the country from Cincinnati to the Bay Area. This journey has not always been easy, but his support and calm demeanor has always lifted my spirits, motivated me to persist, and helped to create a life where we could be our true selves. More than just emotional support, he has even become invested in this dissertation physically and assisted with his expertise in engineering. Whether it was through advice while designing each of the flotation systems developed for this research or help creating visual representations and plots of the data. Finally, I want to thank my daughter for changing my perspective on life and embracing the joy and laughter in even the little things. I dedicate this dissertation to her and hope that it motivates her to pursue her own goals and dreams, no matter what obstacles may come her way.

CHAPTER 1

INTRODUCTION

Central America is a tropical region of the world that experiences environmental catastrophes relatively frequently. From hurricanes, earthquakes, to volcanic eruptions, people have successfully and continually occupied this tumultuous landscape for thousands of years. By analyzing the experiences of ancient Central American populations when faced with environmental disasters, archaeology can assist in preparing and coping for similar threats we face on a worldwide scale today. At the very least, having a better understanding of the ways people have coped with a landscape that is dramatically altered on a regular basis could inform us of effective, or perhaps unsuccessful, strategies for such a way of living.

Through decades of archaeological research, beginning in the early 1980s, the Proyecto Prehistórico Arenal has demonstrated that past populations successfully lived in the Arenal region of Northwestern Costa Rica for thousands of years without dramatically altering their way of life (Sheets 2008, 2011, 2012, Sheets and McKee 1994), all while surviving a hazardous volcanic setting that remains active even to this day. The region is subject to frequent volcanic activity, resulting in layers of ash deposits between periods of human occupation, with abandonments, ecological recovery, and re-occupations after each eruption. The frequent eruptions of Arenal Volcano must have "reinforced traditional knowledge, hazard awareness, disaster experience, and belief" (Sheets 2012:46). Arenal Volcano erupts in a manner that is clearly detrimental to the surrounding landscape every few centuries, yet a level of persistence and continuity of culture is visible within the Arenal region through archaeological evidence. The settlement patterns, use of stone tools and ceramics, and community organization do not experience any grand transformations over millennia of cultural occupation through these radical environmental changes. This has led to a suggestion that the past people of Arenal were less vulnerable and more resilient to environmental disasters compared to people today. For example, when Arenal Volcano violently erupted recently in 1968, hot avalanches and base surges led to major devastation to the surrounding landscape and caused 87 fatalities (Melson 1994).

The only dramatic change in the past peoples of the Arenal region's lifestyle over thousands of years was primarily a transition from burying their ancestors below their domestic structures to instead developing cemeteries, often at high elevation settings near their community. Such a change in settlement organization may at first appear like a stark separation between communities and their ancestors. However, the ancient pathways, that were revealed initially through remote sensing techniques, are found throughout the landscape and were created just after this transition in lifeways, thus indicating that the people of Arenal developed a way to continue to visit their loved ones and their ancestors even when they were displaced during periods of ecological recovery (McKee et al 1994, Sheets and Sever 2007). Their use of a network of paths that were deeply entrenched into the earth and could therefore remain visible even after the entire landscape was blanketed in volcanic ash, actually aided efforts to maintain connections to cemetery spaces, as well as neighboring communities, significant land features such as natural springs, and presumably a variety of ecosystems in which to procure resources for their daily needs (Sheets 2009, 2011). Furthermore, despite periodic eruptions of the Arenal

Volcano, communities returned to the region continuously and re-established processional access to cemeteries perhaps even before villages were reoccupied (Sheets 2011).

While these pathways demonstrate a continual social memory of the landscape, its significant features, and spaces related to an ancestral home, they do not explain how people survived the volcanic setting. The paths primarily indicate that the residents of the Arenal region returned to the same spaces throughout time after displacement and maintained connections. Payson Sheets (2008, 2012) has suggested several factors that led the people of the Tilarán-Arenal region to be less vulnerable and more able to thrive in a volcanically active setting. One of the major factors likely contributing towards their ease of adaptability in times of stress is that the indigenous people of Arenal lived, for the most part, in small, low-population villages with decentralized, egalitarian political structures and benefitted from relatively equitable access to resources (Hoopes 1991, Mueller 1992, 1994, Sheets et al. 1991, Sheets 1994b). Such a social and political organization would have allowed people to be relatively self-sufficient and able to react rapidly to emergencies. The low population density in the region coupled with a reliable social network also meant that surrounding areas could easily support fluctuating populations that result from periodic forced abandonment and displacement. The long-lived processional pathways in the region demonstrate the established connection between these social communities. Ancient villages in Arenal did not have permanent stone architecture, this would have allowed people to be mobile if necessary and thus less attached to a specific location. Finally, Sheets (2008, 2012) presumed that a reliance on a mixture of both wild and domesticated foods created a flexible diet in times of ecological disruption. Food procurement strategies are a highly vulnerable component of human societies, so being able to maintain food yields that can withstand climatic variation would have been crucial in the Arenal region. However, a limited amount of direct data has been collected regarding the diet of this population (Clary 1994, Friedman and Gleason 1984, Piperno 1994, Mahaney, Matthews, and Vargas 1994).

Thus, the primary objective of my work is to examine the plant-human interactions within the Arenal region in the past, with an eye on how people obtained their food resources throughout the millennia that this region has been occupied. Were there any strategies that can be viewed through their engagement with plants that could have allowed these people to live on, unbothered by regular changes in the landscape? In pursuit of such evidence, I have collected paleoethnobotanical data from multiple archaeologically preserved domestic structures in the Arenal region (Figure 1-1) in order to capture a glimpse at what everyday life, and more specifically subsistence practices.

The first site, G995 La Chiripa, contains an early Tronadora phase structure that represents one of the earliest sedentary settlements in the region, dating to 1616 - 1426 BCE. The structure was first discovered in 2016 beneath a processional pathway. Thus, this site provides both early evidence of domestic life but also an example of a settlement that was perhaps revisited, through processions along the pathway long after it was abandoned by descendent communities, since the pathway postdates the structure by many centuries. The second site included within this study is G164 Sitio Bolívar, a village settlement located along the shore of Lake Arenal which was inhabited later in time than La Chiripa, during the Arenal Phase (500 BCE - 600 CE). Together these two settlements provide a diachronic perspective of domestic life within the Arenal region, depicting how lifeways persisted or were altered through time in the wake of continual disruption to the region volcanically. The resource procurement strategies these past peoples incorporated into their daily routines may have been vital towards long-term survival and could have helped the past inhabitants maintain resilience within their environmental setting that often experiences extreme conditions. In the following chapters, I will examine the Arenal region of Costa Rica through time in order to assess these past people's particular way of living within an active volcanic setting and detail their past plant-human engagements which aided in their resilient nature.

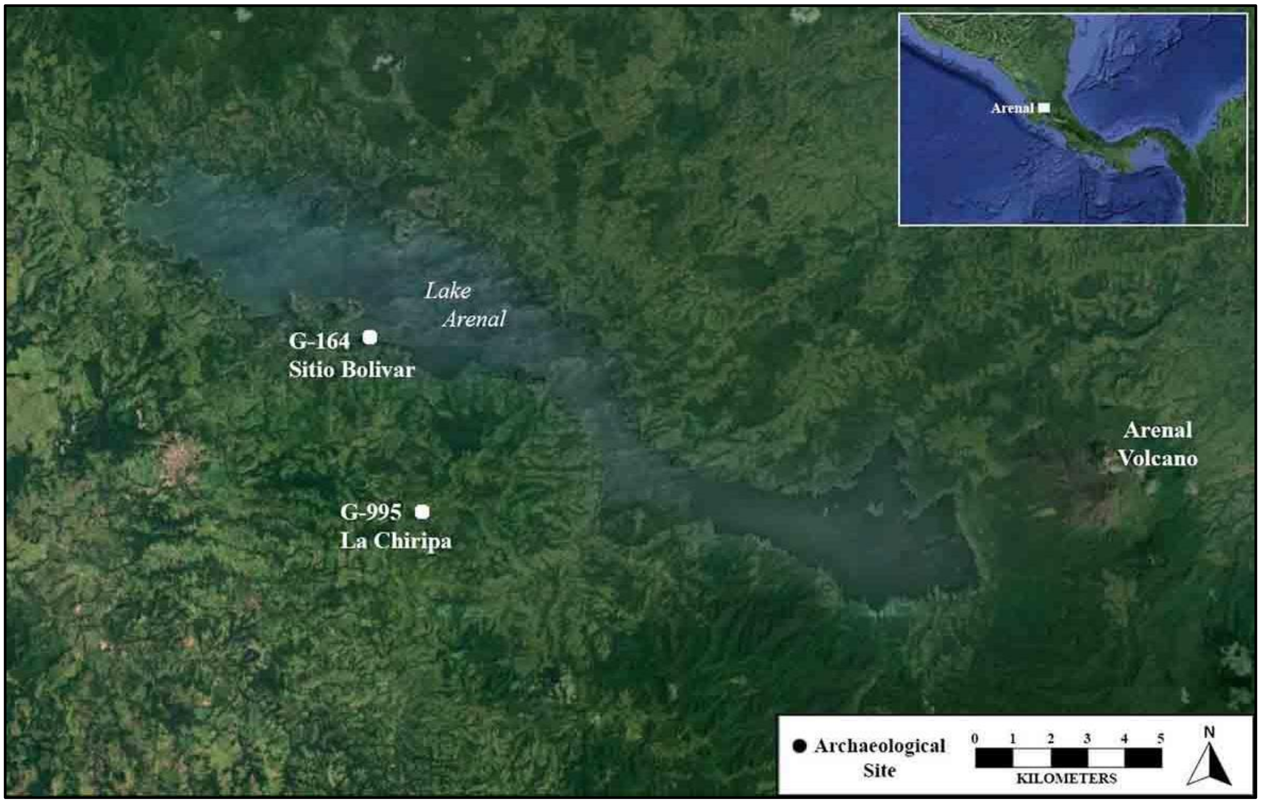


Figure 1-1: *Map of the Arenal region and the two archaeological sites included within this paleoethnobotanical investigation: G-995 La Chiripa and G-164 Sitio Bolívar.*

1.1 Overview

Chapter 2 will introduce the reader to the theoretical frameworks within environmental archaeology that will be incorporated into the assessment of the paleoethnobotanical remains recovered from this study of the Arenal region. The concept of ecosystem resilience, which refers to the level of disturbance that can exist with a system before it must change (Holling and Gunderson 2002: 28), will help to evaluate the diachronic evidence of plant-human engagement within the Arenal region from roughly 1600 BCE to 600 CE. With the region's frequent volcanic activity, past populations must have conducted certain aspects of their lives in a range of adaptive strategies due to the uncertainty of their future resources. Paleoethnobotany can provide a direct view of how people interacted with their environment and details of the plant resource procurement strategies they may have used. The paleoethnobotanical data can illuminate if any resilient or adaptive practices were incorporated into these people's lives. Ideas within the framework of Historical Ecology will also be explored within this chapter to better understand these people's relationship with their surroundings. This framework acknowledges nearly all environments have been shaped by people's engagement with them through a reciprocal relationship, thus dispelling any notion of a 'pristine,' natural equilibrium existing independent of people (Erickson and Balée 2006, Graham 1998, Whitehead 1998).Within this chapter I will work through the different postulates within Resilience theory and Historical Ecology in order to set up the reader with a familiarity of the frame of mind I will use when interpreting the paleoethnobotanical data.

In **Chapter 3**, I shift the reader's focus to the history of archaeological thought regarding domestic spaces and households, with an emphasis on the geographical region of Central America and Mesoamerica. This discussion will review major themes, issues, and directions of analysis included in household studies such as spatial patterning, activity areas, social behavior, social inequality, as well as craft, resource, and food production. The utility of a household-level approach within archaeology will be discussed in order to explain why such contexts are the focus of this dissertation. Archaeological excavations of household contexts can aid in the pursuit of understanding an overarching structure of a society, since a household is the smallest discrete unit that can be analyzed socially and thus home life is where one can find the patterns enacted and perpetuated into a community's way of life (Wilk and Rathje 1982). Paleoethnobotanical methodologies are well suited in investigations of households because nearly every aspect of daily life in the past would have involved plant-based resources, as people would have been much more connected with their environment compared to today. Furthermore, the house can be viewed as an extension of the self (Carsten and Hugh-Jones 1995, Gonlin 2020), thus identity and cultural ideologies can be extrapolated from archaeological pursuits of such spaces.

An overview of the unique environment of the Arenal region and Costa Rica more broadly will be presented in **Chapter 4** in order to orient the reader both geographically and ecologically. While the country of Costa Rica is relatively small in size, it exhibits a wealth of biotic diversity and over 11,500 plant species have been documented scientifically there today (Kappelle 2016, Obando 2002). This chapter will review the various ecosystems and life zones that can be found within the Arenal region and where each of the archaeological settlements in question specifically are situated. These ecosystems are accompanied by implications for people's lives in such settings, such as the potential for agriculture and what types of forests would have been accessible to past inhabitants. Additionally, this chapter will provide a review of the active volcanic setting of the Arenal region and its history of catastrophic eruptions which would have greatly impacted any past populations living within roughly 40 to 50 kilometers or less of Arenal Volcano. Severe eruptions of this stratovolcano occur every few centuries (Torrence 2016), resulting in cycles of ecological recovery and temporary displacement of people from their villages. Yet people lived continually on this landscape for millennia, remained connected to their ancestral homeland and way of life, and benefitted from the fertile soil resulting from the weathered volcanic ash deposits (Sheets and Sever 2006, Sheets 1994, Walker 2011).

In **Chapter 5**, I present the history of archaeological research within the Isthmo-Colombian area with an emphasis on the country of Costa Rica. I outline and survey the major archaeological subareas found in Costa Rica and beyond, beginning with the Greater Chiriquí area in the south and directing the reader's attention northward through the mountainous Central Highlands, up to the Greater Nicoya area, ending with the Arenal region in the northwest. I include details on each subarea's history of research, periods of occupation, ecological settings, known settlement patterns, and use of material culture. While past communities in these different regions were quite variable and in actuality exhibited a mosaic of cultural practices, the review of the broad regional trends will help to both situate the region of Arenal while providing clues to the ways these past societies interacted with each other and exchanged ideas regarding life ways in this tropical setting. Costa Rican archaeological sites showcase impressive settlements connected by intricate causeway systems, with innovative technological developments, artistic achievements, and a variability in sociopolitical regimes (Corrales 2000, Sheets 2011, Vazquez et al. 2002). Most importantly, this chapter reviews the history of archaeological and paleoethnobotanical research within the Arenal region including previous investigations at the archaeological sites under analysis in this dissertation, G-995 La Chiripa and G-164 Sitio Bolívar.

The details of the archaeological excavations at La Chiripa and Sitio Bolívar in which the paleoethnobotanical work of this dissertation were obtained will be presented in **Chapter 6**. This chapter walks the reader through the excavation research design of this dissertation, including both the archaeological and paleoethnobotanical methodologies. Details of the horizontal excavation strategies at each site and a step-by-step account of the stratigraphic levels, artifacts, and any issues within the field are discussed. As a trained paleoethnobotanist, I collected samples aimed at recovering preserved plant remains at these archaeological sites in order to gain my primary data set. As yet, such research is not regularly or systematically practiced within this geographical region. Therefore the collection and processing strategies that I employed while in the field involved a combination of methodologies including water flotation, the screening of sediment through geological sieves, as well as microbotanical sampling of contexts for pollen and phytolith remains. Additionally, the laboratory methodologies will be described within this chapter including the sorting, identification, and analysis of preserved botanical remains at the McCown Archaeobotany Laboratory at the University of California, Berkeley.

The results of the paleoethnobotanical analysis are presented in **Chapter 7**. This chapter begins with a broad presentation of the data where I take a critical look at the overall results, the efficacy of the paleoethnobotanical recovery efforts, and their implications for future archaeological excavations within this geographical region. An evaluation of the species richness for these two sites reveals the high volume of data involved in this investigation as well as a discussion of why these paleoethnobotanical efforts only provide a glimpse of the potential results which could be obtained through a rigorous research design. I present the basic quantification of the macrobotanical data within each stratum at each archaeological site, including measurements of both standardized densities and ubiquity of the most prevalent botanical taxa so that the reader can review the results from a variety of perspectives. I also present and examine the spatial patterning of the recovered plant material within each stratigraphic level at each archaeological site, in which the data was visualized using the matplot library within Python to reveal potential activity areas within these domestic spaces. Lastly, initial comparisons are made between the two archaeological sites and time periods with critical evaluation of any change or continuity that can be observed diachronically for the Arenal region's plant procurement and use patterns. I conclude that the past residents of La Chiripa and Sitio Bolívar engaged with similar flora in their daily lives, but may have held differing priorities and presumably ways of living within their respective tropical forests.

Chapter 8 discusses the implications of the paleoethnobotanical results as they relate to the past engagement these two settlements had with their forested spaces, since the vast majority of botanical identifications were made through analysis of wood charcoal remains. I discuss the quality of the fuel resources that were ultimately burned within and surrounding these house structures and any implications these data set reveals towards the intentions, goals, and priorities of the past residents when exploiting their nearby forests. What type and level of impact did these peoples have on their tropical woodlands? How does these data set compare to other paleoecological investigations in Central America? How does the data compare to Costa Rican forests today? While the assemblage of arboreal taxa identified within this study cannot precisely depict or reconstruct the forests of ancient Arenal, they can indicate the types of forest these past peoples interacted with in order to obtain their desired resources. Did these people travel beyond their lake region or trade with neighboring communities in the pursuit of arboreal materials? This chapter explores a variety of aspects relating to forests, trees, shrubs, and the use of woody taxa and ultimately describes how the residents of the Arenal region engaged with their landscape.

I then shift to an interpretation of just a subsample of the data set, with a focus on just the taxa identified within the paleoethnobotanical samples that produce edible plant parts, whether that includes fruits, leaves, seeds, flowers, roots, or even the bark of a tree. Thus, **Chapter 9** will guide the reader through the foodways of the past people of the Arenal region, looking at the evidence of dietary patterns through a paleoethnobotanical lens. Other material culture recovered from these two sites such as ceramic and lithic artifacts will be incorporated into this discussion to plot the food evidence across horizontal space and reveal the spatial distribution of activities within these household settings. I will contextualize my findings from these two case studies of household use of flora within the broader region of Central America and beyond through comparisons to other data sets and paleoethnobotanical investigations that were conducted nearby. With a narrowed focus on just the edibility factor of the identified botanical taxa, this chapter will analyze the ways that these residents procured their food, what agricultural practices they may have employed, how they prepared their food, presented and consumed their meals, spilled and ultimately discarded what was found archaeologically.

In my final chapter, **Chapter 10**, I will summarize the overall results of this investigation in order to illustrate how these people's interaction with their landscape reveal a rather consistent and stable lifestyle, marked with a continuity of practices in plant engagement over several millennia. The paleoethnobotanical results when considered in tandem with previous archaeological studies in this region demonstrate that thousands of years of generations of residents of Arenal achieved a level of resilience to their volcanic landscape and found a way to maintain their way of life despite regular interruptions, forced displacements, and periods of ecological recovery. I specifically suggest that their procurement of food and fuel resources allowed for a lifestyle capable of adapting to unpredictable environmental disasters. I believe that this investigation demonstrates the value of paleoethnobotanical methodologies and frames the past residents of La Chiripa and Sitio Bolívar as incredibly knowledgeable people who found a way to thrive within the tropical moist forests of the Arenal region despite any obstacles that came their way.

CHAPTER 2

THEORETICAL FRAMEWORKS IN ENVIRONMENTAL ARCHAEOLOGY

This chapter will outline two of the major theoretical frameworks that will be incorporated into interpretations of the paleoethnobotanical data recovered from past domestic settlements in Arenal, Costa Rica: resilience studies and historical ecology.

2.1 Resilience and Adaptability Studies

Environmental crises are socio-environmental crises because it is impossible to separate people from their environment (van der Leeuw 2009) and resilience theory is an approach to study the dynamics of socio-environmental systems that has been increasingly incorporated in archaelgoical studies (Løvschal 2022). Socio-ecological resilience theory developed out of attempts to model the stability of living systems (Holling 1973, Holling 1995, Lewtonin 1969). These models focused on understanding the processes that control the persistence of ecological systems, aimed to know the boundaries of its structure, and assumed that ecological systems were naturally stable and would persist unless people caused disruptions. Scholars of early models thought that once human disturbances were removed from the equation, ecological systems would eventually return to that state of equilibrium (Gunderson and Allen 2010). However, Holling (1973) introduced the concept of resilience to acknowledge that there is a certain amount of disturbance that an ecological system can handle before it shifts into a completely alternate pathway. Traditional definitions of stability concentrate on an equilibrium state and a system's ability to swiftly and efficiently return to the equilibrium after a disturbance; what is termed *engineering resilience* (Holling and Gunderson 2002: 27-28). Alternatively, *ecosystem resilience* refers to the magnitude of disturbance that can be absorbed before a system's structure is changed and focuses on existence of function rather than efficiency (Holling and Gunderson 2002: 28). The first definition suggests that natural systems are predictable, can be controlled, and that a neutral, stable state exists. This second view of resilience is more applicable when considering a sustainable relationship between people and nature.

Now, ecologists perceive resilience in a variety of ways, each with a different set of assumptions. Pimm (1991) suggests that resilience refers to how quickly a variable can "leap back," or return to a state of equilibrium. Holling (1973, 1996) defines ecological resilience as the magnitude of a disturbance that triggers a shift between alternative states, meaning shifts occur when the variables that control a system become a different set of structures. Such shifts in regimes have been documented for example in semi-arid environments that alternate between grasslands and shrub-dominated systems due to drought cycles and fire regimes (Walker 1981). Folke and colleagues (2004) propose that resilience reflects the degree to which a complex adaptive system is capable of self-organization and its capacity for adaptation. This definition considers scales of space and time to be nested. This nested structure of ecosystems is referred to as a panarchy. Gunderson and Holling (2002: 17) say that within a panarchy, resilience refers to the "ability of a biological system, an ecosystem, or a social system to withstand disturbance and still continue to function." However, it is critical to note that resilience is never infinite and that it can eventually be overtaken by large-scale change (Gunderson and Holling 2002: 31). Within this study of past lifeways in the Arenal region of Costa Rica, resilience theory will be used to consider the ability of the past inhabitants of this region to persist through time and withstand disturbances such as volcanic eruptions, since the region is known archaeologically for its longevity of cultural practices over thousands of years.

Resilience theory shows that ecological systems are complex and that they operate across a wide range of space and time (Gunderson and Allen 2010). This requires that assessment of ecological systems should cover multiple scales, from the micro level all the way to a global level. This also requires a view of long-term processes, a view that can be achieved using archaeological research (Redman and Kinzig 2003). Adaptive management should confront various sources of complexity, including not just ecological factors, but also social, economic, political, and organizational components (Holling and Gunderson 2002). The dynamic nature of ecological systems means that it is challenging to predict ways to manage adaptive systems.

According to Ljungqvist (2018), people have reduced resilience today for multiple reasons: overpopulation, severe poverty, unequal access to resources, lack of agricultural diversity, and a lack of economic diversity. Recurrent scarcity was likely in the past, and so people have developed mechanisms to cope with periods of resource shortages (Colson 1979). For example, during times of famine, societies will shift to foods that are normally ignored, break into smaller family groups, refuse to share food, and have the determination to teach their children how they survived. Colson (1979: 21) describes five strategies that could lessen the vulnerability of populations to environmental crises: 1) diversification of activities that do not rely on specialization, 2) long-term storage of foodstuffs, 3) long-term storage and transmission of information, 4) conversion of surplus food into durable valuables, and 5) the cultivation of social relationships from different regions. The presence or absence of these various strategies in past settlements of the Arenal region using archaeological and paleoethnobotanical data will be used to evaluate the vulnerability of these past populations.

Resilience theory is the basis for adaptive management; it acknowledges the uncertainty of the future for resource systems (Gunderson and Allen 2010). Resilience theory demonstrates the connection between dynamic social and ecological systems across a range of organizational scales and it was developed to explain the nonlinear dynamics of complex adaptive systems. The adaptive cycle is of cyclical time, not linear, and as mentioned previously these nested cycles are referred to as a panarchy (Berkes and Folke 2002). Every element involved in a panarchy is hierarchically nested, each with its own adaptive cycle (plants, fields, ecosystems, or landscapes) (Holling, Gunderson, and Peterson 2002). The adaptive cycle includes four main functions of an ecosystem: exploitation, conservation, release, and reorganization (Figure 2-1). The first phase, exploitation, engages the system with a period of rapid growth where species known as r-strategists colonize recently disturbed areas. R-strategists are entrepreneurs and innovators who seize opportunities ecologically. The second phase includes conservation, during which energy and materials are slowly accumulated and K-strategists reduce their impact on the system through their own mutually reinforcing relationships. The potential that accumulates is stored as biomass or can take the form of management, innovation, and the accumulation of knowledge. Growth in conversation slowly becomes rigid, less flexible, and vulnerable to disturbances. This leads to the third phase, release or omega (Ω). Here, a disturbance has caused a system to break apart its different interactions and all the material that had accumulated is released or transformed. Examples of this release phase include droughts, forest fires, or disease outbreaks. During the final phase, renewal or alpha (α), novel controls appear in the system allowing for experimentation and a re-assortment of energy and material. In ecosystems, this is where pioneer species and invasive plants can dominate the system. In a social system, new groups may take control. The faster levels deal with experimentation, inventions, and testing whereas the slower levels stabilize the system and conserve accumulated memory of past successful experiments.

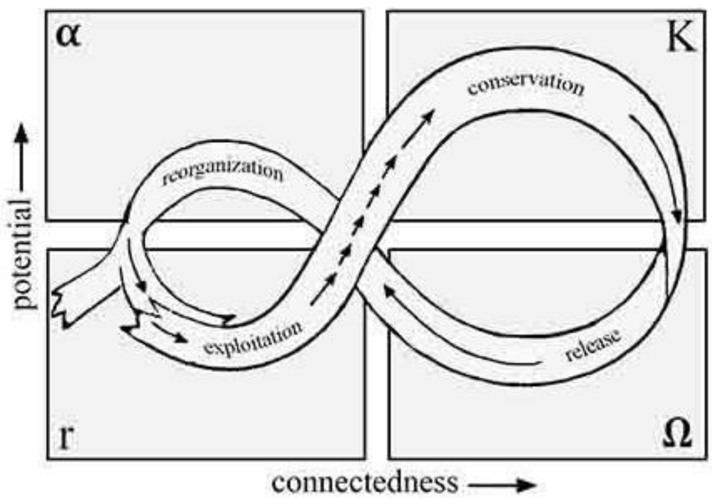


Figure 2-1: *The four ecosystem functions or phases within a panarchy represented as an adaptive cycle (redrawn from Holling and Gunderson 2002:34).*

Adaptive management works in the most productive manner when it incorporates multiple ways of knowing, context is taken into consideration, and decision making occurs at both the top and the bottom of a system (Gunderson and Allen 2010). Humans have survived this long because they are a resilient species (Colson 1979) and have worked with ecological systems that are periodically restructured in order to allow for innovation (Holling et al. 2002). This is why resilience theory and adaptive cycles also value traditional ecological knowledge (TEK) because traditional systems tend to emphasize the importance of allowing for local flexibility to new situations and circumstances (Berkes et al. 2000). Typically, oral histories pass down environmental management practices within traditional communities. While the absence of indigenous populations in the Arenal region makes it difficult to directly investigate lasting practices and oral traditions, archaeological data can indirectly demonstrate their presence through time if cultural traditions continue across the millennia of time represented in this study. Today, this long-term memory of engagements with the environment could help us reshape the systems that are in trouble around the globe. The flexibility that many traditional systems encompass leads to a rich diversity of practices that could be applicable in various situations (Berkes and Folke 2002).

In order for a system to persist in the long-term, those who manage the system cannot be rigid in view, they must be open to potentially useful alternatives (Holling et al. 2002). Long time scales that have a deep perspective of time allow us to examine “true transformations” that represent significant changes in socio-ecological systems (Redman, Nelson, and Kinzig 2009). A historical cycle in contemporary studies is truncated, but archaeology can provide completed cycles. This is why present-day experiments are not adequate representations of socio-ecological shifts. In order to fully understand these shifts in systems over time, ecologists must incorporate archaeological and paleoclimatic data into their understanding of resilient practices. The archaeological record allows us to identify those emergent features that appear to be inevitable in societies which are increasing in complexity, such as social stratification, the compartmentalization of information, and ecological simplification (Redman, Nelson, and Kinzig 2009). It is possible that the small egalitarian groups and low population density within the Arenal region could have contributed towards these past people’s long-term success and continuation of cultural traditions because decisions could be made and acted upon more readily during times of stress (Mueller 1992, 1994, Sheets 2008).

An ecological system’s resilience can decrease when its biological diversity is reduced. This essentially is a reduction of ecological functions and a removal of biomass which creates a vulnerability for that system to smaller forces that could potentially prompt a regime shift. Biological diversity enhances the redundancy of functions within an ecosystem and redundancy of function contributes towards the stability of an ecosystem. This way a loss of a species from that system will not have a great impact on the stability of the system, as long as there was more than one species contributing to the function that lost species played in the entire system. Resilience theory stresses that species richness is only significant when there is a wide distribution of functions present across multiple scales (Peterson et al. 1998). Redundancy of function increases resilience. The botanical material collected from archaeological sites in the Arenal region will allow for a comparison of biological diversity through time and an assessment of the distribution of functions within the taxa recovered.

Erickson (2008) demonstrates the different types of biodiversity exhibited in ecology. Alpha diversity (α) refers to the number of species within a locality, whereas Beta diversity (β) refers to change in the composition of species between adjacent areas. Then, gamma diversity (λ) encompasses all of the species within the region (α x β). Biodiversity is assumed to benefit ecosystem function by increasing biomass, resilience, and productivity. Diversity of flora in ecosystems is said to create a more resilient structure that can withstand perturbations. Agriculturalists who are self-reliant and resilient grow a variety of crops and multiple varieties of each of those crops (Colson 1979). Agriculture that focuses on just a monoculture often leads to a loss of soil fertility, a buildup of unwanted weedy plants and pests, and increased soil erosion.

Colson (1979) stresses the importance of maintaining autonomy and sovereignty, because it can create a more resilient society. When there is social and economic equality, there is more of a support system that is more prepared to deal with environmental shifts. However, such strategies are less productive with the occurrence of large-scale environmental destruction which are more challenging to recover from. For example, deforestation can have such devastating effects on environmental management strategies that it may take centuries to undo the damage it has caused. Globally, ecosystems have been altered significantly more in the past fifty years than at any other time in history (Reid et al. 2005), suggesting that numerous large-scale ecological perturbations have occurred due to human activity. The abundance and frequency of these larger-scaled destructive activities are making it increasingly challenging to maintain resilient socio-ecological systems.

2.2 Historical Ecology

Historical Ecology subscribes to the scientific method, but itself is not a method, it is more a framework or a way of understanding people's relationship with the environment through time (Balée 1998). This field employs data from multiple disciplines; it can be described as a collaboration between many disciplines, including mainly ecology, geography, and anthropology (Balée 1998, Crumley 1998). There are a series of postulates in historical ecology, which have been developed by Balée (2006), that succinctly describe the key concepts of the discipline and outline my discussion of this theoretical framework which will be incorporated into the analyses of paleoethnobotanical remains from the Arenal region.

First, is the idea that *all* nonhuman biosphere (the environment) have been affected by human activity since the genus *Homo*. Using a framework of historical ecology, there aren't any locations on the earth today that have not been affected by people. Wherever people have been, the environment is now different, in both dramatic and subtle ways (Balée and Erickson 2006). People have been impacting, shaping, and altering their surrounding environment for thousands of years and their impacts have been accumulating into more dramatic and visible manifestations (Balée 1998). Climatologists and other scientists argue that people have impacted the environment so much that we are living in a geological epoch that is defined by human's dominance over the earth's ecosystems, the anthropocene (Braje et al. 2014, Malhi 2017).

Within a framework of historical ecology, there is no such thing as nature. Nature is a construct of culture and education (Graham 1998). People's practices never take place in a 'pristine' environment (Whitehead 1998); there is no such thing as a natural standard, equilibrium, or a natural baseline (Erickson and Balée 2006, Pyne 1998). Baselines are always socially constructed. Baselines tend to aim for the status of the environment before human exploitation, but people's interactions with the environment began 1.8 million years ago (Hilding-Rydevik et al. 2018). Because of this, there is limited knowledge of past 'natural' ecosystems. Since historical ecology does not support the concept of nature or wilderness, stability should not ever be assumed a priori and is not necessarily even an achievable goal (Graham 1998). The myth of wilderness as an untouched space of land stems from an urban perception of the environment (Gomez-Pompa and Kaus 1992); it has little basis in the reality of tropical forests in which the current composition of mature vegetation is the legacy of people's use over millennia (Berkes 2018: 15).

There is a mutual influence between people and the biosphere (Balée 1998), it isn't a unidirectional relationship. No organism is isolated, all are part of a community and interact with each other and their environment (Graham 1998). There is a dialogue between nature and culture, not a dichotomy (Balée 1998:14). Nature and culture interact with each other reciprocally. Historical ecology employs a dialectical perspective, where nature and culture are constantly interacting and changing.

All environments have a history that has been recorded and can be viewed archaeologically through the impact of people's cultural practices. Current human-environment choices are always conditioned by previous landscape decisions and that is done in a non-linear fashion (Fisher et al. 2009). Historical ecologists view human actions to be just as significant as forces such as natural selection, which places archaeology as a key methodology when interpreting environmental histories. Historical ecology advocates that it would be best to replace the word ‘pristine’ with ‘old-growth’ when people are describing areas that seem to them to be more natural than cultural. This acknowledges people’s intervention with a setting, even if it was long ago (Balée 2006).

Within a framework of historical ecology, the environment and society are historical constructs. Historical events are responsible for changes in relationships between societies and their environments (Balée 1998). Historical events are the human praxis that imperfectly reproduce structures through time (Whitehead 1998). These events mark people’s interaction with the environment through time. History includes all recorded events and can be documented through various mediums, not just written records (Graham 1998). This is where archaeology aids in the interpretation of history, because the material record adds another line of evidence or another mode of recorded history, that can be alongside historical documents and ethnographic records. Archaeologists record the history or people. Oftentimes, archaeological sites are defined by the presence of just a ceramic sherd. Historical ecologists argue that the presence of people should not be based mainly on ceramics, however, because various other methods of analysis can reveal human activity (Graham 2006, Whitehead 1998). Archaeology is poised to provide material evidence from throughout history, whether that is in the form of ceramics, stone tools, metals, skeletal remains, or paleoethnobotanical and faunal assemblages. However, it is important to remember that not all tools will necessarily preserve archaeologically, such as anything crafted out of wood or plant remains. This preservation bias could impact archaeologists' evidence of past practices. When preserved, organic assemblages can be used to directly discuss people’s relationship through time with their environment. Because of this, Whitehead (1998) argues that even plant remains should be considered cultural.

The second postulate in historical ecology is that human activity does not always lead to degradation or extinction of species, nor does it always create a more habitable biosphere with increased species diversity (Balée 1998, 2006). People do not always influence other life, they just have greater potential than other species to affect the biosphere. People have a high adaptability to environments and also utilize technology, which gives them greater potential to impact the environment compared to other species, which makes humans a “keystone species” (Balée 2002, Erickson and Balée 2006). Historical ecology differs from agroecology in that many of the scholars do not support the use of the labels beneficial, enhancing, sustainable, destructive, or degrading (Balée and Erickson 2006): these terms may not be appropriate temporally or geographically. Scholars who incorporate a historical ecology framework aim to acknowledge that people have impacted the environment, whether it was a good or a bad result. For example, both soil formation and soil degradation are both important byproducts of human practices (Graham 1998).

Typically, people tend to assume that ecosystems that lack the influence of anthropogenic actions are thriving with a diverse assemblage of plants and animals. In reality, high diversity is usually not the equilibrium or indicative of the absence of people, but rather the result of human disturbance (Graham 1998). Ecologist Joseph Connell (1978) suggests that moderate disturbances that occur at an intermediate frequency actually promote the greatest biological diversity. There are certain ecosystems which tend to indicate intensive human interaction has taken place in either the distant or the recent past. Savannahs tend to indicate intense landscape management in the past (Balée and Erickson 2006). These grasslands would have become scrublands or woodlands if it wasn’t for the influence people have played in its creation. This can be seen in central California, where Native Americans kept vast landscapes as grasslands through frequent low-severity cultural burning practices (Lightfoot and Cuthrell 2015). High densities of liana in the Eastern Petén of Guatemala indicate past human perturbation as well (Campbell et al. 2006). Balée (2006) shows that forests are artifacts and that people have created biotic niches. These spaces are sometimes referred to as 'cultural forests,' and can be considered ancient dwelling sites (Rival 1998). The impact people have had on the landscape can also be seen through the sheer number of plant and animal species that have been domesticated in order to benefit people's ways of life. The Americas alone has over 100 species of domesticated plants (Brucher 1989). The influence people have had on a landscape doesn't just result in an increase in domesticated species. Both people in the Amazon and Mesoamerica have been shown to have exploited 'wild' resources (Fedick et al. 2023, Heckenberger et al. 2008, Rival 1998, Shepard et al. 2020, Slotten 2015). There are also many plants that thrive or mostly occur in areas that have been disturbed by people (Whitehead 1998). There are many intermediate stages between wild and cultivated plants (Rival 1998), all of which should be considered when interpreting people's role in the construction of ecosystems.

The third postulate states that different socio-political systems in the same regions can result in differing effects (Balée 2006). This is because unlike with cultural ecology, historical ecology does not believe that human actions and cultural practices are ecologically determined. Therefore, groups of people living in the same type of ecosystem do not necessarily have to have the same cultural beliefs and practices or the same manners of interacting with their landscape. Native Californians are an excellent example of this postulate. This region during Pre-Columbian times was one of the most culturally diverse areas in the world. There were over 60 tribes that lived throughout California, when split by broad linguistic designations. Alfred Kroeber recorded this to amount to over six hundred community villages, or tribelets (Kroeber 1925). Each tribelet had their own language, beliefs, and practices and their territories often encompassed several elevational zones resulting in a variety of plant communities (Anderson 2005: 38). Yet, these people were living in the same region. Depending on where in California they called home, they may have occupied different ecosystems, but many were living in similar spaces and environments.

This phenomenon also occurred in Central America, where native groups developed a variety of agricultural practices in order to interact with their tropical environment. Similar to native Californians, indigenous Central Americans had a diverse set of cultural practices that encompassed over 100 different languages (Suarez 1983). Some areas of Mesoamerica adapted a system of agriculture that incorporated years of swidden-fallow, while others utilized arboriculture, orchards, terraces, checked dams, raised beds, chinampas, drained fields or even slash and burn agriculture (Lentz 2000, Whitmore and Turner 2001). These agricultural innovations sustained Maya populations for several centuries (Lentz 2000). There were diverse forms of agriculture in Mesoamerica during different time periods and that also varied depending upon the ecological zone (Wyatt 2008). Persons are always situated in time and place (Whitehead 1998), which can result in varying beliefs no matter what environment they occupy.

The fourth postulate is that societies can impact landscapes in dissimilar ways (Balée 2006). Not all societies have the same goal or intention when modifying their surrounding environment. Much of this results from cultural differences. Native Californians, for example, did not adopt the agricultural practices that many other groups in North America had incorporated into their daily lives as a primary mode to gather their food resources. Eastern North America had adopted a subsistence based on domesticated species such as marshelder (*Iva* *annua* L.), chenopod (*Chenopodium berlandieri* Moq.), bottle gourds (*Lagenaria siceraria* [Molina] Standl.), squash (*Cucurbita pepo* L.), giant ragweed (*Ambrosia trifida* L.), sunflower (*Helianthus annuus* L.), little barley (*Hordeum pusillum* Nutt.), erect knotweed (*Polygonum erectum* L.), and tobacco (*Nicotiana*) (Fritz 2019: 30, Smith 2006). Whereas the American southwest and Mesoamerica depended largely on agriculture centered around maize (*Zea mays* L.), beans (*Phaseolus vulgaris* L.), squash (*Cucurbita*), tomato (*Solanum lycopersicum* L.), manioc (*Manihot esculenta* Crantz.), and chile peppers (*Capsicum annuum* L.) (Lentz 1999, McAnany 1993, Sheets et al. 2012, Zizumbo-Villarreal et al. 2012). Instead, native Californians were hunter-gatherers that also managed their landscape in a way that encouraged the growth of species valuable for their own ways of life. They used fire to clear areas of undergrowth, control insect infestations, and also influence and increase the productivity of various plants (Lightfoot et al. 2013). Many plants and animals used in daily practices of native Californians such as huckleberry or salmon actually thrived in a landscape managed by regular cultural burning (Lightfoot et al. 2013). Many of the plant's growing habits were enhanced through intentional and systematic fire management regimes (Whyte 2018). Baskets, rather than ceramics, were a key component of storage for Native Californians. The shoots and stems used in basketry were better to work with when they were long and straight. If the bushes utilized in basketry were left to grow without any management for too long a period of time, their branches became intertwined, with many twists and angles, making them unsuitable for use in basketry. Yet, after a low-intensity burn and with frequent pruning, the plants are rejuvenated and sprout new branches that quickly develop in a more straightened manner.

The indigenous people of California also depended upon a series of plants for medicinal purposes that could become overpowered and struggle to grow if surrounding vegetation is allowed to grow continuously without any interruption. Additionally, a main source of their diet came from nuts and foods that grew on trees and would fall to the ground when ripe. When the understory of a forest was overgrown, collecting food resources would have been more difficult with the food material hidden below other plants, debris, and brush. Native Californians practiced frequent, low-severity, surface burns. They would create a mosaic or patched framework using ridges, rivers, basalt flows, and previous burns to control the extent of cultural burning (Lightfoot et al. 2013). Archaeological research in the eastern Petén also shows that the ancient Maya used stone walls or cleared breaks to protect forest gardens from fire (Campbell et al. 2006).

The cultural use of fire to manage the landscape is a key example of how people have impacted their surroundings throughout their existence, but recent practices of fire suppression directed by western civilization has diminished the use of fire to manage the landscape today. Exclusion of fire is incredibly recent and is a denial of the inevitable (Pyne 1998). Urban people fail to see the value of fire, whereas rural people are more closely connected to their land and are more likely to understand how fire can benefit an ecosystem. Today only about twenty percent of burning occurs compared to in the 1400s (Pyne 1998), and we are witnessing the consequences of this lack of fire management today. These fires in Pre-Columbian America were unlike the large, catastrophic fires we see in California today. This is because of the build-up fuel loads resulting from fire suppression practices today. Without burning the land will become homogenized scrub lands and woodlands. Cultural burning practices increased the diversity of indigenous species. Cultural burning practices show that if small-scale disturbances are created, a system becomes more able to cope with a large-scale disturbance (Berkes and Folke 2002).

The fifth and final postulate is that communities of people and the landscapes they interact with can be understood as a total phenomenon (Balée 2006). The concept of landscape is central to Historical Ecology because the landscape is always shaped by past actions (Balée 1998, Whitehead 1998). This view is centered around people (Balée and Erickson 2006). Historical ecology calls for an anthropocentric view, not ecocentric or geocentric (Balée 2006), because of their argument that people are inseparable conceptually from 'natural' events and environmental trends. People are always impacting their surroundings, whether that is intentional, acknowledged, or not at all. Landscapes record both intentional and unintentional acts (Crumley 1998). This idea that humans and the environment are so interlinked is no longer widely accepted or conceptualized in much of western culture, but it can be seen with many indigenous groups with traditional ecological knowledge (TEK) (Whyte 2018). This concept of people and landscapes being a complete phenomenon is shown with the Huaorani people of Ecuador (Rival 1998). They exhibit an inseparability between their people and the forest. The Huaorani believe that the presence of useful plants comes directly from great-grandparents and that the plants' presence indicates an invitation to use the forest. Resources, in their world, are viewed as gifts from deceased relatives and ancestors who are helping their descendants continue to thrive.

It is important to note that historical ecology is not the same as cultural ecology. Cultural ecology focuses on how 'natural' environments affected localized societies and their cultural development over time. Rather than considering a mutual relationship between people and their surroundings, cultural ecology considers nature and culture to be completely separate. Furthermore, cultural ecologists emphasize how nature has influenced or constrained culture. Such as in Amazonia, where some scholars attribute a lack of large, developed populations to the lack of resource potential (Meggers 1954). While this perception is problematic in many ways (this region did have enormous potential resources available, it was managed, and large populations is not a universal goal), it is fundamentally wrong because people's ability to thrive is not determined solely by their surroundings. Human decision making and consciousness is involved in environmental practices (Whitehead 1998).

People in the Amazon did not adapt to their environment, they created it (Erickson and Balée 2006). After European contact, the Amazon adopted more cultivation, agriculture, de-evolution, long fallow, and a simplification of flora (Denevan 2006). People living in the Amazon have been altering the landscape to be more productive for their own purposes for thousands of years. *Terra mulata*, for example, was a burning practice that left intact charcoal, not just ash (Denevan 2006). This modified sediment was created using a cool, moist burn that then created high fertility in the soil allowing for productive agricultural yields. While the carbon produced in these burns is not itself a nutrient, it retains nutrients and makes them more available for other organisms. Carbon also raises the Ph levels, maintains soil moisture, as well as reduces leaching (Denevan 2006). Amazonian people put more effort into domesticating their landscape rather than individual species (Erickson and Balée 2006), which is important to note because cultures do not have to manage their landscapes in similar manners throughout the world.

Historical ecologists also value traditional ecological knowledge because non-state peoples (non-scientists) are closely related to their local biotic and geophysical resources and accumulate knowledge about their surroundings over time (Balée 1998). Historical Ecology celebrates both open-mindedness and scientific inquiry (Crumley 1998) through the integration of both TEK and western science. In this way, historical ecologists are invested in understanding and appreciating emic views of time and emic views of environmental engagements. Historical

Ecology is not just interested in the indigenous uses of plants, but also the history of those uses, and the interest in how some of those uses have continued for thousands of years (Whitehead 1998). However, Crumley (et al. 2018) suggests that it is important to look at both the continuation of cultural practices (stability), and also discontinuation of practices as well through time. While stability may indicate sustainability, the transitions that groups make when altering their cultural practices are also important in order for them to achieve their desired transformations and adaptations during times of stress. Additionally, an understanding of entire cycles of time is significant in historical ecology, a view of the *longue durée*. Rather than just analyzing periods of rapid systemic change that indicate transitions, a focus should also be placed on earlier decision nodes that may have advanced or triggered rapid change.

Crumley and colleagues (2018) caution that current crises are different from the past, meaning past crises cannot be used as direct comparisons for environmental events and catastrophes today. Recent development in societies has increased the scale of economic activity globally, increased homogeneity of practices, institutions, and technologies, and finally it has also increased connectivity between different groups of people with different ways of life. This increased interconnectedness makes today's events unique from the past and creates a more complex string of events than ever before. Crumley (et al. 2018) believes that past events were also always interconnected and interdependent, we cannot separate them or give them different weighted significances.

To summarize, historical ecology focuses on the *longue durée*, events, and cycles (Balée 2006). Historical ecology demonstrates that if climatologists hope to prepare for environmental events that accompany climate change, they will need to consider examples from throughout human history (Crumley et al. 2018). Climate is constantly changing and is long term (Ljungqvist 2018) and it cannot be understood with present-day experiments. Historical ecology is not about building a model to predict decisions (Graham 1998), it provides a framework to help understand how people have interacted with their environment in the past and what impacts people's actions have had on the environment. Historical ecology allows us to understand that many events that much of the world calls 'natural' have been influenced or exaggerated due to human activity. This field of study offers examples to be taken into consideration when dealing with future events and a framework to recognize our own role in managing the earth and its resources.

2.3 Discussion and Conclusions

The role that people have played in ecological systems in Latin America has been debated over the past few decades. Many scholars criticize the past populations of Mesoamerica for overexploiting their environment with overpopulation, deforestation, soil damage, and nutritional difficulties, leading to drought and eventually societal collapse (Abrams and Rue 1988, Lentz, Dunning, and Scarborough 2015, Rice 1993, Webster, Freter, and Gonlin 2000). Some scholars describe many areas of Latin America as fragile with limited agricultural potential (Meggers 1954, Morley 1946). Others suggest that Mesoamerica is incredibly diverse and well-suited for agricultural intensification (Fedick 1996, Harrison 1990, Turner 1978). The region varies ecologically, it has a mosaic of microenvironments that present both challenges and opportunities for people to adapt (Dunning et al. 1998, Dunning et al. 2009). Pre-Columbian cultures in Central America occupied a diverse range of tropical environments, which allows for comparisons of adaptive responses (Chase and Scarborough 2014). Paleoethnobotanical studies are an ideal way to gain direct evidence of socio-ecological practices.

Archaeology can reveal evidence for mitigation, vulnerability, resilience, and long-term sustainability of society (Habu 2018, Sheets and Cooper 2012). Sheets (2012) believes that the most resilient communities to volcanic eruptions are egalitarian villagers of Costa Rica. The residents of the Arenal region also had to deal with severe storms which regularly batter the Cordillera and its vegetation with hurricane-force winds (Nadkarni et al. 2000: 304). The Arenal region, in particular, would have experienced a significant and explosive eruption every four centuries. The frequent eruptions of Arenal Volcano must have "reinforced traditional knowledge, hazard awareness, disaster experience, and belief" (Sheets 2012: 46). This might be a result of the egalitarian nature of these Pre-Columbian populations. Their decision-making likely occurred at the village or even the household level, an indication that their agricultural life-style may align well with agroecological notions. Such populations could have mitigated disasters through strategic household architecture, strategies of food procurement, and extensive networks of community interaction (Cooper 2012). Their social and political organization may have allowed them to have a relatively low vulnerability to environmental stresses. This social organization likely heavily incorporated landscape management practices to interact with an ever-changing environment in a way that kept communities thriving and successful. Since egalitarian societies are decentralized and tend to have lower population levels, they were capable of reacting to emergencies quickly and could readily migrate to areas beyond devastation.

This study's paleoethnobotanical investigations in the Arenal region will address these speculations using data that can directly assess populations of flora through time, with a perspective that views over 3,000 years of people living around Arenal Volcano (circa 1450 BCE to 1530 CE). Ecosystem management is one of the main domains of adaptive strategies that societies have employed throughout history in order to deal with their environment (Redman 2012). People are creators of new technologies and built environments in order to face their challenges. Although no baseline or equilibrium will be assumed, analyses of archaeological remains recovered from the Arenal region will be used in this study to interpret the past lifeways of these peoples whose longevity of cultural practices has been intriguing to scholars. This paleoethnobotanical research aims to explore how pre-Columbian people reacted to challenges within their socio-ecosystems, interacted with their biological diverse setting, and how populations today could potentially benefit from traditional practices evidenced through archaeology.

CHAPTER 3

HOUSEHOLD ARCHAEOLOGY

If the house symbolizes the household, archaeologists are able to study these architectural features in order to gain insight into daily life of the past (Gonlin 2020: 389). Research in Central America has increasingly focused on household archaeology with an interest in describing and explaining the variation observed in household studies (e.g. Brown 1989, Douglass 2002, Douglass and Gonlin 2012, Ford and Fedick 1992, Haviland 1988, Hendon 2002, Killion 1992, Manzanilla 1987, Marcus 2004, McAnany 1993, Robin 2003, Wilk and Ashmore 1988). For example, sites like Copán in Honduras have one of the largest well-dated sets of entirely excavated commoner residences in the Maya area (Webster, Gonlin, and Sheets 1997, Willey and Leventhal 1979). This chapter will review the history of household archaeology as a discipline, both within and outside of Central America, as well as the major themes, issues, and directions of analysis included in such studies such as spatial patterning, activity areas, social behavior, social inequality, as well as craft, resource, and food production.

3.1 A History of Household Archaeology

Household archaeology began during a time of self-criticism within the archaeological community, partially as a reaction to cultural history approaches (Binford 1972, 1983, Clarke 1968, 1973, Willey and Sabloff 1980). The earliest archaeological studies of households began in the 1970s (e.g., Flannery 1972, Flannery 1976, Flannery and Winter 1976, Hunter-Anderson 1977, Winter 1976), a time in which archaeological thought was shifting and the discipline adjusting to correct for prior cultural biases. The topic of households in archaeological studies became more developed in the 1980s with theoretical and methodological work, with a focus on domestic contexts (e.g., Ashmore and Wilk 1988, Netting, Wilk, and Arnould 1984, Wilk and Netting 1984, Wilk and Rathje 1982). This theoretical framework has a wide array of origins, with influences from bioarchaeology, settlement archaeology, ethnography, ethnoarchaeology, iconography, epigraphy, and cognate sciences (Arnould 1986, Gonlin 2020, Kramer 1982, Whittington and Reed 1997, Willey 1956, Wilk 1988, Wright and Vásquez 2017). Early work incorporated multi-scalar approaches, which could look closely at agents performing activities and social relationships archaeologically (Ashmore 2002). Being able to recognize agents from the archaeological record and their specific social roles brought in strong ethnographic interpretations (Conkey and Gero 1991).

Household archaeology has many characteristics built upon both processual and post-processual theories. Processual archaeology helped establish activity areas as a key focus of anthropological research. Activity area analysis continues to be a way to understand the use of space in the domestic setting (Manzanilla and Barba 1990). To a processualist, the appeal of the household or corporate group was that it was the most basic level of social analysis possible and the most ideal context to look at activity areas (Hayden and Cannon 1982). Using processual lines of thought, the study of households as activity areas attempted to create a defined relationship between greater social processes and their material counterparts using a functionalist outlook (Reid and Whittlesey 1982, Wilk and Rathje 1982). Processual frameworks called for an emphasis on the scientific method, statistical techniques, and encouraged the use of multiple lines of evidence in order to bring a sense of scientific rigor to the discipline (Beaudry 1989, Kent 1984, Reid and Whittlesey 1982). The various subfields within archaeology began to be more integrated using multidisciplinary and holistic perspectives, with the combined use of ceramic, lithic, architectural, botanical, and faunal data, along with ethnographic and historical documents. Incorporating varied modes of analysis inevitably reveals the variation that exists within archaeological data. This ended up challenging ideas of a normative model of culture but at the same time was problematic because processual archaeologists seek to define broad generalizations across both time and space [using significant differences in variation].

Household archaeology adopted various characteristics of the post-processual theoretical movement as well, most notably because it follows a more "peopled" reconstruction of the past (Robin 2003: 309). Post-processualists generally reject positivism, which is the philosophical system that supports scientific methods that do not rely on direct observation and seek universal generalizations (Trigger 1996). They argue that all interpretations of the past are innately subjective and support the existence of multiple truths instead of a single narrative. In this theoretical framework, the role of archaeologists is to provide information to the public so that they can construct their own understandings of past cultures and peoples (Hodder 1984). In this way, household archaeology is able to suggest varied ways of knowing and conceptualizing one's place in the world through the eyes of past people.

Post-processualists view the built environment as a medium that influences and reflects social actions (Hodder 1999). These actions can be analyzed a number of ways that include newer methods such as micromorphology, chemical residue analysis, trace element analysis, and microfossils (Godino and Madella 2013). Fernández et al. (2002) looked at the presence and purpose of ancient household activity areas through soil chemical signatures on the surfaces of present-day Maya houses. Microscale approaches are often stressed in household archaeology, such as the paleoethnobotanical methods incorporated into this study of households in the Arenal region of Costa Rica. Microscale approaches involve attention given to single-contexts and a systematic sampling strategy during excavations to assist with the interpretation of depositional events (Harris 1989). This method impacts all aspects of excavation, even altering collection strategies and sampling techniques in order to observe available variables in the archaeological record. The next challenge is to connect these microscale observations to imagine the lived experience of past peoples (Tringham 1991, 2012). Can we as archaeologists recreate life histories of people through their preserved material remains? This, I believe, is a key goal of household archaeological studies.

A significant contribution from processual archaeologists to the study of households is the use of ethnographic or ethnoarchaeological analogy (Hayden and Cannon 1982, Kramer 1982). Studies of present-day cultures using ethnography, ethnoarchaeology, and ethnohistory can fill in the missing elements left by the typically poor preservation of household settlements. Including ethnographic detail helps to bridge the gap left by middle-range theory that separates perceptible archaeological phenomena from the imperceptible human behavior that produced it (Binford 1977). Archaeologists are concerned with the manner in which histories are represented through material things and ethnographers provide a way to link the roles of material goods in social relationships (Joyce 2000: 190). Ethnographic studies can reveal the different ways that buildings, people, and ideas are interrelated (Carsten and Hugh-Jones 1995), making their incorporation into household archaeology incredibly insightful. As noted by Levi-Strauss, houses are a specific form of social organization and can directly represent social groups as well as the world surrounding them. However, it is crucial to note that ethnographic analogy does not prescribe household behavior, it only can signify possibilities (Allison 1999).

There have been numerous ethnographic studies of households that have greatly aided in archaeological interpretations of such spaces. For example, Kramer (1982) conducted ethnographic fieldwork in Iran looking at interhousehold variability. Similar studies were also done in Mesoamerica, where Hayden and Cannon (1982) studied the variability of artifacts in relation to socioeconomic differences in contemporary Maya households. Household research specifically in the Maya area has benefited greatly from ethnoarchaeology (Gonlin 2020), the study of current peoples' formation, use, and discard of material culture (including architecture) and how that can explain archaeological phenomena. The study of households was further enhanced by contributions from Schiffer (1983), who demonstrated the cultural and natural transformations as they relate to the archaeological record, suggesting the multitude of factors that impact the discard and deposition of material culture.

While ethnographic studies and ethnohistoric description studies prove to be a useful data source, their accounts actually minimize the variation seen among social organizations by Pre-Columbian houses (Chase 1993, Allison 1999). Wilk (1997) warns that households are dynamic and changeable, and therefore assuming stability of a household in a present-day situation as relatable to past households is problematic. Consequently, interpretations of ancient Maya households using current and historic analogs must be done with caution and a skeptical perspective.

Scholars working within household archaeology made efforts to expand our knowledge of past peoples to include everyday contexts and the remains that have resulted from regular, daily practices [such as in domestic spaces]. Many early archaeological investigations had focused on durable, monumental architectural spaces. Such spaces were typically used in the past primarily for specific ceremonial or political purposes (palaces, temples, tombs) and were occupied mainly by ruling classes, or those who had the wealth and resources to build such impressive and long-lasting structures. How could a discipline claim to understand a group of people through such a narrow focus? The onset of household archaeological investigations was accompanied by a realization that communities where most people worked and most likely spent the majority of their lives were just as significant of a field of study and constituted critical components towards the understanding of a group of people from the past. Household archaeology encompasses all people in a society. The full spectrum of inhabitants can be viewed through a household archaeology lens, from humble, commoner homes of ordinary peoples (Lohse and Valdez Jr. 2004, Robin 2013, Smith 2010, Snarskis 1984a, Webster and Gonlin 1988) to royal palaces (Christie 2003, Evans and Pillsbury 2004, Inomata and Houston 2001, McAnany and Plank 2001).

Past research that has focused on elite architecture and tombs has left out information on the vast majority of the inhabitants of that area and settings in which the majority of lived lives took place. Largely missing from archaeological interpretations were commoners (non-elite), women, slaves, and even neighboring communities (Sheets 2006: 20). Admittedly, this bias towards elite contexts in archaeology is generally due to those types of contexts benefitting from a greater state of preservation due to a higher prevalence of durable materials. More permanent and dependable materials [such as stone] would have been more accessible to those in power due to the level of physical effort and organization related to such projects. Of course, a stone structure will survive and last through millennia of time much better than a thatch-roofed domicile constructed out of compacted earthen materials such as clay and soil. Furthermore, that durable architecture will be more noticeable and readily accessible to an archaeological survey compared to the remnants of an earthen structure, which merely left some subtle changes in soil color, texture, and compaction. Another factor that further reduces the probability of domestic spaces becoming preserved as an archaeological site is that these spaces tend to be more affected by natural disturbances, especially in tropical climates, due to erosion, solar radiation, and bioturbation by flora and fauna (Sheets 2006: 21). This bias in preservation leads to innumerable "invisible" structures that cannot as readily be accounted for in archaeology since their foundation, walls, and roofs were built entirely out of perishable materials (Gonlin 2020).

3.2 Defining a Household

Anthropologists in the 1960s who studied households were concerned with the use of the word "household" and associated terminology such as "domestic". It is difficult to form a succinct definition of a household that is applicable to all ways of life and all time periods. Gonlin (2012) argues that a household does not have a singular meaning within or across societies and that it is quite similar to how the concept of gender is different between individuals and societies, as well as being ever changing (Conkey 2001). There is never just a single household type within any society, let alone across societies (Wilk and Rathje 1982). Hammel (1984) suggests that much of this difficulty in forming a discrete definition is due to the lack of distinct rules regarding what constitutes a household. Early scholars heavily incorporated cross-cultural anthropological case studies in order to demonstrate the lack of universal characteristics to households (Hammel and Laslett 1974, Wilk and Netting 1984). Goody (1972) critiques the use of the word "household" as used in census listings, where it was defined as "all the persons who occupy a housing unit". Goody (1972: 118) explains why this definition is problematic when compared with households among different societies and throughout time, yet still suggests that there are "basic similarities in the way that domestic groups are organized throughout the whole range of human societies". Thus even within scholars' own work, the terms and their definitions are problematic. "Domestic" activities could be defined as those that "are concerned with the day-to-day necessities of living, including the provision and preparation of food and the care of children" (Bender 1967: 499). Fortes's (1958: 8) defines the domestic group as "a householding and housekeeping unit organized to provide the material and cultural resources needed to maintain and bring up its members." Many definitions of "domestic" (Bender 1967, Fortes 1958, Goody 1972, Hammel and Laslett 1974) include a) activities relating to food production and consumption, and b) activities linked to social reproduction and raising children.

Despite all of these many definitions, archaeologists tend to agree on these two main approaches when describing households: a) a focus on the physical and material aspects (i.e. architecture and spatial distribution) or b) a focus on social, behavioral, and economic conditions. The following sections will explore each of these aspects of household studies.

3.2.1 Spatial and Architectural Approaches

Some researchers emphasize the physical aspects of households in archaeology, by referring to compounds, camps, courtyard groups, domestic structures, or patio groups and units (Hayden and Cannon 1982, Kent 1999, Killion 1987, Manzanilla and Barba 1990, McAnany 1992, Roth 2000, Tourtellot 1988). Initially, shape and size of household structures was interpreted as being related to functional characteristics of households and to infer lifestyles and types of social groupings in the past. Some archaeologists argue that larger structures, or those that require significant investment, are related to increased settlement (Diehl and Gilman 1996, Robbins 1966). In his comparison of Near Eastern and Mesoamerican villages, Flannery (1972) suggests that round or circular dwellings indicate a semi-nomadic people and that rectangular house structures are more indicative of sedentary people. In a similar manner, smaller households could indicate a more mobile lifestyle (Wilk and Rathje 1982). There are a range of assumptions that have been made about shape and lifestyle that today are recognized to have much more complexity than these suggestions imply.

Flannery (1976) noted that within Mesoamerica the configuration of domestic structures varied. He summarized highland groups as using square structures, whereas round structures were characteristic of the lowlands. Flannery later returned to this idea and argued that architectural shifts are ultimately related to economic organization of households (Flannery 2002), a finding also supported by Feinman, Lightfoot, and Upham (2000). Meanwhile, Redman (1982) suggests that new ways of organizing labor along with increased need for storage also impact architectural forms. Wilk (1997) tested whether or not house size correlates to social position, occupation length, or wealth. However, the range of houses found among the Maya correlates to more than differences in socio-economic status because houses are expressions of "worldviews, religion and ideology, political connections, the reproduction of cultural practices, memory of place, and social relations that contain inequalities within and beyond the house" (Gonlin 2020: 389).

As Flannery notes, agriculture does not necessarily determine village structure and development and notes that villages are widespread and that they are architecturally diverse. (Flannery 1972). In the Middle East, villages developed before cultivation, whereas in Mesoamerica villages weren't developed until after cultivation was widely practiced. Flannery suggests that a sedentary lifestyle is not just about whether or not a group has developed agricultural practices, it is more about the establishment of and ownership of resources. As is commonly seen in settlements throughout the world, the presence of ancestor burials serves as a claim to land and property (Bulan 2015, Hunter 2017, McAnany 2013).

Alexander (1999) suggests that household archaeologists should not focus on just structures that served as dwellings, rather archaeologists should consider entire house lots which also consisted of gardens, patios, and storage facilities. The Classic Maya tended to build their residences with the structures arranged around courtyards or patios which could include storehouses, kitchens, dwellings where residents could sleep, spaces to work on specialized tasks, or simply areas to socialize (Gonlin 2020: 392). Life in tropical environments such as Central America meant that many daily activities such as processing food, cooking, and weaving took place outdoors in patio areas and these extra-mural areas need attention from archaeologists as well in order to accurately understand past household activities (Hutson et al. 2007). Cultural historians tend to forget the space around house compounds and focus solely on the physical structures (Alexander 1999, Hirth 1993). Yet examples such as the household units excavated at

Joya de Cerén in El Salvador reveal various contexts existed adjacent to dwellings including household gardens, fruit trees, a sweat bath, a religious center, and a structure likely used for community gatherings (Sheets 2006).

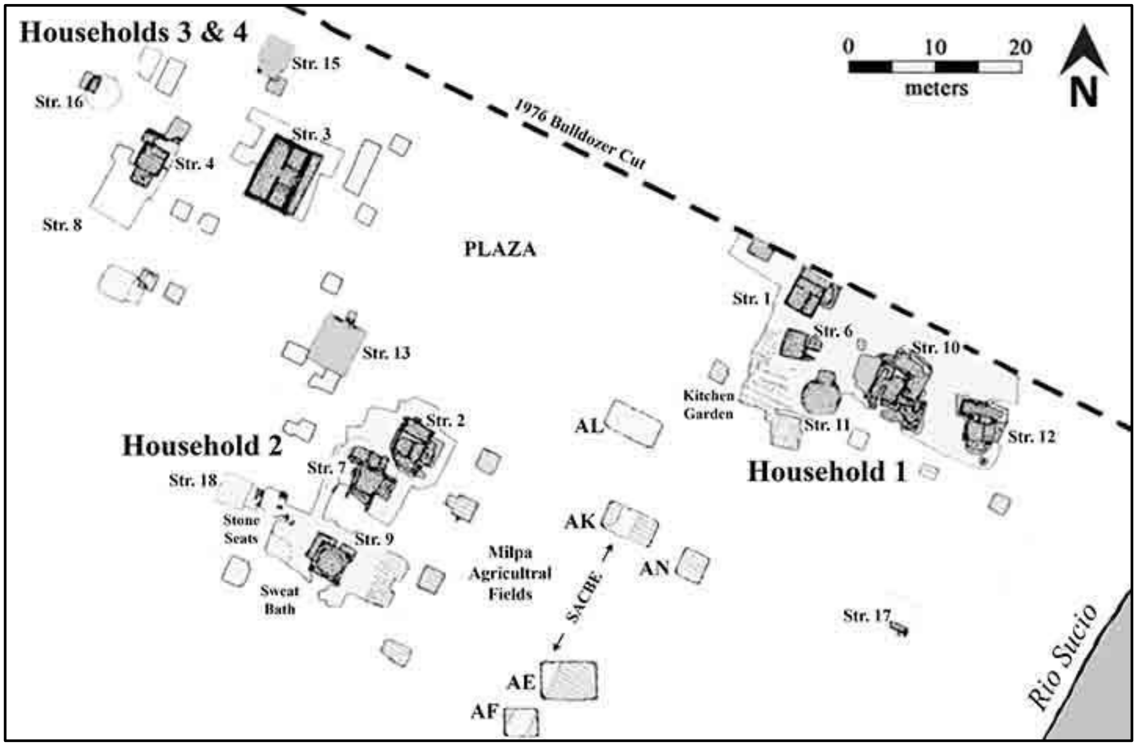


Figure 3-1: *Map of the excavations at the village site of Joya de Cerén in El Salvador, demonstrating the spatial distribution of household structures and nearby associated features including kitchen garden plots and agricultural fields (redrawn from Sheets 2002: Figure 1.1, Slotten 2015).*

While a household can consist of multiple structures and features, these domestic structures are not necessarily only occupied by one group. There may have been an entire sequence of households that inhabited a structure over generations. Not all attached rooms are used or owned by the same group of people either. This further complicates the archaeological record, and creates challenges when attempting to distinguish between a series of occupations of the same space.

Much of these types of studies were more descriptive than analytical (Douglass and Gonlin 2012). Architecture cannot completely dictate behavior (Allison 1999), so activity areas cannot be defined simply by their space. Additionally, architecture is not a two-dimensional floor plan, as many archaeologists encounter based on what is preserved. In order to truly understand past lifeways, archaeologists must be able to imagine the three-dimensional spaces that people lived and worked within. It should not be the shape of the structures that is of importance, it is more the intentions behind the construction and the physical size of the structure that are more significant. How many people did a house structure support? Is the amount of people living within one household linked to their daily practices? For example, agriculturalists may benefit from larger families that have children to help out with various tasks. The size of a household can correspond to the amount of land that its members own and the amount of labor its members are involved in regularly (Wilk and Rathje 1982).

Wilke and Rathje (1982) describe three essential and interlinked elements of a household: social, material, and behavioral. The social element is composed of the number of members in that household and their relationship to each other. The material component is the dwelling where those people reside, any of their possessions, and the areas where they perform their activities. Lastly, the behavioral element is the activities that are performed. Through these different elements, Wilk and Rathje demonstrate that households are complex and should not be defined solely by a physical structure. To summarize, house form is determined by many variables, including the degree of economic heterogeneity by household members, the amount of people living in that space, and also the volume of materials stored in that same space (Hunter-Anderson 1977).

3.2.2 Social Approaches: The Household as an Activity Group

The household is a fundamental unit of society and is bound by both economic and social factors (Ashmore and Wilk 1988). Archaeologists are interested in households as the foundational connection between people. Many researchers also use a more social or economic approach, rather than one based on architecture or physical space, when describing households by incorporating terms like activity areas, activity spheres, production units, or coresidential units (Allison 1999, Ashmore and Wilk 1988, Stanish 1992, Wilk 1991, Wilk and Netting 1984). This view places households as the next order of organization above the individual (Hammel 1984: 40). The house is a physically constructed space, but it is also socially and ideologically constructed (Gonlin 2020: 394).

Many archaeologists consider the household to be the most fundamental social unit of analysis (Hayden and Cannon 1982). A household is an activity group and social unit that shares various functions: production, reproduction, distribution, transmission, consumption, shared ownership, co-residence, and reproduction (Netting, Wilk, and Arnauld 1984, Wilk and Ashmore 1988: 4, Wilk and Rathje 1982). Household functions may include "architecture, midden deposits, activity areas, and social relatedness among household members" (Douglass and Gonlin 2012: 20). Household archaeology "focuses on the group sharing the same residence and participating in certain common functions" (Sheets 2006: 20). It attempts to reconstruct past activities on the household level that deal with the production of goods, sharing and redistribution of those goods, reproduction of their culture, and also the transmission of goods to the next generation (Wilk and Rathje 1982). Skills and knowledge are passed down through generations through the household unit. Households are the primary location for daily social interactions and thus also the site of reproduction of social structures and relationships (Hendon 2021, Douglass and Gonlin 2012, Robin 2013, Wilk and Rathje 1982).

Many factors are often incorporated into anthropological concepts of the household: co-residence or propinquity, family or kinship ties, and domestic functions. Members of a household may be linked or connected via actual kin relationships or they may be related by simply acting cooperatively or living as co-residents (Douglass and Gonlin 2012: 3). It is not necessary for these two concepts to both be present in order to define a household unit. One can co-reside with others without having blood relations, just as one could still feel connected as a family unit without living under the same roof. While Deetz (1982) advocates for archaeologists to uncover expressions of families behaviorally and psychologically in household remains, Bender (1967) suggests that kinship should be separated conceptually from domestic functions when interpreting households, because kinship deals more directly with defining a family rather than defining a household. Not all households are families. The domestic environment should not be interpreted as a 'family' unit, that is a result of our own social constructs (Hendon 1996). By describing households as units of activity with a focus on function and behavior, kinship, familial ties, and physical forms and proximities of structures are irrelevant, making cross-cultural comparisons more accessible. It is necessary to have a pan-cultural definition of households, because the various variables associated with them differs across time and space. The concept of house societies (Levi-Strauss 1982, 1987) as social groups aids in the study of cooperative units rather than lineal descent (Gonzalez-Ruibal 2006, Joyce and Gillespie 2000). These units can be permanent or temporary and may represent different roles among different individuals, whether that is social, ritual, economic, or political (Gillespie 2000).

Even though kinship lines and co-residency are often influential in determining a household group, they are not always the most significant characteristic (Arnould and Netting 1982). Wilk and Ashmore (1988: 3) categorize households as activity groups. This definition emphasizes actions over the composition or size of group members who are co-residing; suggesting that is most significant to interpret households based on what they do. Archaeological investigations and ethnographic work has shown that household members could work collectively on a variety of tasks, such as the processing of food or the manufacture of tools and goods such as baskets, thread, jade, and ceramics (Ardren 2017, Beaudry-Corbett and McCafferty 2002, Hendon 1997, Kovacevich 2013, Rochette 2014).

Susan Kent (1984) defines activity areas as the locus at which a particular human event occurred and the household is the most abundant or common activity group (Wilk and Rathje 1982). Each household is essentially a sphere of activities, so archaeologists cannot simply look at the material remains left behind in such spaces, but must also envision household functions, i.e. what households "do" (Ashmore and Wilk 1988: 5, Douglass and Gonlin 2012: 3, Wilk and Netting 1984: 5). Tim Ingold contributed towards the analysis of household archaeology with the concept of 'taskscapes' (Ingold 1993), which brings a landscape to life, where it is entangled with the dwelling of its inhabitants, rather than reducing the landscape to a stasis or backdrop to social life (Gruppuso and Whitehouse 2020, Ingold 2017). Taskscapes encompass an array of related activities, just as landscape is an array of related features. Taskscapes are socially conceptualized spaces where human activities are performed but are not limited spatially and are loosely defined. Daily activities and tasks shape and transform the environment both socially and ecologically. Ingold's concept of a taskscape aligns well with historical archaeology, which was discussed in the previous chapter, aligning human's activities with the environment rather than considering them separate entities.

Archaeology of household contexts often leads to a small-scale focus with an emphasis on the living domain, since that was recognized as where activities took place (Ashmore and Wilk 1988, Wilk and Rathje 1982). Households are small-scale commonplace contexts of everyday life. Daily practice is viewed as the "substantial set where negotiations of social agents take place" (Godino and Madella 2013: 1). Many household archaeologists attempt to directly identify daily practices and describe household behavior through domestic architectural remains (Allison 1999, Kent 1990, Blanton 1994). However, the notion that social behavior overlaps physical space is a modern, and western view of life.

While many of these issues in defining a household are problematic in anthropological ethnographies, they are more challenging when dealing with the archaeological record.

Archaeologists are constrained by what is preserved in the material record; they interpret domestic artifacts, features, and structures. Archaeologists do not excavate households, they view the remains of household behavior and the outcomes of social activities that were performed in the past. Archaeologically, it is tempting to refer to households as groups of people that occupy the same residential space (Kramer 1982) because co-residence is often a feature that is accessible when observing records of the past. Archaeologists have to "infer dwelling units from the material record," which leads them to "infer households from the dwelling units" (Wilk and Rathje 1982: 618). Furthermore, archaeological interpretations of households are burdened by the variable preservation of material remains. For this reason, it is important for archaeologists to recognize the multitude of ways a household can be defined throughout their research design, including in the formulation of the project, to the theoretical approach, and the methodology used to collect and analyze data. The ambiguity that surrounds the material record can make interpretations difficult, but Gero (2007) insists that it is still a meaningful endeavor.

There are many assumptions regarding activity areas that are problematic when applied to the archaeological record. First, the assumption that artifact assemblages can indicate activity areas is biased based on the archaeologist's own culture and the artifact's spatial patterning. Ethnocentric biases can lead to misguided assumptions of other group's activities, both spatially and temporally. How an artifact was used may have changed throughout its life history. Archaeology shows that recycling and the reuse of artifacts is actually quite common, so there isn't always a simple explanation for the purpose of any material. Other issues regarding common assumptions by household archaeologists are that activity areas aren't always monofunctional and also that not all activities are practiced universally by a specific gender. Generally, monofunctional areas occurred more when specialized activities were completed within a household space.

Kent (1984) demonstrates these issues with case studies from the American south west, Spanish American settlements, and Euroamerican groups. In her study, she shows that Navajo households have very few monofunctional activity spaces. Each space is used in a different manner based on a person's mood, the time of day, or even the season. Additionally, the Navajo have very few activities that are designated for a specific gender. This is in stark contrast to Euroamerican groups, which can exhibit gender-specific and monofunctional activity areas. Euroamerican households in Kent's study designated kitchens to be spaces for women to perform food-related activities and some spaces served just one function, such as a bedroom or a bathroom. Spanish American households in Kent's work were placed somewhere in between on this continuum of activity area designations and tendencies. They did have areas which only served a single function, such as bathrooms, but overall, they had fewer cases of this compared to Euroamericans. Kent's work shows that activity areas cannot simply be determined based on the spatial distribution of artifacts and ecofacts and that many factors are involved and interdependent in activity areas.

An additional issue with interpreting activity areas from households is that house floor assemblages are always a palimpsest, these spaces would have been constantly modified and would have changed even throughout the course of a day (Allison 1999). LaMotta and Schiffer (1999) demonstrate the dynamic nature of house floor assemblages through an explanation of the formation processes involved with domestic structures. The authors list three main stages of life for house floors: they are inhabited, abandoned, and then finally there is a period of post-abandonment. Preserved archaeological remains on house floors should be interpreted with caution because these spaces often have their objects removed during abandonment and objects that were utilized within them are commonly prevented from being deposited back into that space. LaMotta and Schiffer (1999) estimate that all objects used in a house are not going to be deposited exactly where they were used, and not all objects that archaeologists recover from house floors were necessarily ever used in that space in the past. According to the authors, it is rare for the material remains recovered from a house floor to be in a primary context. Much of this is likely due to regular cleaning of that space while it was in use, resulting in only the remains of micro-artifacts and residues that would not have obstructed the use of that space. Anything of value would have been transported with the inhabitants when they left, except for cases where a settlement was rapidly abandoned, such as at Joya de Cerén (Sheets 1994b, 2006).

In the following sections, common themes that emerge through household archaeology will be discussed, such as spatial distribution of settlements, social inequality, and craft production.

3.3 Households Across the Landscape

Much of household archaeology grew out of settlement archaeology which looked at the distribution of human activities across a landscape (Drennan 1988, Sanders, Parsons, and Santley 1979, Wilk and Ashmore 1988). Trigger suggests that settlement pattern research was "the most important methodological breakthrough in the history of archaeology" (2006: 379) because large scale mapping and survey projects documented the presence of much larger populations than originally thought, especially in Mesoamerica (Hendon 2021: 159). Through settlement archaeology, studies of households have taken on a processual approach and focused on reconstructing the human behaviors related to the artifacts in the archaeological record. For example, settlement studies may look at a village-scale analysis and interpret the placement and size of dwellings in order to estimate social status of individual households, with the idea that favored locations will be occupied by higher-status groups.

Gordon Willey (1956, 1965) was the first to use the methodological approach of settlement archaeology within the Maya area with a survey of the Belize valley settlements neighboring Barton Ramie. Willey developed settlement pattern studies in a way that was new to the area because it included residential units. However, settlement pattern studies became problematic when they attempted to estimate population size based on structures, with uncertainties existing as to whether a single structure should count as a household or if an entire compound or a plaza group constituted a household (Leventhal and Baxter 1988). Multi-family residences are a common feature in Mesoamerica, for example at Tula where structures were arranged around a central patio and also physically connected (Healan 1989). These house compounds at Tula revealed multiple groups residing in the same general space but were each separated by their own individual cooking areas. This same concept can also be seen on northwest coast of North America, where multiple families share plankhouses (Samuels 2006). The issue of the quantity of structures that comprise a household has not been resolved due to the complex and dynamic nature of households, along with the shift in ideas concerning the multitude of functions of structures throughout Mesoamerica.

Drennan (1988) also analyzed Mesoamerican settlements diachronically and spatially. He found that the southern Maya lowlands had a more dispersed settlement pattern compared to central Mexico areas such as Teotihuacan or Tenochtitlan that had much higher population densities. From this study, he argues that dispersion of households can be explained based on agricultural practices, community size, political control, and economic functions (Drennan 1988:

284). Whalen (1988) further emphasized the importance of household distribution in Mesoamerica with his study of households and communities in Oaxaca. These studies all assume that "household organization reflects and is shaped by the structure of society" (Whalen 1988: 254) and is therefore indicative of the structure of the society.

In Balkan prehistory, archaeologists have shown that the household was the preferred unit of social and economic cooperation through the use of spatial and diachronic inquiries (Tringham and Krstić 1990). As Neolithic settlements in this area shifted towards permanent villages with a sedentary lifestyle, they remained in aggregations built out of co-residential domestic groups. Because the household was central to the framework of Balkan settlements such as at Selevac, populations never exceeded the limit for this style of organization. Only population levels that were of a workable size could be maintained in a system that was based on "loose-knit, flexible, corporate, kin-based groups" (Tringham and Krstić 1990: 614). Archaeological studies of households at Selevac show that some societies deliberately moved away from increasing social complexity, an idea pushed forward in processual studies which idealized societies along a linear evolutionary path. Selevac maintained their social organization based on the household unit from the Neolithic through the Bronze Age, whether that was as a household unit or a large, permanent settlement.

During the Iron Age in Britain for example, Clarke (1972) demonstrated that settlement patterns had significant social and cultural differences across space and between communities. Clarke shows that in certain areas of Britain circular structures likely served domestic functions, whereas in other areas these structures exhibited a wide range of functions such as for storage of resources or as ceremonial shrines. His study also pointed out patterns of household characteristics on a regional level, such as that earthworks serving as territorial boundaries only existed in the southern region of England and houses were generally small in size, whereas northern Britain exhibited a variety of house sizes throughout the Iron Age.

In southern Central America, documents by the Spanish in the early 1500s suggest that the lower foothills of volcanoes were significant and convenient places upon which to live (Ibarra Rojas 2021: 55). Archeological sites such as Alvarado, along the slopes of Irazu volcano (Azofeifa López 2023), and past settlements near Barú Volcano in Panama (Anchukaitis and Horn 2005) corroborate these Spanish documents. Ibarra Rojas (2021) also notes that historical documents by the Spanish comment that available water resources were related to indigenous settlement locations, such as coastal areas and inland locations close to navigable rivers. Archaeologically, it is true that sites in southern Central America tend to be located on elevated ground close to sources of fresh water, and this holds true for the Arenal area as well (Mueller 1994: 67). Throughout the archaeological phases within the region, sedentary occupations were concentrated near permanent streams and the ecotonal south shore of the present-day Lake Arenal (Sheets 1994b: 314). The distribution of archeological sites around Arenal also suggests that people preferred living in the drier life zones, yet the residents would have had access to a variety of ecological zones and resources. In the Caribbean Lowlands region of Costa Rica, early sites (1500–500 BCE) were located in areas important for hunting and collecting, but later sites (up to CE 1000) showed a preference for alluvial farmland (Findlow, Snarskis, and Martin 1979). The Guayabo de Turrialba site is situated between a steep mountainous slope, a river, and a sheer cliff. This settlement location was likely for defense purposes as well as ideal for taking advantage of land that could be agriculturally productive according to Lange (1992: 427). At the end of the main causeway at the site is a large circular mound, 4 meters high, which would have supported a conical roofed circular house structure about 20 meters high. This structure is strikingly similar to the cone of the Turrialba volcano, which can be seen in the distance. However, as Lange (1992) points out, it is misleading to generalize settlement preferences in Southern Central America because sedentary sites have been found in a wide variety of settings including coastal, inland, and riverine settings.

3.4 Social Inequality and Differentiation

Documentation of households has generally been left out of much of written records, across all socio-economic statuses or whether the residence is rural or urban. Archaeologists make this analytical unit more visible and offer insight into the daily lives of households (Douglass and Gonlin 2012). Household archaeology also opened up the incorporation of models of power and social inequalities, differentiation, as well as feminist approaches. According to Levi-Strauss (1983), wealth, status, and prestige are intrinsic features of household organization. Levi-Strauss asserts that houses are a social form that naturalizes rank differences and competition over wealth and power (Carsten and Hugh-Jones 1995, Waterson 1995), making the household an ideal unit to look at inequality in the past. Scholars use the differential distribution of various lines of evidence to assess social differences in the past, such as burials, household artifacts, and residential architecture. These all help archaeologists gain information about the relative wealth of households and the existence of social inequality (Haviland 1981, Rathje and McGuire 1982: 708).

Material culture excavated at Lomas Entierros in Costa Rica indicate that different status members did perform distinct economic activities (Núñez-Cortés 2020). Elite sectors of the site contained ceramics suitable for the serving of food and possible feasting events, finely decorated metates, indications of textile production, as well as flaked stone tools. Wealthy areas of Lomas Entierros were associated with chipped stone surplus production, as evidenced by stone scrapers, perforators, and knives found in elite middens but absent in all intermediate and low status contexts (Núñez-Cortés 2020: 312). Bifacial lithic technology was foreign to the area and linked to the arrival of Mesoamerican migrants, therefore elites may have controlled production and knowledge associated with their manufacture. Cooking and storage jars at Lomas Entierros were found separate from elite domestic spaces, suggesting that upper class individuals could disengage from food processing activities (Núñez-Cortés 2020: 311).

However, the status of individuals is not necessarily inferred from portable objects or even tangible remains (Carsten and Hugh-Jones 1995: 7). For example, at Copan socioeconomic differences were marked more through the size and material of structures (Hendon 2010). Assessments of the physical space of households is a common mode of analysis to compare wealth of household groups, where many scholars assume that wealthier households are larger and generally encompass more people than less-well off ones (Hayden and Cannon 1982, Wilk 1991). The size of households is generally estimated using the physical size of structures, the quantity of structures, and the amount of cooking or production areas (Hendon 1991). It is important to recognize though that structures do not always mark the boundaries of a household (Godino and Madella 2013). Household-related activities can occur both within and outside of a structure. Therefore, the size of a household is not limited to just the size of structures, and the concept of land ownership is a significant component as well as complicating the matter. In an agricultural society, access to good, fertile land is significant towards the accumulation of wealth (Gonzalez Fernandez 2012). Larger domestic structures could be a result of the accumulation of family members aspiring to inherit land or the addition of members who contribute toward labor tasks (Hendon 1991, Wilk and Rathje 1982). However, there is not necessarily a link between the size or extent of cooking areas and the number of families using that space (Kramer 1982). Families can share cooking areas and some people may not even cook their own food but entirely rely on others for their meals. The concept of households as a bounded unit loses the dynamic nature of human interactions that in reality creates households (Anderson 2003).

Ultimately, the prosperity of a household is challenging to determine, since no single factor or variable appropriately measures wealth or the access that a household has to goods and services (Netting, Wilk, and Arnould 1984). As Blanton (1994) pointed out in his study of agrarian societies, similar structure types can be occupied by either wealthy or poor individuals, signifying that architecture alone is not a useful indicator of status. Blanton (1995) argues that inequality of households is formed through ideology, which creates and maintains social imbalances through elite derived actions. Because of this, Blanton suggests that symbolic communication and ideology are core components of inequality that archaeologists should strive to understand in household contexts.

Household archaeology not only brought out more analysis of status differences economically, but also archaeological work that considers age and gender differences in the past. Critical viewpoints that embrace a feminist perspective impact both the methodologies incorporated into archaeological studies and the content of such studies (Conkey and Gero 1991). Central to studies of the household are engendered concepts of class formation, political power, the organization of resource production, and the use of space (Conkey and Gero 1991: 4). Power dynamics and social agency within households cannot be realized without a feminist theoretical perspective (Spencer-Wood 2004). Analysis of the production, organization, distribution, and transmission of goods and products should be free of assumptions that place uniform roles and relations between men and women (Tringham 1991: 101-102). By engendering the past, archaeologists are conducting much more inclusive and extensive analyses. For example, Gonlin (2012: 82) incorporates an engendered perspective of households by including all of the people within them (women, men, and children) that produce, consume, and perform activities. All of these members create a coresidential activity group (Ashmore and Wilk 1988). Tringham (1991: 98) demonstrates that in order to understand behavior and activities in the past, archaeologists must establish an engendered perspective into their scientific inquiries.

Household food production has proven to be a key focus area when exploring gender roles and social relations in the past (Brumfiel and Robin 2008, Gonlin 2012, Hastorf 1993, Hendon 2010, Neff 2012). These studies encompass gender divisions of labor and social differences in wealth and political power within societies. A common misconception of engendered household studies is that investigations are focused on women, but rather people of all genders, ages, ethnicities, and statuses are considered and all of these elements are combined to interpret larger social processes (Brumfiel and Robin 2008, Goldstein 2008). Archaeological studies of households have helped to demonstrate how both men’s and women’s roles have overlapped throughout history and that women have contributed greatly to roles beyond just the domestic realm (Brumfiel and Robin 2008). False dichotomies are often created, such as the assumption that men were hunters and women were primarily collectors of subsistence goods. The same misconception has been applied to household functions, where domestic spaces are perceived as private and all other spaces as public. The household domestic economy is a dynamic, active, and integral part of public lives as well (Brumfiel and Robin 2008: 4).

Spatial analysis of Kaggaba settlements in Colombia incorporated engendered ideological concepts found that grouped dwellings located near terraced fields may have been spatially occupied by males and females separately (Oyuela-Caycedo 1991). The archaeological data from this study suggests that spatial segregation based on sex created separate dwellings within a single household unit. Understanding the ideological concepts regarding sexual segregation allows archaeologists to recognize other behaviors that are embedded within a social structure (Steadman 2015). Archaeology at the microscale of the household makes women visible along with their production of goods (Tringham 1991). Microscale perspectives of social relations are directly linked with larger scale productions, and therefore a critical mode of interpretation.

Bioarchaeological work within household settings can demonstrate social patterning in past societies including differentiation between age, gender, occupation, and social class, among others. Analysis of skeletal material at the Maya site of Tikal revealed clear sexual dimorphism where females in smaller domestic groups were substantially shorter than females in more elaborate architecture" (Wright and Vásquez 2017: 69). Additionally, across the social spectrum, males had clear nutritional advantages based on stable isotope data and therefore had distinct patterns of food consumption. DNA analysis and strontium-isotope analysis applied to over 1,200 human skeletal remains at Copan demonstrated both the complexity and the relatedness of individuals within patio groups and revealed the diversity of inhabitants with the presence of "foreigners" in the city (Miller 2015).

Information about gender roles in the past is difficult to obtain through other modes of analyses besides archaeology. Ethnohistoric records tend to oversimplify women's roles in a society by focusing on cooking or weaving, for example (Brumfiel 1991). Many ethnohistoric documents were recorded by Western culture, and subsequently encouraged women's production to be treated as a non-dynamic element limited to domestic spaces in prehistory (Brumfiel 1991: 226). Women's labor has always been essential towards population reproduction and growth economically, socially, and politically.

A household can also be viewed as an expression of identity. The household is created through relationships the residents have towards their cultural practices and ideologies as well as to their landscape (Gonlin 2020: 395). Evidence for dedication and termination ceremonies suggest that the house can even be considered a being that is brought to life, occupied, and later decommissioned according to community practices. For example, ethnographic records show that ceremonies took place among the 20th century Maya involving food offerings to celebrate new houses (Redfield and Villa Rojas 1934: 146–147, Wisdom 1940: 130–131). Termination rituals ensured that a house was abandoned properly and served as a form of closure (Gonlin 2020).

3.5 Craft, Resource, and Food Production

An additional topic that household archaeology has brought to the forefront of recent research is resource production, which includes a variety of tasks such as cooking, farming, and craft production. Douglass and Gonlin (2012) argue that the majority of production in past societies took place at the household level rather than separate workshops, where commoners performed the majority of production-related tasks compared to the elite members of a society. Scholars exploring this field analyze the scale of production along with the manner in which labor was organized. Craft production expands the productivity of households beyond agricultural work and also diversifies the intake of resources, creating more stability in the long-term (Hirth 2009).

Wilk and Rathje (1982) assert that the household is the smallest and also the most abundant activity group because it is the most common social component of subsistence, making households primary producers. It can be argued that one of the main functions of a household is to provide subsistence to its members in order for the group to continue and be successful (Netting, Wilk, and Arnould 1984). Some scholars have even gone so far as to suggest that certain activities are universal among households, such as subsistence-related actions. This could involve the procurement of resources, as well as the storage and preparation of food (Flannery 1976). Some households may have specializations though. This could be manufacturing tools or the cultivation of a certain type of plant resource.

The degree to which the Maya elite had control and influence over every-day commoner activities such as agricultural production is still a subject of uncertainty and speculation. There is an overall lack of evidence for Maya food production, which limits the understanding of complexities such as economy, which has been nearly absent from iconographic records (Jackson 2013, Potter and King 1995, Scarborough and Valdez 2009). There is a substantial lack of knowledge about possible elite influence on agriculture (Webster 2002: 175). Elite had control over the maintenance of forests for religious or pleasure purposes (Thompson et al. 2015) and also likely redirected resources for their own consumption and towards construction of monumental architecture in order to assert their power and control both politically and ideologically (Scarborough and Grazioso-Sierra 2015, Webster and Murtha 2015). Little is known concerning the influence the elite had on the organization of labor, production, distribution, and any decisions regarding agricultural practices at the commoner level, with no evidence of elite influence at the village of Cerén (Sheets and Dixon 2013).

Sweely (1988) shows that the structure of power relations can be inferred by the spatial arrangement of an archaeological site at the household level, using Joya de Cerén as a case study. Sweely proposes two models, and does this using the locations of metates, or grinding stones, which have been left *in situ*. Her analysis suggests two different interpretations of power relations in this rural agricultural village. First, perhaps there was an authoritative figure who oversaw all of the women using the metates in Household Group 1. This figure would have exerted their control of individual's actions to maintain their power. Second, Sweely suggests that power relations could have actually been more egalitarian. This would have been the case if communication among those using the metates was uninhibited by authority figures. This would prevent any dominant ideology from being enforced and would instead result in a flexible notion of power relations. The recognition of multiple possible scenarios of how power was enforced at Cerén shows that ambiguities in archaeological data should be embraced and presented. There can be multiple, valid views of the past and the material record assists in demonstrating some of those understandings.

Did Mesoamerican and Central American households grow their own food and therefore make their economies more diverse (Dunning et al. 2003)? Food production could have been locally controlled (Foias 2002, Hageman and Lohse 2003, Scarborough and Valdez 2009) and maybe even seen as relatively independent (Sanders and Webster 1988). Agricultural systems could also have been managed by upper class individuals who guaranteed that crops encouraged upward mobility in the hierarchical system (Chase and Chase 2001, Ford 1996). The reality was likely a combination of these possibilities. If the elite did have an overarching authority on agriculture, this would be revealed with standardized and large-scale features, as opposed to the smaller household gardens which can vary significantly by location (Houston and Inomata 2009: 240-249).

Many studies of agrarian societies have demonstrated that households often have a kitchen garden associated with and adjacent to their residential spaces (Doolittle 1992, Killion 1992, Sheets 2006, Szuter 1991). Additionally, households often incorporate a variety of features that protect kitchen gardens or improve their productivity. This could include the use of fences or walls that create boundaries, create a microclimate, or water management features that enhance agricultural yields. Boundary markers in kitchen gardens are especially present when there is more competition for land. Freidel and Sabloff (1984) have found stone-partitioned fields on Cozumel, suggesting the possibility of land ownership leaving an archaeological signature. Recent excavations at Cerén provided an opportunity to see this land division of agricultural fields without such permanent markers like stone, clay, or trees in the landscape (Sheets and Dixon 2013, Slotten et al. 2020).

Ethnographic and archaeological work on residential settings have indicated that agricultural fields may be located close to settlements as well as located farther and more distant from a settlement. Netting (1977) refers to this as an infield-outfield system. According to Killion (1992), mono-cropped agricultural fields may have been farther from domestic structures, whereas multi-cropped fields would have been located closer to where people lived. As can be seen with these examples, studies of residential or household contexts in archaeology have expanded our understanding of craft and food production in the past.

3.6 Summary and Conclusions

Carsten and Hugh-Jones (1995) demonstrate that as people construct their homes, they are also constructing their own identities, both as individuals and as groups. In this way, the house can be viewed as an extension of the self. Our identities are tied to where we came from and home is central in our understanding of self. Studying household contexts can help archaeologists reach an understanding of self and identity in the past. The household is where archaeologists can truly look at past social lives (Hendon 2004). Houses are built by active agents who make decisions within their own particular ontological framework of meaning by incorporating cultural expectations, status, and individual preferences into architectural spaces (Guengerich 2017). People shape the house, and the house shapes people.

Several analytical methods are incorporated into household archaeology that help us determine the nature and spatial distribution of activities as well as the potential meanings behind some of those activities (Douglass and Gonlin 2012). Archaeologists try to understand how a household is materialized in the archaeological record and challenge themselves to reimagine the lives of those people. Wilk and Rathje (1982) view this field of study as a way of bridging the mid-level theory gap, where social change and lived lives can be viewed at a small scale. The household is “responsive to social, economic, and political change, and it functions as a unit of adaptation” (Douglass and Gonlin 2012: 2). Because of this, households can document cultural change through space and time and are indicators of social norms.

In Costa Rica, there has been a limited amount of archaeological investigations of household structures and domestic settings. In part, this is due to poor visibility of earthen made structures which were common throughout the country. It is possible to identify earthen structures through the remnants of post holes that supported the walls, left as subtle changes in soil color that can be detected by skilled excavators if preserved. In some areas of Costa Rica, especially in the Central Highlands, the past inhabitants did incorporate stone into the construction of house mounds, making them more readily visible archaeologically. Much of the discussions of household structures in Costa Rica has focused on their shapes, forms, spatial distribution, and composition of floors or walls.

Kramer (1982) cautions that archaeologists should not view each household as a representative of an entire society, it is just a sample. If anything, household archaeological studies have demonstrated the variation of ways of living in the past and that this scale of analysis is critical towards an understanding of any society.

This previous chapter's focus on historical ecology and resilience studies coupled with the present chapter's review of household archaeology provides the theoretical framework that will be used to interpret the archaeological data collected as part of this dissertation. The next chapter presents the environmental background of this region of the world, detailing the climate, ecological life zones, and volcanic setting that characterizes Arenal, Costa Rica. A discussion of household archaeology specifically within Costa Rica will be integrated into Chapter 5, which reviews the history of archaeology within this country as well as the geographical regions and patterns that have emerged in order to situate the region of study in this dissertation (Arenal).

CHAPTER 4

THE ENVIRONMENT OF COSTA RICA:
BIODIVERSITY, THE VOLCANIC LANDSCAPE

Costa Rica, although small in size (51,100 km^2), exhibits immense biotic diversity with around 95,000 known species found in the country today, including approximately 11,500 plant taxa (Kappelle 2016: 5, Obando 2002). However, it is estimated that half a million species are thriving in the country today, since it is believed that so far only 19% of all of Costa Rica's species have been scientifically documented (Kappelle 2016: 3-6). Over 2,000 of those plants which have been recorded scientifically are tree species (Kappelle 2016:6), in stark comparison to all of North America which has about 1000 tree species (Condit, Perez, and Daguerre 2011: 11). Globally, Costa Rica is among the most species rich countries with 95 Climate Groups and 55 Biotic Units (Groombridge 1992, Herrera 1986, Herrera and Gomez 1993). Although other countries may have more species in absolute numbers, Costa Rica is the most species dense when the amount of species present per km^2 is considered (Obando 2002). Major ecological systems that can be found here include tropical rainforests, seasonally dry tropical forests, tropical cloud forests, temperate forests, and high-elevation ecosystems such as *páramo* (Dirzo 2001, Janzen 1983). Volcanic cordilleras such as Arenal are especially rich in endemic plant species and the nearby Monteverde Cloud Forest Biological Preserve contains roughly one third of the species found in Costa Rica (Nadkarni and Wheelwright 2000).

The country's lush ecosystems have been threatened over the past couple of centuries due to large scale production of exports such as coffee, banana and sugarcane, conversion of land for cattle ranching, deforestation due to a global interest in precious hardwoods, and the construction of large infrastructure and urban sprawl, among many other factors (Hall 1985, Kapelle 2016, Merker at al. 1943). Beginning in the early 1970s, the country began to protect areas with the creation of national parks, forest reserves, and other protected areas (Obando 2002). Today, these protected spaces amount to roughly 26% of the country's territory and now the country is viewed as a successful model of biodiversity research and conservation (Kappelle 2016: 4).

Costa Rica is situated in the tropics at 8-11° latitude. Since the country is narrow in its territory, it experiences an Isthmian effect and is influenced by both the Atlantic and Pacific oceans. Costa Rica receives storm systems coming from the east and the Caribbean sea during the summer (roughly May through September) and a dry season during the winter (roughly January through April) (Condit, Perez, and Daguerre 2011: 11). The annual precipitation of the country is largely determined by the continental divide and central mountain range (see Fig. 4-1) which runs from northwest to southeast and rises to a maximum elevation of 3,819 meters (Herrera 2016). The mountain range is high enough to intercept storms from the Caribbean, thus the eastern portion of the country contains the wettest areas with greater than 3,000 to 7,000 mm annual precipitation and the Pacific slope is considerably drier with just 1,000 to 3,000 mm (Condit, Perez, and Daguerre 2011: 12, Herrera 2016: 19).

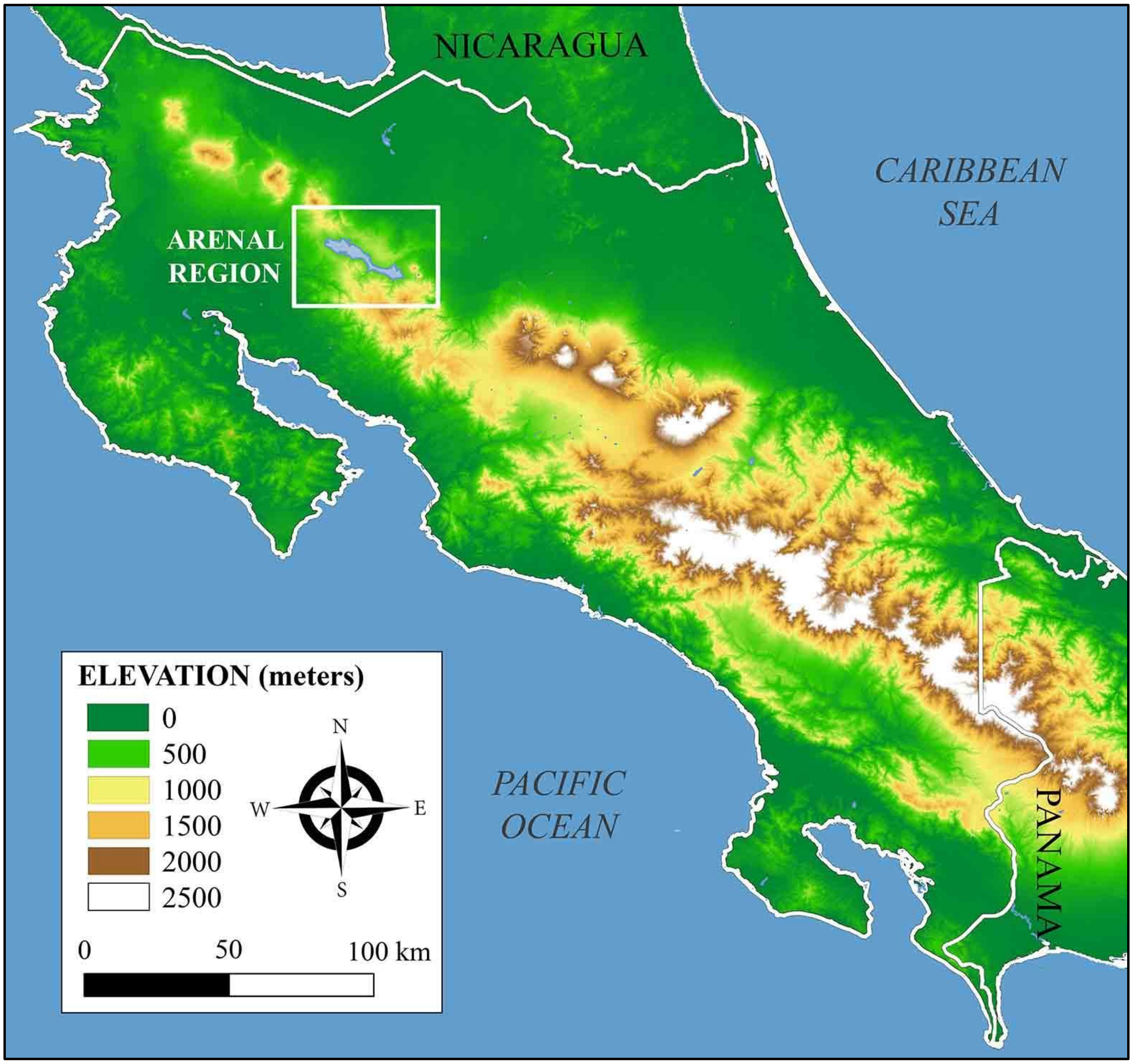


Figure 4-1: *Elevation map of the country of Costa Rica. The central mountain range and continental divide influences the environmental conditions on the eastern and western side of the country. Map created using Shuttle Radar Topography Mission (SRTM) data collected by NASA.*

The region of focus in this archaeological study is Arenal, in the northwestern portion of the country and situated along the central axis of mountains and the continental divide. While the continental divide does run through Arenal, the region is actually at a lower average elevation (808 meters) compared to the Central Volcanic Mountain Range to the south which has peaks above 2,000 meters (Bergoeing 2017: 135). The lower elevation of the Arenal region makes it a likely candidate as a corridor between regions and thus a potentially significant trade route within lower Central America, since the isthmus of Central America serves as an important land bridge between North and South America. Central to the region is Lake Arenal (Fig. 4-2), which would have been a major source of freshwater in the past just as it is today. Although, the lake's size has been greatly enlarged in recent times (the lake level rose from 512 to 545 masl), due to the hydroelectric Sangregado Dam constructed along the Arenal river in 1980. Before the dam was constructed, Lake Arenal would have had a much smaller lake area of open water surrounded by marshy pasture. Southeast of the lake is Arenal Volcano, a dominant feature on the landscape that will be discussed in further detail below. Lake Cote is another fresh water source in the region, just to the north of Lake Arenal. It is the largest natural lake in the country (Arford 2001), but it has not been studied as extensively therefore its role in past people's lives is not as well understood as Lake Arenal (Soto et al. 1993).

Figure 4-2: *Photograph of Lake Arenal, as viewed from the town of Tronadora.*

Because of Arenal's location along a volcanic cordillera, it tends to experience abundant rainfall, drizzle, cloud cover, and fog (Herrera 2016: 25). The Arenal region has tropical seasonality which is more pronounced in precipitation rather than in temperature variation (MacArthur 1972). The region experiences a relatively constant humidity and stable temperatures throughout the year. Arenal has a dry season from October through April and a rainy season from May through September. A climatic gradient occurs across lake Arenal. On the eastern end of the lake, closer to the volcano, there is minimal seasonal variation, a greater rate of precipitation (over 6,000 mm of rainfall annually), and lower temperatures (22-23℃). Whereas on the western end of the lake, farther away from the volcano, there is greater seasonality, a much lower rate of precipitation (less than 2,000mm of rain annually), and a higher mean temperature (24℃). An understanding of the variation in precipitation in the region is crucial for this study because the types of vegetation that can be found will differ greatly.

As mentioned earlier, the continental divide runs right through the Arenal region and in close vicinity to the archaeological sites discussed in this study. Many rivers, major streams, and their tributaries descend dramatically from both sides of the continental divide, thus creating a thoroughly dissected landscape with intense rapids, spectacular waterfalls, and picturesque gorges and *quebradas* (Clark, Lawton, and Butler 2000). Quebradas are deep, narrow gorges carved into the bedrock from the tributaries.

Within the Cordillera de Tilarán a great diversity of animal species has been documented including 658 butterflies, 425 birds, 60 amphibians, 71 snakes, 29 lizards, 25 fish, and 121 mammals including bats, rodents, anteaters, peccary, monkeys, sloths, paca, tapir, deer, rabbit, coyotes, jaguars, lions, manatees, and otters (Lawton et al. 2016: 433-437). Manatees lived in lake Arenal until around 1950, dying out due to overhunting (Sheets 1994: 9). Unfortunately, little is known about past people's interactions with fauna in Arenal because there is extremely poor preservation of bone due to soil acidity and heavy rainfall (Sheets 2009).

4.1 The Holdridge Life Zones

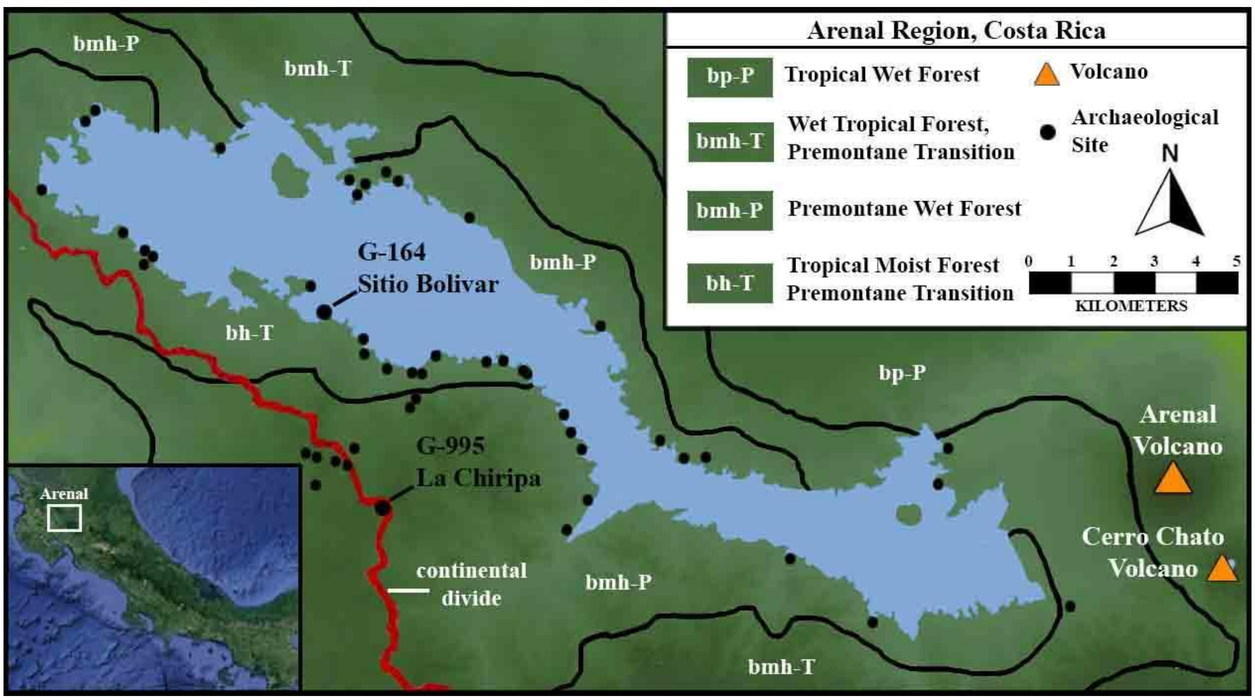


Figure 4-3: *Map of the Arenal region, Costa Rica, with the archaeological sites included in this study, the Holdridge Life zones (Holdridge et al. 1971), and the continental divide outlined. Redrawn from Sheets (1994:7).*

Due to climatic microvariation created by the volcanic range and its valleys, Arenal contains many different tropical zones or microenvironments, all located within relatively short distances of each other due to change in characteristics such as slope, elevation, and exposure (Holdridge et al. 1971). Leslie R. Holdridge and his colleagues' overview of Costa Rican vegetation into life zones is based on data collected in the 1960s and is commonly referred to as the Holdridge life zones (Holdridge et al. 1971). The system is a useful analytic system that distinguishes between bioclimatic variations and classifies vegetation within 12 different climatic categories that include dry, moist, wet, and rain forests distributed over tropical/lowland, premontane, lower montane, and montane elevations. Four of these life zones have been recorded within the Arenal region, as depicted within Fig. 4-3 and Table 4-1. The life zones are differentiated by environmental factors such as elevation, temperature, the amount and timing of precipitation, and vegetation. The flora and fauna differ among these landforms and life zones. Species richness is greater in the montane zone, and also greater on the Pacific slope compared to the Atlantic slope (Haber 2000a: 50).

These life zones and their characteristics have great implications for the habitability and potential for agriculture in each microclimate, and subsequently patterns of settlement and cultural practices (Sheets 1994). Distinct boundaries between these life zones do not physically exist and the transition between all types is gradual (Condit, Perez, and Daguerre 2011: 14). Gomez (1986) and Herrera (1986) later updated the Holdridge system to map the vegetation macrotypes of Costa Rica, leading to the 55 biotic units mentioned at the beginning of this chapter. Within the sections that follow, the original codes and Spanish names for each life zone are presented within parenthesis.

Table 4-1: *Characteristics of the Holdridge life zones that occur in the Arenal area, as discussed within the text (Bolaños and Watson 1993, Haber 2000a: 42).*

Holdridge Life Zone	Code	Elevation	Mean Annual Rainfall	Mean Annual Temp.	Dry Season Duration	Canopy Height	Agricultural Potential
Wet Tropical Forest, Premontane Transition	bmh-T	0-700 m	4000-5500 mm	21.5-24°C	0-3.5 months	40-60 m	difficult
Tropical Moist Forest, Premontane Transition	bh-T	600-800 m	1950-3000 mm	21.5-24°C	0-5 months	30-40 m	ideal
Tropical Wet Forest	bp-P	700-1400 m	4000-7000 mm	17-24°C	0-2 months	30-40 m	difficult
Premontane Wet Forest	bmh-P	800-1450 m	2000-4000 mm	17-24°C	0-5 months	30-40 m	limited
Lower Montane Rain Forest	bp-MB	1550-1850 m	3600-8000 mm	12-17°C	0-3 months	20-30 m	difficult

Distinctive habitats within these life zones include steep, dry, rocky ridges along the uppermost elements of the Aguacate Formation, swampy low reliefs of the Monteverde Formation, and wind-exposed ridges along the crest of the Cordillera (Lawton et al. 2016: 428-429). Much of the variation in forests of the Arenal area is associated with wind; the Tilarán-Arenal area is extremely windy with a mean annual speed of 15 km per hour predominantly from the strong trade winds of the north and northeast (Herrera 2016: 25, Sheets 1994). Today, Tilarán alone supplies half of the wind-powered energy for the entire country. The wind can negatively impact vegetation and land use today and likely did as well in the past. Many wind deformed trees are common in the area today (Figure 4-4), but these are isolated trees rather than forests which would have more protection and stabilization.

Figure 4-4: *Trees near the G-995 La Chiripa site demonstrating the extreme winds that are common in the Arenal region.*

Figure 4-5: *View of Lake Arenal from the G-164 Sitio Bolívar, which is situated in the Premontane Transition zone of the Tropical Moist Forest.*

The Premontane Transition zone of the Tropical Moist Forest (bosque humédo-Tropical or bh-T) is located on the western side of the lake below 800 m in elevation and is the zone that is the most ideal for agriculture in the region (Bolaños and Watson 1993). This is because it does reliably experience a dry season annually that can last up to 5 months, the soil is more fertile and still maintains enough moisture to support crops, the soil acidity is the lowest in this region, and this zone also has the lowest risk of soil erosion (Holdridge 1967). Sitio Bolívar (Fig. 4-5) is situated within this area and is thus particularly more well-suited for seed crop agriculture compared to the La Chiripa site. “Moist forests” are how Holdridge describes forests that are between wet and dry. These forests are mostly evergreen and with some epiphytes, but deciduous species are also common (Lawton et al. 2016: 428). The moist forests of Central America are known for their tall trees such as kapok (*Ceiba pentandra* [L.] Gaertn.) and espavé (*Anacardium* *excelsum* [Bertero & Balb. ex Kunth] Skeels) (Condit, Perez, and Daguerre 2011:12), both of which were identified from the macrobotanical remains in this study.

The La Chiripa site (Fig. 4-6) is situated directly along the continental divide at around 950masl in the Premontane Wet Forest (bosque muy humédo-Premontano or bmh-P), which is characterized by mature evergreen rain forests, a wet season of nine months, and moderate erosion difficulties. The soil in this zone is often saturated, anaerobic, quite acidic, with moderate to poor fertility. The Premontane Wet Forest zone is found between 800 and 1500 m in elevation and straddles both slopes of the continental divide (Haber 2000a). Although this zone is not technically considered to be a cloud forest, ground level clouds frequent the area during the wet season, as seen in Figure 4-7 (Haber 2000a). Agriculture in this zone today is generally restricted to slopes or alluvial areas and Tosi (1980) suggests that permanent or semi-permanent crops are more appropriate here compared to annual crops. Wet forests in the Holdridge (1967) system represent a classic evergreen rainforest with a few deciduous species. This zone has tall trees, a dense canopy, and a moderate presence of epiphytes such as orchids, bromeliads, ferns, and mosses, although epiphytes are less common below 1400 m (Condit, Perez, and Daguerre 2011: 12, Lawton et al. 2016: 428). Additionally, wet forests tend to have many more species compared to dry forests.

Figure 4-6: *View of the landscape at G-995 La Chiripa, which is situated along the crest of the continental divide in the Premontane Wet Forest. Today, the space is used for cattle pasture.*

Along the crest and ridges of the Cordillera from 1,500 to 1,850 m in elevation is the lower montane rain forest (bosque pluvial-Montano Bajo or bp-MB) that is regularly immersed in clouds and wind-blown mist (Haber 2000a: 43, Lawton et al. 2016: 428). Lower montane forests resemble wet forests with tall trees and dense canopies reaching 15 to 30 m in height. However, tropical cloud forests can appear in this zone where clouds often sit, leading to even higher densities of a diverse set of epiphytes, ferns, and bryophytes compared to the previously mentioned zones (Condit, Perez, and Daguerre 2011: 12, Lawton et al. 2016: 428). The heavy rainfall, humidity, and cloudy skies make agricultural activities in this life zone difficult, largely due to the poorly drained soils (Haber 2000: 43, Li et al. 2019).

The Wet Tropical Forest, also known as the Superhumid Zone (bosque muy humédo-Tropical or bmh-T), and Premontane rain forest (bosque pluvial-Premontano or bp-P) are located closer to Arenal Volcano. These life zones are not ideal for agriculture because of the excessive precipitation, thoroughly saturated and acidic soils with a low fertility that experience erosional and leaching hazards (Lawton et al. 2016: 428). The landforms throughout the area are quite variable, ranging from alluvial flats, low and high mesas, valleys, hills, and steep slopes (Sheets and McKee 1994). The Premontane rainforest has a high diversity and dense evergreen canopy with trees reaching 30 to 40 m in height (Haber 2000a: 43). The Wet Tropical Forest zone along the western side of Arenal Volcano can have evergreen forests with a canopy height that reaches 40 to 60 m and abundant epiphytes and lianas (Haber 2000a: 44). These zones receive excessive precipitation which leads to various other issues such as experiencing the lowest solar radiation or sunlight among the different life zones.

Figure 4-7: *Photograph of the La Chiripa site that demonstrates the dense fog which envelops the area regularly, since it is located close to a Tropical Montane Cloud Forest setting.*

4.2 The Volcanic Landscape

There are four volcanic ranges within Costa Rica: the Guanacaste, Central, Tilarán, and the Talamanca (see Fig. 4-8). This amounts to a total of nine active or recently active volcanoes that have erupted during the Holocene (the last 11,500 years) including Rincón de la Vieja, Miravalles, Arenal, Chato, Poás, Hule, Barva, Irazú and Turrialba (Alvarado and Soto 2008: 358) and 61 dormant volcanoes (Bergoeing 2017). The term 'active volcano' means that there is potential for new eruptions, even if that volcano has not erupted for decades or centuries (Grattan and Torrence 2007:6). Arenal Volcano is part of a larger chain of volcanoes called the Cordillera de Tilarán, which is just south of the larger Guanacaste range (Alvarado and Cardenes 2016: 45). The Tilarán range, 105 km in length, follows the general direction of the country along a Northwest-Southeast axis and contains three volcanoes: Los Perdidos, Cerro Chato, and Arenal (Bergoeing 2017: 15). This range contributes to the continental divide, which creates the Pacific and Caribbean Lowlandss to the west and east. The Cordillera de Tilarán is composed mostly of volcanic rocks from the Aguacate group, the oldest of which date to the late Miocene 8.5 to 10.5 Ma and the youngest rocks were formed during the Pliocene 2.6 to 4.3 Ma (Chaves and Saenz 1974). More broadly, Arenal Volcano is part of the Pacific "ring of fire" as a result of the active subduction zone between the North American and Caribbean tectonic plates (Soto and Alvarado 2006).

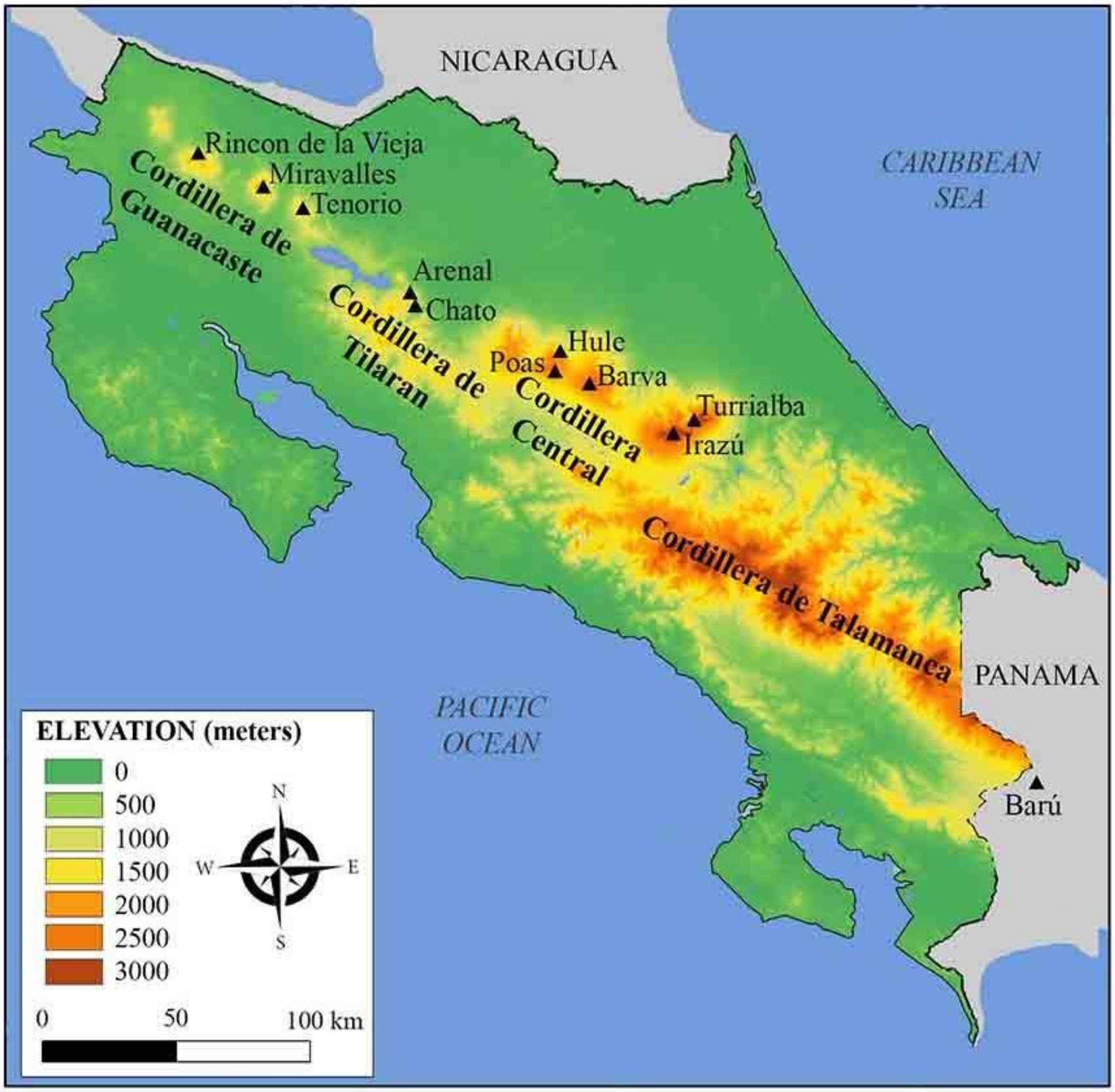


Figure 4-8: *Elevation map of the major volcanic ranges in Costa Rica with any volcano that erupted during the Holocene labeled. Map created using SRTM data collected by NASA.*

Arenal is estimated to be the youngest volcano in Costa Rica with an approximate age of 40,000 years and the only volcano in Costa Rica that has issued flows since the Spanish conquest. Its modern cone reaches 1657 meters above sea level and was formed by pyroclastic flows (Bergoeing 2017: 7). It is a “stratovolcano composed of alternating ashes, slags, lapilli and lava blocks, and deposits of burning clouds” that has been active since roughly 7,000 years ago (Bergoeing 2017: 7). The last documented eruption of 1968 emitted dangerous pyroclastic flows and burning clouds that claimed 500 victims (Bergoeing 2017: 169, Melson and Saenz 1973). At least 22 explosive eruptions have taken place in the last 7,000 years from Arenal (Soto and Alvarado 2006), the estimated timing of each can be found in Table 3-2.

Table 4-2: *History of major eruptions of Arenal Volcano and the cultural phase in which they occurred. Shaded entries represent cultural paleosols and correspond to archaeological units or levels discussed in the excavations at G-995 La Chiripa and G-164 Sitio Bolívar (based on Egan 2019: Table 4-4).*

Cultural Phase	AT-x	Estimated Age
	AT-22	CE 1968
	AT-21	CE 1446
Tilarán	AT-20	CE 1416
Tilarán/Silencio	AT-30	CE 1295-1416
Silencio	AT-19	CE 1048
	AT-18	CE 958
Silencio/Arenal	AT-50	CE 493-868
Arenal	AT-17	CE 472
	AT-53	CE 226-451
	AT-16	CE 101
	AT-15	101 BCE
	AT-54	372-176 BCE
Tronadora	AT-14	553 BCE
	AT-13	733 BCE
	AT-12	914 BCE
	AT-11	1095 BCE
	AT-10	1276 BCE
	AT-9	1456 BCE
	AT-60	1637-1534 BCE
	AT-8	1692 BCE
Fortuna	Chato	1814 BCE
	AT-7	2281 BCE
	AT-6	2748 BCE
	AT-5	3215 BCE
	AT-4	3682 BCE
	AT-3	4149 BCE
	AT-2	4616 BCE
	AT-1	5083 BCE

Figure 4-9: *Photograph of Arenal Volcano, taken by the author in 2018.*

The Arenal region experiences frequent eruptions and earthquakes and is classified as a catastrophic environment; severe eruptions of Arenal Volcano have occurred on average every 336 years (Egan 2019: 121, Torrence 2016). Catastrophic eruptions of Arenal Volcano could be extremely destructive, with minimal survival of flora and fauna and ecological recovery taking centuries (Jago and Boyd 2005). However, not every major eruption of Arenal Volcano would have impacted the area surrounding La Chiripa in a way that required people to abandon the region entirely (Egan 2019). Many eruptions would have only caused short-term death to low-lying vegetation, with larger flora such as arboreal species withstanding the volcanic episodes, and ecological recovery possibly only taking months to years. Past peoples would reoccupy volcanically hazardous areas: thinner ash falls would allow people to stay in an area but thicker ash falls meant that people could occupy an area once the soil and vegetation had recovered (Sheets 1994: 15).

Hazard and risk perception maps created by Egan (2019, Figures 4-17 and 4-18) depict and simulate what areas would have been impacted by each volcanic eruption of Arenal Volcano during each of the cultural phases. Zone 3 would have had the least impact from an eruption with mainly low lying vegetation being the only flora that couldn't survive. Trees would have been able to withstand these conditions and ecological recovery could happen shortly from months to perhaps years. Zone 2 would have experienced more severe damage with collapse of structures, widespread flora and faunal destruction including any aquatic life in the lake. Most trees would likely survive these conditions, but overall ecological recovery would be more gradual and take decades. Zone 1 is the area closest to Arenal Volcano and the most impacted and destroyed by eruptions. Very little life could survive within zone 1 in the event of a catastrophic eruption and recovery would be quite slow, taking perhaps centuries in areas on or near the volcano. While La Chiripa existed before any of the Tronadora phase eruptions, the site would have been within zone 2 for a couple of Arenal's eruptions, but generally is within the safer, less impacted zone 3. The same is true for Sitio Bolívar during the Arenal phase; it is only ever within zone 3 during the major eruptions of Arenal Volcano. Generally, people in this area certainly would have been impacted by the periodic volcanic eruptions, but they would not have been forced to abandon the region entirely because ecological recovery would have taken only months to years, rather than centuries.

In the past, people in Arenal would have been quite aware of the volcano, not just through its periodic eruptions, but also through its dominance on the landscape with its iconic cone shape reaching 1,670 meters above sea level. The majority of known archaeological sites in the region are situated in a location where past villagers would have been able to view the volcano on a clear day (Egan 2019: 122). Figure 4-10 demonstrates how the volcano can be viewed from the G-995 La Chiripa site when the sky is clear of too much cloud cover. The volcano was not necessarily a negative presence on the landscape. Although deposits of volcanic ash can be initially detrimental to fauna and flora, after the ash has weathered it can become a very fertile, mineral-rich soil that is suitable for cultivation of food and other resources (Grattan and Torrence 2016, Walker 2011). The mountain ranges of Costa Rica are primarily composed of udic andisols, which are formed from volcanic ash deposits (Alvarado and Mata 2016: 69). The soil in the Tilarán area is mostly developed from volcanic ash (93%) and the remaining soil developed from basalts (Tosi 1980). These soils are frequently rejuvenated by andesitic volcanic ash deposits which constantly enrich the environment with nutrients. In the country today, many agricultural products are produced in andisols such as coffee, sugarcane, heart of palm, and roots and tubers. In the event of a volcanic eruption, coarser soil such as sandy and sandy-loam materials are deposited near the crater, whereas further away from the crater silty loam or loam textures are more abundant (Alvarado and Mata 2016: 69). These soils develop from the volcanic tephra that was ejected through weathering processes.

Figure 4-10: *View of Arenal Volcano from the G-995 La Chiripa archaeological site (Photograph by author).*

Most Andisols have moderate fertility and nearly neutral pH values (Alvarado and Mata 2016: 70). Recently deposited Andisols can have limited amounts of Nitrogen and high values of Phosphorus that is retained tightly by the clay, creating a difficult setting for agriculture. Tosi's study of the Tilarán area (1980) showed that the soils were mostly “typic hydrandept,” which are high in water retention capacity, low in density, low in available phosphorous, potassium, zinc, and manganese but high in iron, copper, calcium, and magnesium. At lower elevations along the Cordillera de Tilarán, some of the soil are Inceptisols, which are younger soils which developed from rock, riverine, volcanic, or clay materials.

The Tilarán-Arenal area today certainly has fertile soil, where wooden fence posts germinate and develop into trees, subsequently creating “living fences” (Fig. 4-11) (Budowski and Russo 1993, Sauer 1979). These trees provide many benefits to farmers besides as physical support for fencing; the trees provide wood for fuel or for construction, edible fruits, handicraft material, medicinal products, gums, resins, dyes, as well as various other products (Budowski and Russo 1993:67). Additionally, a living fence post can produce several cuttings for new fence post plantings every year. In tropical America, living fences are a widespread agroforestry practice and form of sustainable agriculture (Budowski 1987), with nearly 100 different tree species used for such a purpose in Costa Rica (Budowski and Russo 1993).

Figure 4-11: *View of the “living” fence posts in the pasture at the finca El Silencio, within walking distance of the La Chiripa archaeological site.*

Archaeological evidence of the influence of volcanoes on daily life in Costa Rica during pre-Columbian times is sparse, with very few references to knowledge or myths about volcanoes present in the archaeological record (Alvarado and Soto 2008: 356). There is a ceremonial center that existed near Irazú Volcano and some volcanoes have ancient cemeteries and trails, but no petroglyphs or sculptures with volcanic themes have been found. Few indigenous languages are still in use today within the country (Chorotega, Boruca, Bribri, Cabécar), and these populations are not close enough to active volcanoes and do not have any oral traditions related to volcanoes (Alvarado and Soto 2008: 357). Although, an indigenous group in northern Costa Rica, the Malekus, believed that the god of fire lived in the Arenal Volcano (Alvarado 1989). Some clues exist in place names however, such as at Guayabo de Turrialba, a major archaeological site on the slope of Turrialba volcano whose name is derived from the indigenous name Toriáraba means ‘river of fire’ (Gagini 1917, Hurtado de Mendoza 2004). The site has a roadway built from lava boulders that provides a direct view of the volcano which had several major eruptions since the 8th century (Alvarado and Soto 2008, Reagan et al. 2006). Additionally, the native named Irazú volcano has etymological roots linking it to tremor and noise or thunder (Alvarado and Soto 2008: 359). Various artifacts found in Costa Rica can also demonstrate past people’s interactions with volcanic stone as it was an important geological resource. Lithic objects such as axes, celts, and knives were made from andesites and basalts and were likely prized for their durability (Alvarado and Soto 2008: 358). Elaborate metates (grinding stones) were mostly made from andesites and the well-known sculptural spheres from the Diquís Delta were constructed using volcanic rocks as well (Alvarado and Soto 2008: 358, Escalante and Soto 2007).

Multiple eruptions from Volcan Barú in northwestern Panama apparently had little direct effect on the prehistoric populations in the immediate vicinity of the Laguna Santa Elena (Anchukaitis and Horn 2005, Holmberg 2007), suggesting human adaptation to such ecological settings. Thus, it is likely that the Arenal residents were also coping to volcanic eruptions and knew how to navigate their shifting environmental conditions.

4.3 Conclusions

The Arenal region of Costa Rica is incredibly diverse and contains a variety of microclimates or life zones in which past people could have interacted with in order to procure resources for their daily needs. With this basis of the environmental setting of Arenal now established, the next chapter will review the archaeological history of Costa Rica in order to situate the reader within the social setting of this region in the past.

CHAPTER 5

ARCHAEOLOGY OF COSTA RICA:
THE CULTURAL HISTORY OF ARENAL AND ITS NEIGHBORS

Archaeologist's pursuit towards knowledge of Pre-Colonial Costa Rica has been a challenging endeavor due to many factors. The country has suffered greatly from extensive looting, leaving many archaeological sites destroyed and much of the artifacts recovered are no longer associated with their archaeological context, meaning very little is known about the origin of many artifacts. Unfortunately, the humidity and soil conditions in most of the region lead to generally poor preservation of organic material, which adds to the difficulty of recovering cultural remains. Stone architecture was for the most part rare in this area (limited to certain subareas and more recent time periods), deterring the interests of many archaeologists in the Americas who instead focus their research efforts on larger-scaled stone building societies such as the Maya, Aztec, or Inca. Nevertheless, Costa Rica boasts impressive settlements connected by intricate causeway systems, with expansive plazas, platforms, terraces, and advanced irrigation systems (Sheets 2011, Vazquez et al. 2002). Most pre-Hispanic buildings in Costa Rica were constructed using wood and thatch material on top of large earthen mounds with cobble foundations, some as large as 30 m in diameter. Much of the archaeology conducted up until the 1970s in the country had focused on high-status grave offerings rather than households, thus highlighting instead the finely crafted goods, jade pendants, hammered gold ornaments, mace-head sculptures, and elaborate metates that are associated with burials.

A term that has been used to define this area of the Americas is the "Intermediate Area," meaning the area between Mesoamerica and the Andes (Haberland 1957:156, Hoopes and Salgado-Gonzalez 2021). Willey (1979:277, 1990:51) suggested that the Intermediate Area was different enough from Mesoamerica and the Andean area, but that it did not have its own distinctive patterns, state-level societies, or extensive cultural horizons. Some scholars even went so far as to call the isthmian section of Central America a backward frontier area of Mesoamerica that is composed entirely of cultural influences from the civilizations to the north and South (Lothrop 1926, 1963, Johnson 1963, Baudez 1970, Stone 1972, 1977). Based on this term Intermediate Area, the isthmus of southern Central America has been viewed as a corridor through which ideas, objects, and people moved back and forth (Cooke 2021, Linares 1979:21).

Although objects from distant regions of Mesoamerica have been found archaeologically in the 'so called' Intermediate Area, Sheets (1992: 34) points out that they are actually quite rare in frequency compared to the great numbers of pottery vessels and jade objects made in local styles. Today, the region is viewed in more favorable terms with appreciation for its variability in sociopolitical development and technological innovations (Hoopes 1992, Corrales 2000). Sheets (1992) advocates for an emphasis on the achievements of the societies in this area within their own social, religious, political, economic, and environmental contexts. He specifically recognizes these societies' avoidance of the state, smaller geographical polities, smaller population size, greater stability over the long-term with economic systems that are adaptive, and the maintenance of egalitarian and ranked social organization. The artistic achievements of the region also emphasize independence and diversity. Cultural influence from the Olmec, Maya, Aztec, Chibchan, and Andean societies can be seen within this region, but the indigenous peoples of Costa Rica adopted and modified a variety of practices to fit their local circumstances as did everyone else across the Americas (Snarksis 2003: 160). Foreign items may have been valued for the exotic symbolism they represented, but did not replace or define local traditions (Ibarra Rojas 2001). Therefore, the term Intermediate Area is negative and does not properly recognize the achievements and distinctiveness of these past peoples, many scholars today instead refer to the area as Lower Central America, Southern Central America, Greater Central America, or the Isthmo-Colombian Region, thus using a strictly geographical term rather than a culturally loaded one (Corrales 2000, Fonseca 1998, Hoopes and Fonseca Zamora 2003, Hoopes and Salgado 2021, Joyce 2021, Lange and Stone 1984, Sheets 1992).

Figure 5-1: *Map of Costa Rica highlighting the main cultural regions based on Prehispanic archaeological sites: Greater Nicoya, Arenal, Caribbean Lowlands, Central region, and the Greater Chiriquí region.*

Although Costa Rica is a small country in terms of land area, the climate and terrain varies widely, as was discussed in Chapter 4, making it one of the most ecologically diverse areas on earth. There was also a diverse set of cultural practices and ways of life in this region in the past. Multiple archaeological regions have been defined: including Greater Nicoya, Arenal, the Caribbean Lowlands, the Central region, and the Greater Chiriquí region (Figure 5-1). While there are similar trajectories of social change among the various regions, they also exhibit variation temporally and sociopolitically (Murillo Herrera 2010). The riverine conditions of the area allowed for excellent transportation between regions for trade and migration (Lange 1980).

Just as the ecological setting of Costa Rica is diverse, so were the cultural practices and linguistic traditions in Pre-Columbian times. The Isthmo-Colombian area was occupied by people from the Chibchan language family, from eastern Honduras to northern Colombia and Venezuela (Fonseca 1998:39). Modern day Costa Rica was the most diverse area within this linguistic family according to genetic data (Constenla 1991, Kennett et al., 2022). Adding to this cultural and linguistic diversity, the first Otomanguean migrations from Mexico arrived in northwestern Costa Rica around 900 CE, with the Uto-Aztecan migrations following that (Ibarra and Salgado 2009, Salgado and Fernandez 2011). In southern Costa Rica, Chocoa speakers migrated from Colombia.

The Spaniards arrived in Costa Rica in 1502 CE, which began a transition period that decimated the indigenous societies with great population declines, loss of cultural practices, and even the extinction of many groups. Major visits by the Spanish to Costa Rica, Panama, and Nicaragua during their conquest of the Americas include Juan de Castañeda and Hernan Ponce de León in 1519, Francisco Hernández de Córdoba in 1523, Pedro Arias de Dávila in 1526, Gonzalo Fernández de Oviedo y Valdés in 1528, and Bartolomé de Las Casas in 1534. The earliest visits by Juan de Castañeda and Hernan Ponce de León were met by supposedly hostile inhabitants with their weapons ready. These Spaniards also captured several indigenous persons to use as interpreters and guides on their travels (Solórzano Fonseca and Quirós Vargas 2006). Three years later Gil González Davila traveled overland from Panama to Nicaragua, exchanging goods as he went (Ibarra Rojas 2021: 55). Hernández de Córdoba later followed the same route as Davila and encountered much violence during his travels, leading him to "fortify" himself through the founding of the city of León. The indigenous people of Costa Rica fiercely resisted the Spanish for a couple of generations and the country was the last among Central America to be conquered (Timm 2000: 408). Denevan (1992) estimates that the pre-Columbian population of indigenous peoples was about 400,000 at its peak. Hall and Perez Brignoli (2003) argue that the total population of the Isthmo-Colombian Area was much greater than this, on the order of several million. It was reduced to 80,000 by 1563 (MacLeod 1973). It is estimated that in less than a generation, as much as 95 percent of the population had been lost through disease, warfare, and the illegal export of slaves (Newson 1982, Steinbrenner 2021b: 23). Although many indigenous languages are extinct or endangered, genetic studies demonstrate that as much as 30 percent of Costa Ricans today carry DNA from indigenous ancestors (Barrantes and Morera Brenes 1999, Campos Sanchez, Raventos, and Barrantes 2013).

Historical documents by Spanish chroniclers provide some details about households in this region. Fernández de Oviedo y Valdés ([1526] 1950) describes impermanent structures made of wattle-and-daub walls and thatch roofs that were long and rectangular in shape during his visit to Costa Rica and Nicaragua. The Spanish chronicler Fray Augustín de Cevallos sent a detailed report to the king of Spain that describes several customs of the people living in the central Atlantic lowlands of Costa Rica in 1610. He describes that people lived in palenques, which he describes as long houses or "forts built in the native fashion" (Lothrop 1926: 446). Fray Augustín de Cevallos also notes that chiefs and high-ranking individuals live in the same house as many women, whereas common people are generally more monogamous. Juan Vázquez de Coronado also witnessed and chronicled large settlements, which reportedly had over 65 large multi-family houses (Vázquez de Coronado 1976).

Table 5-1: Chronological phases of the different subareas of Costa Rica.

<table>
<tr><th>Time</th><th>Period</th><th>Geater Nicoya</th><th>Arenal</th><th>Central Highlands</th><th>Atlantic Watershed</th><th>Gran Chiriquí</th></tr>
<tr><td>1600</td><td rowspan="2"></td><td rowspan="6">Ometepe
1350-1550 CE</td><td colspan="4" rowspan="3">Contact Period</td></tr>
<tr><td>1550</td></tr>
<tr><td>1500</td><td rowspan="8">VI
1000-1550 CE</td></tr>
<tr><td>1450</td><td rowspan="2"></td><td rowspan="9">Cartago
800-1500 CE</td><td></td><td rowspan="7">Chiriquí
900 - 1500 CE</td></tr>
<tr><td>1400</td><td rowspan="6">La Cabaña
1000-1450 CE</td></tr>
<tr><td>1350</td><td rowspan="2">Tilarán
1300-1400 CE</td></tr>
<tr><td>1300</td><td rowspan="6">Sapoá Period
800-1350 CE</td></tr>
<tr><td>1200</td><td rowspan="7">Silencio
600-1300 CE</td></tr>
<tr><td>1100</td></tr>
<tr><td>1000</td></tr>
<tr><td>900</td><td rowspan="5">V
500-1000 CE</td><td rowspan="5">La Selva
500-1000 CE</td><td rowspan="3">San Lorenzo
700 - 1000 CE</td></tr>
<tr><td>800</td></tr>
<tr><td>700</td><td rowspan="5">Bagaces Period
300-800 CE</td><td rowspan="5">Curridabat
300-800 CE</td></tr>
<tr><td>600</td><td rowspan="4">Aguas Buenas
300 - 900 CE</td></tr>
<tr><td>500</td><td rowspan="11">Arenal
500 BCE -
600 CE</td></tr>
<tr><td>400</td><td rowspan="15">IV
1000 BCE -
500 CE</td><td rowspan="7">El Bosque
200 BCE -
500 CE</td></tr>
<tr><td>300</td></tr>
<tr><td>200</td><td rowspan="8">Tempisque
500 BCE-
300 CE</td><td rowspan="6">Pavas
300 BCE -
300 CE</td><td rowspan="6">Concepcion
phase
300 BCE -
400 CE</td></tr>
<tr><td>100</td></tr>
<tr><td>0</td></tr>
<tr><td>100</td></tr>
<tr><td>200</td></tr>
<tr><td>300</td><td rowspan="13">La Montaña
1500-200 BCE</td></tr>
<tr><td>400</td><td rowspan="12">Barba
1500-300 BCE</td><td rowspan="12">Sinancrá
1500-300 BCE</td></tr>
<tr><td>500</td></tr>
<tr><td>600</td><td rowspan="14">Orosí
2000-500 BCE</td><td rowspan="14">Tronadora
2000-500 BCE</td></tr>
<tr><td>700</td></tr>
<tr><td>800</td></tr>
<tr><td>900</td></tr>
<tr><td>1000</td></tr>
<tr><td>1100</td><td rowspan="11">III
4000-1000 BCE</td></tr>
<tr><td>1200</td></tr>
<tr><td>1300</td></tr>
<tr><td>1400</td></tr>
<tr><td>1500</td></tr>
<tr><td>1600</td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td></tr>
<tr><td>1700</td></tr>
<tr><td>1800</td></tr>
<tr><td>1900</td></tr>
<tr><td>2000</td><td rowspan="2"></td><td rowspan="2">Fortuna/Archaic
4000-2000 BCE</td></tr>
<tr><td>2100</td></tr>
</table>

In this geographical chapter, the following subsections will review the major archaeological subareas of Costa Rica, beginning with the Greater Chiriquí region in the south, through the mountainous Central Highlands, and up to the Nicoya Peninsula in the North, and ending with the Arenal region, which is the focus of this investigation. Table 5-1 compares the different chronological periods among the different regions, but it is important to recognize that concrete boundaries between phases or periods are provisional constructs. Changes in cultural practices would have been more transitional, both between time periods and geographic boundaries.

5.1 The Greater Chiriquí Region

The southern portion of the country is known as the Greater Chiriquí (Figure 5-2), and includes the Diquís and Chiriquí subareas in Puntarenas province on the Pacific slope of the Talamanca Mountain range and the Bocas del Toro province on the Caribbean slope, yet the subregions and culture subarea are debated (Cooke 2005, 2014, Corrales 2000, 2001, 2016, Haberland 1976, 1984, Hoopes 1996, Linares de Sapir 1968a, 1968b, Linares and Ranere 1980). The Talamanca range separates the Diquís region from the rest of the country, making it somewhat isolated (Corrales 2000). Recent geological and paleo-ecological studies conducted by Holmberg (2005, 2007, 2009) show that multiple eruptions of Volcan Barú affected human settlements in the southern highlands, but that people remained present nevertheless.

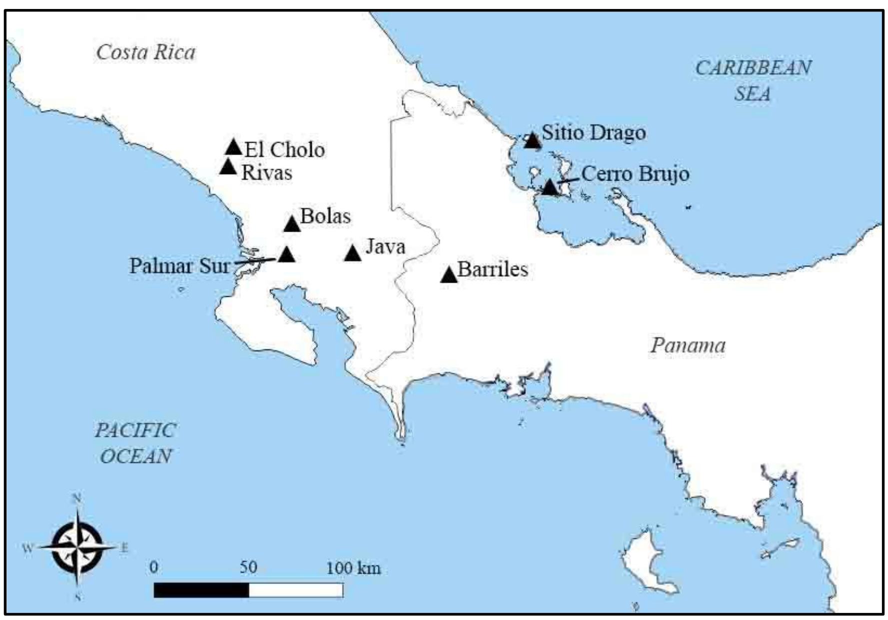


Figure 5-2: *Map of archaeological sites mentioned within the text in the Greater Chiriquí Region.*

The Greater Chiriquí region has coastal beaches with stretches of mangroves, broad fertile plain, and hot, humid tropical forests with iconic trees such as algarrobo (*Prosopis*), cashew (*Anacardium occidentale* L.), nance (*Byrsonima crassifolia* L. Kunth), jocote/wild plum (*Spondias purpurea* L.), and annona (*Annona pittieri* Donn. Sm.) (Frost 2021, Haberland 1984, Stone 1977). Vegetation reconstruction at Laguna Santa Elena in Southern Costa Rica demonstrates an intensification of maize cultivation around 400 CE, and disturbance taxa include Cecropia, Asteraceae and Poaceae. Forests around then had *Myrsine*, *Weinmannia*, Melastomataceae, *Alchornea*, *Hedyosmum*, and *Quercus*. (Kerr at al. 2020). In recent times, the area has been heavily used for cultivation of exports such as banana, cacao, and palms (Fernández and Quintanilla 2003).

The Greater Chiriquí region is known archaeologically for the stone sculptures of spheres and anthropomorphic peg-base statues, spiral petroglyphs, elaborately crafted gold objects, large habitation sites, and detailed sculptural representations of elites such as at Barriles (Bollaert 1863, Otis 1859, Palumbo 2009, 2013, Stirling 1950, Wake 2024: 105). Early scholars dismissed the area as lacking complex sociopolitical systems and paramount villages (Linares and Ranere 1980: 66-67, Steward 1948, Steward and Faron 1959), yet archaeological evidence of elaborate metates, exotic ceramics, and contact period accounts of prestige goods such as gold pendants suggest otherwise (Graham 1992, 176, Snarskis 1984b: 210, 1992, Wake 2024). Recent scholars argue that complex societies come in various forms and do not all follow the same pattern, and that the Isthmo-Colombian area was organized in supremely flexible ways in order to enhance their autonomy (Berry and Palumbo 2024).

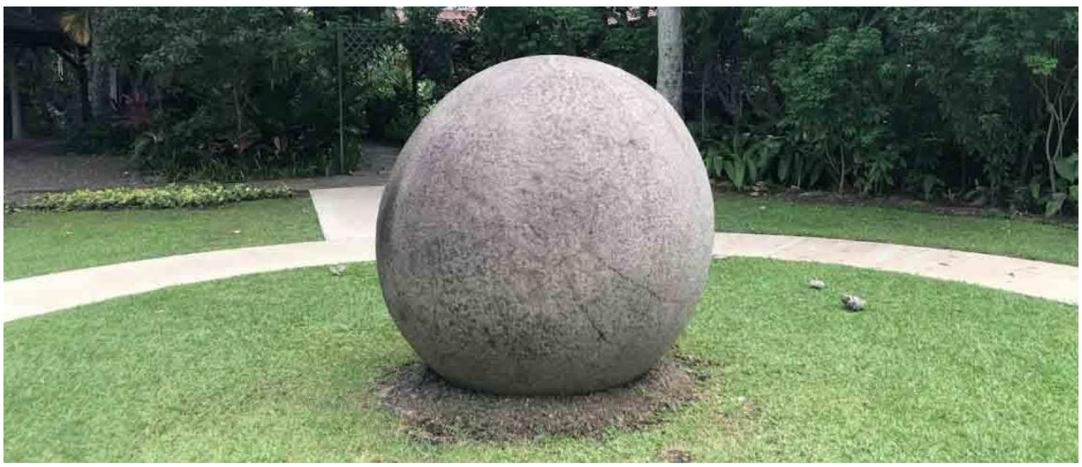


Figure 5-3: *Stone sphere from the Diquís region on display at the Museo Nacional de Costa Rica. Photograph by the author.*

Giant spherical stones were shaped from volcanic boulders of the Diquís region (Figure 5-3) and have been reported from over 30 archaeological sites in Costa Rica and Panama, amounting to over 300 stone spheres having been identified from this region (Baudez 1993, Fernández and Quintanilla 2003, Hartman 1901, Hurtado and Gómez 1988, Kennedy 1966, Lothrop 1963, Stone 1943, 1954). These spheres have smooth finishes, are nearly perfect in shape, are often found in groups, and can be quite large in size, ranging from 20 centimeters to more than two meters in diameter (Fernández and Quintanilla 2003). Stone balls have been found in open fields and the upper parts of mounds on paved surfaces, often surrounded by scattered ceramics fragments, earthen mounds, foundations, and cemeteries (Badilla, Quintanilla, and Fernández 1998). Excavations at Palmar Sur-Sierpe (occupied between 600 and 1200 CE) suggest that the groups of stone spheres were arranged and oriented toward the cardinal directions, particularly east to west (Fernández and Quintanilla 2003: 212). These stone spheres cannot be viewed individually; they are always found in groups and form a community of sculptures (Corrales 2024). The placement of the spheres was often in a location associated with a ramp leading to a mound structure. Manufacture of these stone balls was highly specialized work that required a great deal of knowledge and skill with chisels, hammers, and abrasives. Transportation of these monumental sculptures would have required considerable organization and perhaps levers. Whether these stone spheres were evidence of privileged access or were simply markers of group membership and rituals linked to astronomical observations is still debated (Corrales and Badilla 2007).

Figure 5-4: *Objects of jadeite (true jade) and other green stones (quartz, chalcedony, opal, agate, and serpentine) on display at the Museo Nacional de Costa Rica. Photographs by the author.*

Various objects made of jadeite and other green stones (quartz, chalcedony, opal, agate, and serpentine) were manufactured by the indigenous people of Costa Rica between 500 BCE and 700 CE (Figure 5-4). Jade first appeared in the last centuries of BCE in the form of fine lapidary work, began to diminish by 500 CE with the arrival of gold, and ultimately disappeared around 700 CE (Snarksis 2003: 161). This is in stark contrast to Mesoamerica, where it was still a powerful symbol in the sixteenth century. The most typical form of jade found in Costa Rica is the celthform pendant (formerly identified as an "axe-god"); it consists of an animal (often avian) or human figure on a celt-like polished semiprecious rock or mineral (such as jadeite) that was drilled for suspension purposes (Hoopes, Mora-Marín, and Kovacevich 2021, Kuboyama-Hairakawa 2023, Mora-Marín 2021). These lapidary technologies represent a thousand years of tradition and were a widely shared part of material culture in Indigenous Costa Rican societies (Kuboyama-Hairakawa 2023). The early focus on jade (300 BCE to 500 CE) coincides with settlements concentrated on fertile land, small scale communities, and a lifestyle of living in harmony with the environment (Snarskis 2003). According to Snarskis (2003), the shift to gold is linked to settlements that are located in strategic locations that allow for defense and reflect increased hierarchical systems and the presence of warfare.

Metallurgy in this region is represented by gold (Figure 5-5), copper, and *tumbaga* (a gold-copper alloy also known as *guanín*) objects formed either through open-mold casts of animal designs or as sheets, including ones shaped into flat, circular disks (Fernández and Quintanilla 2003: 206). Gold can be found within the sediment carried by the rivers and streams that descend from the mountains of the Osa Peninsula, where gold is extracted today manually from many rivers in the area. There are not any known natural deposits of copper in this region, the material likely originated more from the Central Region and the Talamanca Range (Castillo 1997). Common motifs on the gold objects include birds with unusual wings, beaks, and claws, as well as lizards, serpents, bats, frogs, and spiral styles (Fernández and Quintanilla 2003). The avian imagery seen on artwork throughout the Isthmo-Colombian region can be identified to have represented a variety of bird species (Cooke et al. 2003).

Figure 5-5: *Gold objects on display at the Banco Central de Costa Rica's Museo del Oro in San José, Costa Rica, where reportedly over ninety percent of the collection comes from southern Costa Rica (Fernández and Quintanilla 2003: 221). Photographs by the author.*

Dispersed sedentary settlements and population centers appear around 300 BCE, during the Sinancrá and Concepcion phases (Corrales 2000, Drolet 1983, 1992). The Diquís Delta has large communal habitation sites with circular floors constructed out of river stones that could have housed a large number of people. The stone walls that lined mounds in this region likely elevated house structures in order to be resilient to the periodic flooding of the Diquís delta (Corrales and Badilla 2015). During the Aguas Buenas phase (300 BCE to 900 CE), ceremonial centers emerged with the presence of status differences at these centers, but settlements remained small and dispersed throughout the landscape (Calderón 2023: 21, Drolet 1983). Sites such as Bolas, Java, and Barriles demonstrate the presence of earthen mounds, relatively heterarchical settlements located at higher elevations, stone spheres and sculptures, craft production, and evidence of ceremonial feasting activities during this phase (Calderón 2023, Drolet 1983, Palumbo 2018). At the Java site in the Coto Brus Valley (650-850 CE), excavations of the earthen mounds showed that residents were not strongly differentiated in terms of wealth based on the ceramic and lithic assemblages (Calderón 2023).

During the Chiriquí phase (900 - 1500 CE), population growth continued with the appearance of more population centers which are now more concentrated at lower elevations near the coast and rivers (Drolet 1983, Frost 2009, 2021, Frost and Quilter 2012, Quilter 2004). This phase also is connected to the emergence of inequality, which is likely linked to craft production and the long-distance exchange of goods as was discussed within Chapter 3 (Drolet 1992, Fernández and Quintanilla 2003, Quilter and Blanco 1995).

Settlement patterns have been reported in southern Costa Rica, with centralized settlement patterning at sites such as the Formative Period site of Barriles (Palumbo 2009) and the later period sites of Rivas (Quilter 2004) and Farm 6 (Corrales and Badilla 2015) in the Greater Chiriquí region. The presence of non-structural 'hamlet' sites (identified by their refuse concentrations only) formed the basis for a hierarchical system of smaller villages clustered around larger villages and ceremonial centers (Drolet 1984, 1992). However, a hierarchically based nucleated settlement patterning may just be one of the social dynamics present, as some scholars suggest that social configurations in the area were quite variable in their internal site organization due to localized preferences (Herrera 2016, Palumbo 2009). Indications of status differentiation are largely dominant in later time periods, and interpretation of certain markers as evidence of status differentiation such as monumental construction and ceramic and lithic assemblages are subjective (Herrera 2016). At the El Cholo site in southern Costa Rica, Herrera (2015, 2016) interpreted the function of the main circular structures as a funerary complex rather than as a residence, based on the abundance of funerary material found within the structures. This suggests that the primary center of the site may be a community burial ground rather than an elite residence. Frost (2009) also noted the central significance of the Panteón de La Reina, a hilltop cemetery, in the organization of Rivas, a late period site in the Térraba-Coto Brus valley. This settlement organization corroborates what is seen at the El Silencio cemetery in the Arenal region, which has numerous footpaths radiating out from it, connecting multiple communities to the funerary setting (Sheets 2011). Herrera (2016) suggests that many sites interpreted as primary elite centers could also be interpreted as aggregation or nucleation points for the surrounding population, as evidenced by the variability in mound forms and functions reported. Mounds, hilltop cemeteries, and petroglyphs could indicate community topographic references and mnemonics that delineated territory, lineal affiliations, and resource boundaries (Buikstra and Charles 1999, Herrera 2016, Sheets 2009, 2011, Zilberg 1986).

Sitio Drago is a coastal village in Bocas del Toro consisting of a grouping of low earthen mounds and a mortuary mound near its center that was occupied during the Aguas Buenas and Chiriquí phases (from 650 to 1400 CE) (Wake 2024: 114). Paleoethnobotanical investigations at the site identified numerous carbonized seeds and fruits from both screen and flotation samples from midden contexts. The plant identifications include maize, beans, palm nuts (*Astrocaryum* and *Bactris*), garden herbs (*Eryngium foetidum* L., *Myrcia gatunensis* Standl., and *Xylopia bocatorena* Schery), tree fruits such as papaya (*Carica papaya* L.), *Garcinia* spp., nance (*Byrsonima crassifolia*), sapodilla (*Manilkara zapota* [L.] P. Royen), and sapote (*Pouteria sapota* [Jacq.] H.E. Moore & Stearn), and shrub fruits such as bejuco (*Cordia spinescens* L.), guabito de rio (*Zygia longifolia* [Humb. & Bonpl. ex Willd.] Britton & Rose), huito (*Genipa americana* L.), jagua macho (*Randia armata* [Sw.] DC), and chacruna (*Psychotria*) (Martin 2015: 119-120). The villagers intensified their production of fruit trees and maize fields near residential structures, with tree and shrub fruits representing the overwhelming majority of plant resources in the assemblage. Martin's (2015) reconstruction of subsistence activities at Sitio Drago demonstrates how villagers were able to develop a resilient subsistence economy that did not degrade the environment over time.

Subsistence at Cerro Brujo, a shell midden site in the Bocas del Toro region (1000 CE), reveals a subsistence pattern that incorporated "slash and mulch" vegeculture farming where the inhabitants focused on root and tree crops such as manioc or yuca (*Manihot esculenta*), yam (*Dioscorea* sp.), and peach palm or pejibaye (*Bactris gasipaes* Kunth) as well as marine and terrestrial mammals (Linares 1976,1977, Linares and White 1980). Carbonized plant remains from Sitio Abuelitas demonstrate other plants that formed the subsistence regime of the region, including beans (*Phaseolus* sp.), Huito (*Genipa americana*), Pimiento (*Myrcia gatunensis*), Pumpwood (*Cecropia* spp.), Schery (*Xylopia bocatorena*), and chacruna (*Psychotria*) (Martin 2015). Burned raphia palm (*Raphia taedigera* [Mart.] Mart.) nuts found at Black Creek (Baldi 2011: 99) and Sitio Drago (Wake 2006) were likely consumed for thousands of years and formed a core ingredient in the subsistence strategy of the Greater Bocas del Toro region (Wake 2024: 112).

Chronicles by the Spaniards who arrived in Southern Costa Rica (published by León Fernández 1882), document the presence of chiefs who ruled over towns or *palenques* (large houses). The Spanish of course comment extensively on the large quantities of gold possessed by the chiefs who use it in negotiations, as well as stores of cacao, corn, and textiles. Juan Vázquez de Coronado describes a violent encounter with the settlement of Couto situated between two rivers, which reportedly had over 65 large multi-family houses (Vázquez de Coronado 1976).

There are many indigenous groups living today in southern Costa Rica including the Borucas, the Térraba, the Bribri, Cabécar, and the Guaymí, although their populations sizes are quite small (Barrantes 1993, Corrales Ulloa 2000:7). Most of these groups can be traced back to living in this area for several millennia based on linguistic and genetic data, except for the Térraba people who arrived in the 18th century after being forced to move away from the Caribbean coast (Corrales Ulloa 2000).

5.2 The Central Region

The Central Highlands, the Central Pacific Region, and the Caribbean Lowlands are considered to be three distinct subareas, but they share many features and so are collectively called the Central Region (Figure 5-6). Early archaeological work in the region includes Alfaro's investigations at El Guayabo de Turrialba (1893, 1896) and Hartman's excavations at Las Mercedes and Las Huacas (1901, 1907).

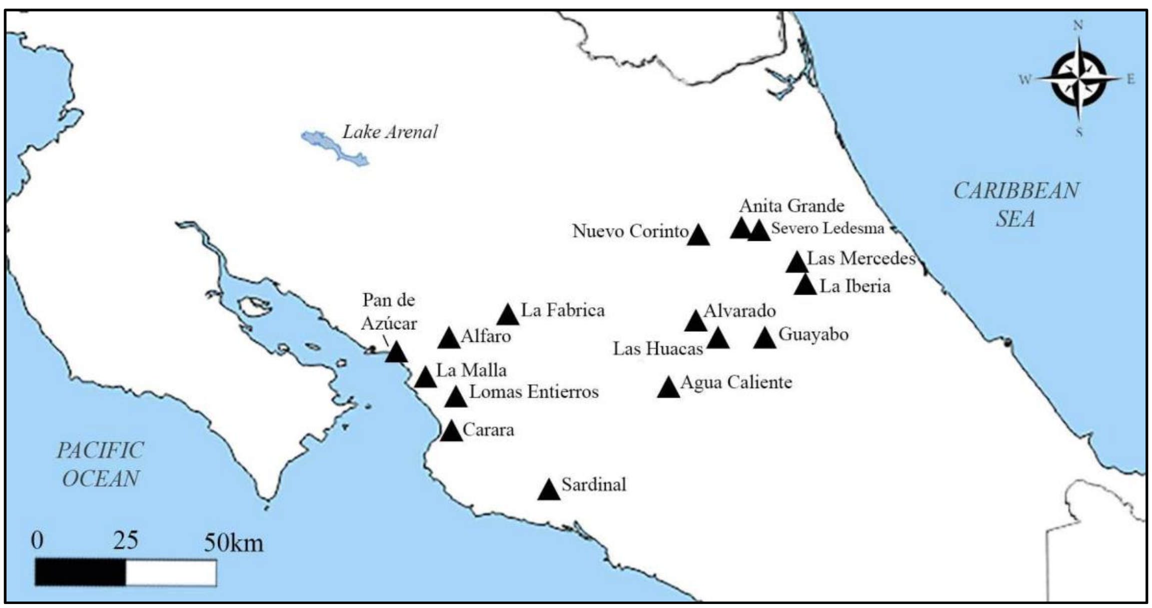


Figure 5-6: *Map of the archaeological sites mentioned within the text in the Central Region.*

The Central Highlands, where the modern capitol San José is located, is characterized by chains of volcanic mountain ranges that include the Poás, Hule, Barva, Irazú and Turrialba volcanoes. Common plant species in this region include laurel (*Cordia alliodora* [Ruiz & Pav.] Oken), mahogany (*Carapa guianensis* Aubl.) coral oak (*Terminalia amazonia* [J.F. Gmel.] Exell), golden fruit (*Virola koschnyi* Warb.), ojoche (*Brosimum alicastrum* Sw.), cedar maria (*Calophyllum brasiliense* Cambess.), and botarrama (*Vochysia ferruginea* Mart.) (Núñez-Cortés and Ruiz-Cubillo 2022: 4). Coastal sites focused their efforts on the exploitation of mangrove resources (Corrales 1992). The Caribbean Lowlands is characterized by piñuela (*Bromelia pinguin* L.), the wild rubber tree (*Castilla costaricana* Liebm.), ceiba (*Ceiba pentandra*), orchids, ferns, bromeliads, and other epiphytes (Stone 1977). The Spanish reported a diet that incorporated maize, beans, sweet potatoes, calabashes, and vegetable pears or ixtle (*Aechmea magdalenae* [André] André ex Baker).

The Central Region is known archaeologically for its anthropomorphic vessels, petroglyphs on boulders, bottle shaped secondary burials, and elaborate metates. The elaborate metates from this region, and Costa Rica more broadly, are considered to "art tools" that are both works of art and utilitarian objects used for grinding and processing food (Miller Graham 1992). Unfortunately, there has not yet been a systematic macrobotanical analysis of these elaborate metates to determine what substances or foods may have been processed on their surfaces. The elaborate "flying-panel" metates (Figure 5-7) carved from volcanic stone can range in size from 30 cm to 1.5 m or more. These metates are assumed to be used to grind food material such as maize or root crops like manioc, but many in Costa Rica are interpreted more as thrones or funerary offerings because of their large size, long legs, and detailed decorative elements (Herrera and Corrales-Ulloa 2024). Hoopes (2007) notes that these metates may also have been used to grind medicinal and psychotropic plants as well as human bones based on their imagery of trophy heads and human bodies. The flying-panel metates often include depictions of humans with exaggerated large heads masked with zoomorphic faces and headdresses that often incorporate images of humans, birds, crocodiles, felines, monkeys, and bats (Snarskis 2003: 175). Purely animal figures do also appear, most often birds. Lange (1971: 212) argues that the lack of use wear on decorated metates, along with their grandiose size, suggests that they could have been used symbolically as "seats of power." Costa Rican figurines depict both men and women seated upon simple metates, thus both genders were associated with ritual and ceremonial practices involving metates and women, linking food processing to social power in the area. Food production was therefore not limited to the use of simple, utilitarian metates (Preston-Werner 2008).

Figure 5-7: *Examples of elaborate metates on display at the Museo Nacional de Costa Rica in San José, Costa Rica. Photographs by the author.*

People have occupied the Central Region of Costa Rica since the Paleoindian period, with the arrival of hunter-gatherer groups around 10,000 BCE (Corrales 2001, 2011, Snarskis

1978). Early sedentary occupations appear between 300 BCE and 300 CE, the Pavas or El Bosque phases, with the evidence of agricultural activities through the recovery of manos and metates (Corrales and Quintanilla 1996). Settlement patterns in this early phase are described as small, dispersed villages with rectangular foundations, often located along the coastline or rivers; although little evidence of architectural remains have been found from this phase (Corrales and Quintanilla 1996: 101, Snarskis 2003). The social system at this time has been described as egalitarian, yet distribution networks seemed to rely on the authority of a "chief" as discussed by Corrales and Quintanilla (1996) and Fonseca (1992), but see Hoopes (2005) for an alternative view.

In the Central Caribbean Lowlands, the Central Valley, and the Central Pacific regions of Costa Rica early houses were rectangular in shape and dispersed across the landscape 50 to 100 meters apart (Snarskis 2003: 170). Elevated circular house foundations constructed between 400 and 600 CE are found at Nuevo Corinto in the Caribbean Lowlands (Salgado et al. 2021). Later house forms during the gold period in the Central Caribbean Lowlands are "simple circular house foundations of large river cobbles (30 to 40 centimeters), over which a pole or cane and thatch circular structure was erected" (Snarskis 2003:188) of the kind referred to as a *palenque*. An example of such a construction can be seen in Figure 5-8, an artistic representation of houses from the Caribbean. Sites distant from large rivers employed field stones.

Figure 5-8: *Caribbean houses carved from ground stone on display at El Museo del Jade, San Jose, Costa Rica.*

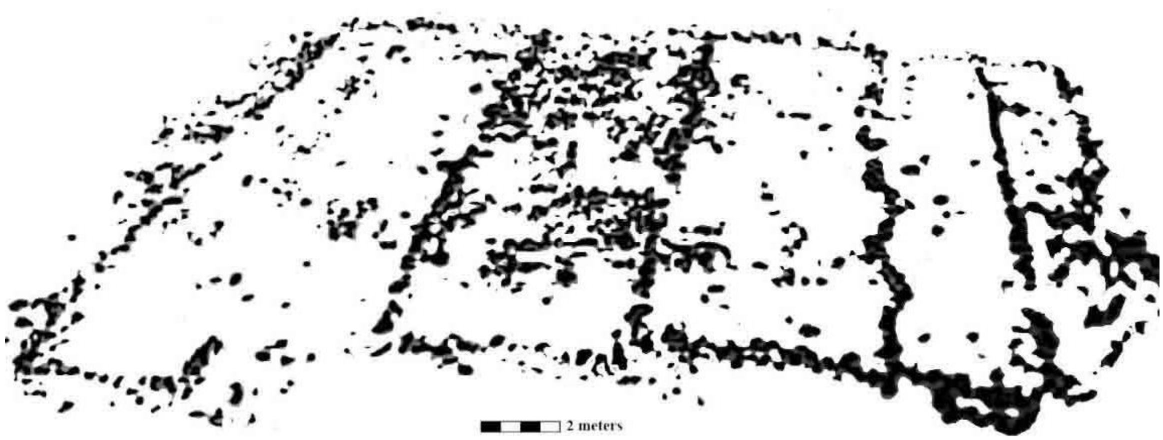


Figure 5-9: *House complex foundations at Severo Ledesma (CE 1-500) in the Caribbean Lowlands of Costa Rica (redrawn from Snarskis 2003: Figure 6).*

A relatively early house foundation was horizontally excavated at an El Bosque phase (200 BCE to 400 CE) site called Severo Ledesma (also referred to as El Tres by Stone and Balser 1965) in the Caribbean Lowlands (Figure 5-9), revealing a rectangular structure that measured 25 by 15 meters and likely housed thirty to fifty people (Snarskis 1978, 1984a, 1984b). The structure was apparently open and unroofed near the entrance, with a central corridor constructed out of cobblestone, and a large roof on the other end (Snarskis 1978, 1984a, 2003). A large burial was found 2 meters below, underneath the roofed portion of the structure. Snarskis (2003: 171) notes that the large house complex shares a similar structure with house forms from northern areas of Honduras. Two smaller "nuclear family" structures were identified 100 meters from the larger structure at Severo Ledesma, measuring 3.5 by 12 meters. Similar foundations are also known from several sites in the Turrialba Valley (Snarskis 2003). In the Pavas phase (300 BCE - 300 CE) of the Central Highlands, fired adobe floors become prevalent, but the house shape is often unclear, because it is not defined by stones. A carbonized maize cob was recovered from the midden at the Severo Ledesma site, identified to be an eight-rowed member of the South American race 'Pollo' (Snarskis 1976: 348).

Macrobotanical maize has been found in the largest quantities during the El Bosque phase of the Central Region (Blanco Vargas and Mora Sierra 1995, Snarskis 2003). Populations increasingly occupy alluvial areas over this time, which Herrera (2024) suggests is a sign of increased agricultural activity. However, significant amounts of carbonized pejibaye (*Bactris gasipaes*) and coyol (*Acrocomia vinifera* Oerst.) seeds have been recovered from domestic areas in the Jacó Valley (Corrales 1990, Corrales and Mora 1990). Both of these plants were used to make chicha beer (Hoopes 1995). Recent archaeological excavations at the Alvarado site examined subsistence strategies during the Pavas Phase along the slopes of Irazu volcano (Azofeifa López 2023). Examination of ceramics, lithics, macrobotanical, and macrobotanical remains revealed activity areas within the site including a residential zone, areas for cultivation, lithic manufacture, and zones marked for food consumption. Agriculture at Alvarado focused on both root (*Ipomoea batatas* [L.] Lam. and *Dioscorea* sp.) and seed crops (*Zea mays* and *Phaseolus vulgaris*) while utilizing a slash-and-burn system according to Azofeifa López (2023). Early evidence of subsistence practices in the Central Pacific subregion include the consumption of maize, beans, squash, jocote (*Spondias*), sweet potato (*Ipomoea*), fish, pejibaye (*Bactris gasipaes* or *Elaeis oleifera* [Kunth] Cortés), and plants in the Asteraceae and Marantaceae families during the Pavas phase (Blanco Vargas 2002, Corrales and Mora 1990).

The Central Valley, Caribbean Lowlands, and Greater Chiriquí regions experienced a sudden increase in population, with large, nucleated villages appearing around 300 to 500 CE (Snarskis 1986, 2003). The Central Region contains archaeological sites that boast some of the most complex settlements socially and through architectural spaces and material culture, suggesting the presence of new social hierarchies from 300 to 900 CE (the Curridabat and La Selva phases) (Corrales and Quintanilla 1996, Núñez-Cortés 2020). Monumental construction projects found in the Central region during this phase include earthen mounds presumably with houses built on top, often incorporating cobblestones, at settlements such as Alfaro, Guayabo, La Fabrica, La Malla, Nuevo Corinto, and Sardinal (Alarcón and Badilla 2021, Corrales 1992, Quintanilla 1992, Corrales and Núñez 2018, Salgado et al., 2013, Solís et al., 2019). Some of the oldest evidence of metal objects are found in this central region by 500 CE, suggesting that this area may have been where metallurgy was first introduced into the region (Fernández and Quintanilla 2003: 219). House foundations in the Caribbean Lowlands region are marked by stone circles, but were rectangular in shape prior to 500 CE. This shift suggests a significant shift in worldview occurred around that time, as reflected by the change in both house forms and prized crafted goods from jade to gold (Hoopes 2005, Miller Graham 1992, Snarskis 2003).

Agriculture based on the staple crop maize becomes widespread around this time as well. At La Malla, a settlement situated on the coast on the interior edge of the mangroves, a variety of mollusks and fauna including iguana, deer, and fish were consumed from 300 to 800 CE (Quintanilla 1992). Macrobotanical remains of maize, beans, and palms, and coyol (*Acrocomia*) as well as grass, maize, aster, and Heliconiaceae phytoliths have been identified at Pan de Azúcar (Blanco Vargas 2002).

Politically important sites such as Las Mercedes and Guayabo include life-size sculptures of humans that suggest a level of glorification of certain individuals or officials during later periods (Hartman 1901, Stone 1977: 180–81). A recent discovery of a Chacmool sculpture at Las Mercedes in the plaza near where the life-size sculptures were situated demonstrates Costa Rica's connection with Mesoamerican settlements such as Chichen Itza and Tula as far back as 1000 CE (Rosenswig and Vázquez 2021). The chacmool sculptures in Costa Rica were likely produced locally due to their distinct styling with faces oriented straight upwards and the individual's sex depicted. Rosenswig and Vázquez (2021) interpret the chacmools found in Costa Rica as ritual furniture that chiefs used to enhance their power through Mesoamerican-inspired rituals.

Both rectangular and circular foundations of stone cobbles have been identified at archeological sites in the Turrialba Valley of Costa Rica. In the Central Valley a village site called La Fábrica de Grecia is composed of circular domiciles constructed with stone cobble foundations dating between 500 to 900 CE (Guerrero Miranda 1980, Snarskis 1984a: 156-157). Based on the high concentrations of cane-impressed fired adobe found associated with the foundations, the walls of the structures were likely 3 to 5 centimeters thick and reached a height of 50 centimeters (Snarskis 2003: 178). The circular house foundations here are interpreted as being indicative of a nucleated village type.

Figure 5-10: *Cobblestone lined mounds at El Guayabo de Turrialba in the Central Region of Costa Rica (photograph by author)*

Snarskis (2003) identified a pattern for architectural organization within major settlements of the Central Region of Costa Rica that is centered around an elite district that consisted of an open, rectangular plaza, a cobblestone causeway, and two large mounds that have staircased entrances. This architectural organization can be seen at many sites such as La Malla, Sardinal, Alfaro, La Fabrica, and Guayabo (Alarcon and Badilla 2021, Corrales 1992, Corrales and Núñez 2018, Quintanilla 1992, Salgado et al. 2013). A view of this complex at Guayabo is seen in Figures 5-10 and 5-11. This space is considered to be not just the center of political and economic activity, but also a residential district for the elite. Four to five hearths are usually found on the secondary main mound, evidence of its domestic focus according to Snarksis (2003). Fray Augustín de Cevallos (1992) describes that the ranking class or chief were housed in the higher mound, whereas the lower mound housed the high-ranking wives who were dedicated towards the maintenance and sustenance of the chief and high-ranking individuals (Lothrop 1926). The lower mounds often contain multiple hearths, metates, and manos (Snarskis 1992). The river cobbles used to make the causeways (Figure 5-12), as well as those shoring up the main mounds, are usually quite uniform in size within an circular outline ranging in length from 30 to 40 centimeters (Snarskis 2003: 188).

Figure 5-11: *The main plaza and elite district at El Guayabo de Turrialba in the Central Region of Costa Rica, showing the cobblestone lined mounds (photograph by author).*

Some variation in this model does occur, for example at Las Mercedes there is only one primary mound surrounded by cobblestone walls (Vázquez and Chapdelaine 2008, Vázquez and Rosenswig 2016). Yet, overall at the site, there are at least eight elite residential mounds, each measuring 2m in height and 30m in diameter (Vázquez et al. 2018). Interestingly, lidar data at the Lomas Entierros site does not conform to this pattern set forth by Snarskis (Núñez-Cortés and Ruiz-Cubillo 2022), rather the settlement is organized around a central terrace system of half-moon shaped cobblestone walled terraces that could have been used for residential, agricultural, or burial purposes. The elite residential area of the site is not at the core as suggested by Snarskis' model (2003), but instead such spaces are situated at the highest vantage point on this sloped site. With the aid of lidar, 67 structures built with cobblestone were detected, only eight of which had been documented previously due to heavy forest coverage limiting the view of features (Herrera and Solís 1988). Núñez-Cortés and Ruiz-Cubillo (2022) suggest that more sites in the Central Region may follow alternative patterns of architectural organization if investigated with valuable mapping tools such as lidar that allows for the detection of archaeological features under abundant forest cover.

Snarskis (2003: 178) speculates that the transition from rectangular to circular house foundations began during 400 to 700 CE, coinciding with what he perceived as a decline in the use of jadeite artifacts in the region. In the Bay of Culebra in Greater Nicoya, circular house foundations appeared a bit later, around 800 to 1000 CE (Snarskis 2003: 160). According to Snarskis (2003: 188),"A change in house form reflects a change in worldview." However, Sheets (1994b) suggests that the shape and ground plan of house structures is not necessarily a reliable indicator of cultural affiliation using the example of Household 1 at Joya de Cerén in El Salvador, which has both circular and rectangular structures within the household grouping.

Nuevo Corinto, which is situated in the Caribbean Lowlands, in the Línea Vieja district of the Limón Province, is also considered to have been a significant La Selva and La Cabaña phase sociopolitical center (Vázquez and Rosenswig 2016). The architectural core of the settlement consisted of circular elevated platforms for supporting domestic structures constructed between 400 and 600 CE (Salgado et al. 2021). Recent microbotanical investigations of phytoliths at Nuevo Corinto identified numerous plant taxa within and near Mound-01 including a variety of grasses, palms, herbs, trees, roots, and crops (Hoopes and Bozarth 2012, López-Rojas et al. 2024). Hoopes and Bozarth (2012) recorded phytoliths from the domesticated palm pejibaye (*Bactris gasipaes*), which produces nutritional edible fruits, and the tuberous root crop lerén (*Goeppertia* sp. - also known as *Calathia allouia*), suggesting regular agricultural practices at the site. The phytolith data suggest the continuous management of botanical resources at this settlement over a period of 3,000 years and subsistence patterns that relied upon both wild and domesticated plant resources including maize, palms (*Geonoma* sp., *Bactris* sp., *Iriartea* sp., *Chamaedorea* sp.), roots (Marantaceae), and arboreal taxa (López-Rojas et al. 2024).

Figure 5-12: *View of the stone-paved causeway at El Guayabo de Turrialba that runs through the center of the settlement (photograph by author).*

The last precolumbian phases in the Central Region before the arrival of the Spanish are Cartago, in the Central Highlands, and La Cabaña phases (800 to 1500 CE), in the Carribean Lowlands. Between 850 and 1150 CE, major settlements intensified their construction efforts with more architectural features, both in type and quantity, and settlements are hierarchical with a principal town and secondary villages settlement pattern (Alarcón, 2018, Corrales and Quintanilla 1996, Murillo 2010, Snarskis 2003). Types of architectural features could include earthen mounds, burials, house foundations, sunken features, stone paved causeways (Figure 5-12), elevated terraces, water drainages, and retaining walls. Sites such as Las Mercedes provide a view of spatial organization of settlements in the Central Region of Costa Rica after 1000 CE. Las Mercedes was the center of a regional chiefdom, with ten smaller settlements or secondary centers such as La Iberia and Anita Grande also known, each with an elite residential mound at their core (Vázquez et al. 2012). The stone-paved causeways can be quite extensive, such as at Las Mercedes where they measure 7m in width and 1.4 km in length (Vázquez and Rosenswig 2016). Both circular and rectangular cobble foundations can be found for domestic structures, and rectangular structures at the Carara and Jesus María sites are thought to have functioned as group food storage or even for religious purposes (Corrales and Quintanilla 1996:109). Agriculture tools indicate the continued production of maize and stones with circular depressions were used to process coyol palm fruits and ferment the sap for chicha.

There were more extensive and complex village settlements during the later Cartago phase, such as the Lomas Entierros site, located in a strategic defense-oriented setting on the mountainous border close to Río Tárcoles. Settlements in this phase are characterized by a nuclear unit mound complex surrounded by small habitational units and farming fields (Corrales and Quintanilla 1996:106). At the Lomas Entierros site, in the Central Region near the Pacific coast (800-1500 CE), analysis of chemical residues found within ceramic vessels that were used for the preparation and consumption of foods by different socioeconomic strata indicated that all sectors of the population had access to the same carbohydrate-rich food resources (Núñez-Cortés and Barba 2023). These foods could be rich in sugars and starches, for example tubers. Carbohydrate residues were identified in vessels of all shapes and value groups. But protein residues and fatty acids were mostly found within highly-valued ceramic bowls, indicating that animal products were more exclusive foods for the elite and intermediate status groups at the settlement. Carbonized coyol (*Acrocomia*) seeds were also identified at the site, indicating consumption of palms (Núñez-Cortés 2020), perhaps for making fermented chicha.

5.3 The Greater Nicoya Region

Greater Nicoya (Figure 5-13) is a mostly flat terrain punctuated with mountainous chains of volcanoes in the northwestern part of the country that includes the Rivas, lake areas, and Pacific coast of Nicaragua and the Nicoya Peninsula within the Guanacaste province of Costa Rica. While Arenal is also located within the province of Guanacaste, for this dissertation it is treated as a separate subregion just to the east of the Greater Nicoya subarea (Hoopes 1984).

Greater Nicoya as an archaeological subarea is defined by its material culture including polychrome pottery, distinctive mortuary practices, and its stone sculpture tradition (Lange 1984, Steinbrenner 2021a). Notable artifacts that are characteristic of the region include zoomorphic jars and pendants (often avian), tripod metates, jade celts, and mace heads (Stone 1977). Although avian imagery is prevalent on ceramics in the Nicoya region, McCafferty and McCafferty (2024) argue that this is not a reflection of consumption habits but rather of shamanic practices. Some of the earliest archaeological investigations in Costa Rica took place in the upper part of the Nicoya Peninsula. For example Bransford (1884) classified and named ceramics belonging to the Luna and Palmar wares.

The tropical dry forests in Nicoya are characterized by cedar (*Cedrela*), pine (*Pinus*), guanacaste (*Enterolobium cyclocarpum* [Jacq.] Griseb.), guapinol (*Hymenaea courbaril* L.), havillo (*Hura crepitans* L.), nazareno (*Peltogyne*) and various cacti and spiny shrubs (Stone 1977). Cacao (*Theobroma*) can be found in the area today and is heavily irrigated and often shaded by Madera Negra (*Gliricidia maculata* Kunth ex Steud.). Agricultural root crops in the Tempisque and Bagaces periods found along river banks in the Nicoya included manioc or yuca (*Manihot esculenta*), tiquisque (*Xanthosoma violaceum* Schott), and ñampi (*Dioscorea trifida*). Excavations in Pacific Nicaragua have recovered microscopic and macroscopic plant remains including carbonized jocote, a fruit that can produce a fermented wine, beans, cacao, and coyol palm nuts. Notably, this region has recovered no evidence for maize (McCafferty 2021: 135-136). Historical documents by the Spanish record the consumption of various animals in Nicoya in 1529 including fish, shellfish, deer, tapir, rats, paca, armadillo, peccary, birds, toads, and other species (Fernández de Oviedo (1976).

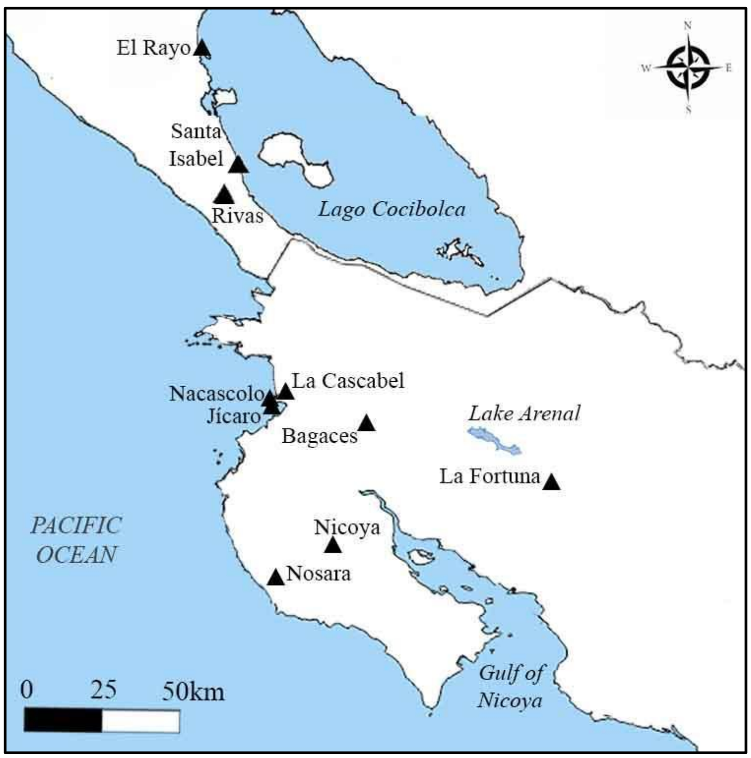


Figure 5-13: *Map of archaeological sites mentioned within the text in the Greater Nicoya Region.*

Members of the Misumalpan and Chibchan language families appear to have been the first to inhabit the area of Pacific Nicaragua and Nicoya (Ibarra Rojas 2021: 50). Early sites occupied during the Tempisque period (500 BCE to 300 CE) have been identified in the Ometepe, Chontales, Nicoya Peninsula, and Tempisque Valley subregions (Haberland 1982, 1992, Lange 1984, Norr 1986, Ryder 1982, Vázquez et al. 1992). These populations supposedly subsisted on agricultural products, although the evidence for this is mainly through the presence of metate fragments found within burials (Healy 1988, Willey 1980). Based on mortuary treatment, cemetery organization, and grave goods, this early time period is when ranked social systems emerged (Hoopes 2005, Lange 2006).

House mounds from La Arenera period (200-400 CE) were circular in shape, had a diameter of roughly 10m, and contained a hearth in the center (McCafferty and Zambrana 2024). During the next period, Bagaces (300 to 800 CE), settlements increased in size and appeared more often as coastal villages. Additionally, the northern and southern sectors of Greater Nicoya began to diverge in terms of their ceramic traditions, mortuary practices, and the inclusion of jade objects (Herrera 1998, Lange 2006). In the Bay of Culebra cemeteries were relatively remote and separated from habitation sites and burials placed individuals in the flexed position within stone-lined pits (Wankmiller 2016). Iron-ore and slate mirror artifacts recovered from funerary contexts at numerous sites in Northern Costa Rica including Bagaces, Nosara, La Fortuna, and Las Huacas dating to the Bagaces Period document interaction between the Chibcha and Maya regions (Salgado et al. 2023). One of the mirrors included Maya hieroglyphic inscriptions while most mirrors were often accompanied by jade artifacts within elite contexts, suggesting that these objects were strongly related to the internal power relations and ability to obtain foreign produced items within this society. Rock paintings of handprints as well as solar, cruciform, anthropomorphic, and zoomorphic images at Cueva La Conga, although north of Nicoya, demonstrate the ritual use of caves in Nicaragua dating back to 680 CE (Baker and Armitage 2013).

After 700 CE, population increased and villages in the Greater Nicoya subarea were concentrated along the coast, river drainages, or near water sources within the intermontane valleys (Lange 1980, 1984, 1988). A mixed subsistence pattern was practiced in this subarea throughout the whole chronological sequence including agricultural production, fishing, hunting, and gathering activities (Vázquez et al. 1992). At La Cascabel, a village site near the Bay of Culebra, house foundations, shell deposits, stone sculptures, and burials reveal an occupation from 800 to 1550 CE (Aguilar Vega 2021). Due to poor preservation, the original size and shape of the house structures is unknown. House structures included incorporated wattle-and-daub walls and floors made of baked or fired clay in addition to fine, compacted sand. Excavations at Santa Isabel in Pacific Nicaragua revealed similar findings with domestic structures of wattle-and-daub construction with floor surfaces that were either compacted sand or stone (McCafferty 2021: 138). The village economy at Cascabel was based upon the extraction and processing of oceanic resources, particularly fishing and artisanal shell production. In addition, village craftspeople worked on the production of fabrics and wood resources as evidenced by an abundance of spindles, spinning wheels, and lithic materials such as polishers, hammer stones, drills, axes, and celts (Aguilar Vega 2021: 196-198). The residents likely manufactured thread, nets, baskets, and wooden instruments. Craft production was organized around the domestic sphere and involved members of the family unit (Aguilar Vega 2021: 208).

During the Sapoá Period (800 to 1350 CE) burial practices shifted dramatically to extended burials in unlined pits that are no longer in distinct cemetery sites, but rather are associated with domestic structures (Herrera 1998, Lange 2006, Wankmiller 2016). Cranial and dental modifications became more common as well (Hoopes 1980, Wankmiller 2016). Both of these characteristics are common among Mesoamerican groups to the north (Price et al. 2002, Wankmiller 2016). Jícaro, located on the coast of the Papagayo Peninsula, is one of the largest known archaeological village sites in the country and presents Sapoá period occupation with numerous large shell mounds (*concheros*), petroglyphs, habitation structures, and activity areas as well as a substantial mortuary component (mostly between 900 to 1300 CE) organized around what appeared to be an egalitarian community (Wankmiller 2016). The association of burials with house structures, dental decoration and cranial modifications, along with the presence of trophy skulls at Jícaro reveal traits that are distinctly Mesoamerican. Salvage archaeological excavations at Nacascolo (Hardy 1992, Solís and Herrera 2011, Vázquez 1986) show that the site was continually occupied for approximately 2,000 years and have revealed similar mortuary practices to Jícaro with numerous burials associated with both habitation structures and large shell mounds. Wankmiller (2016: 339) suggests that people exchanged traditions, goods, and ideas along the Pacific coast and that these burial practices do not necessarily represent a group that identifies as Mesoamerican.

Much of the archaeological investigations in Greater Nicoya have focused on the sequence and timing of migrations by Mesoamericans south into the region and the differences in social organization between the northern sector (southwest Nicaragua) and the southern sector (northwest Costa Rica) this created (Lange 1984, Salgado and Vázquez 2006). The Greater Nicoya region has been characterized as having strong similarities to its Mesoamerican neighbors to the north, especially El Salvador and Honduras. Kirchoff (1943), Willey (1971), and Coe (1962) considered this subarea to be a part of Mesoamerica rather than the Intermediate Area. Linguistic and archaeological evidence point to the arrival of Mesoamerican migrants such as the Chorotega circa 750 CE and the Nicarao and Maribios circa 1300 CE (Ibarra Rojas 2021: 50, Steinbrenner 2021b: 36-37). It is still unknown if the Chorotega migration, likely people originating from Central Mexico, was a single event or a continuous process over a long period of time (McCafferty and Steinbrenner 2005). Lothrop (1926), Salgado and Vázquez (2006), and Lange (2006) note the strong Mesoamerican presence in the area after 800 CE, most strongly evidenced by the Classic Maya motifs on ceramics. Bioarchaeological examples of Mesoamerican influences in Nicoya include the distinct dental filing found on male individuals at Nacascolo (Hardy 1992) and cranial deformation among males at Jícaro (Herrera Villalobos and Solís del Vecchio 2021). There was also dental filing on an individual of undetermined sex at La Guinea, which Hoopes (1980) suggests was done to make the teeth look like those of a crocodile or iguana. However, recent research recognizes that the Mesoamerican influences had been overemphasized by early investigations. McCafferty et al. (2012) point out that other significant Mesoamerican traits such as its distinct ceremonial architecture and maize based subsistence regime are lacking in evidence. The region has substantial variation in material culture and archaeological evidence does not reveal a homogenous set of cultural practices (Steinbrenner 2021:7-8). Interestingly, at the time of Spanish contact, ethnohistoric sources indicate that a Uto-Aztecan dialect was spoken in Greater Nicoya as well as incorporation of deities and calendar names originating from Mexican cultures (Fowler 1989, Hoopes and McCafferty 1989, McCafferty and Steinbrenner 2005).

5.4 The Arenal Region

The area of focus in this dissertation is the Arenal region of Costa Rica, which is located in the northwestern part of the country within today's Guanacaste province. Both the Greater Nicoya and Caribbean Lowlands culture areas had clear influence on Arenal traditions throughout the documented archeological record, as is evidenced through ceramic, lithic, and funerary practices (Sheets 1994b). Greater regional patterns elsewhere in southern Central America also impacted the Arenal area, such as an increase in population density peaking during the Arenal phase (500 BCE - 600 CE) and the elaboration of ceremonial practices as seen in funerary settings and feasting rituals (Sheets 2008). Despite the clear interactions between Arenal and its surrounding regions, Sheets and Mueller (1984, Sheets 1994a) and Hoopes (1994b) point out that Arenal maintained its own political, economic, and cultural autonomy over time and therefore should be considered as a distinct cultural region. Throughout the majority of the periods in which Arenal was occupied, these communities appear to have been relatively self-sufficient and independent of outside groups when compared to other areas of Mesoamerica. Sheets (1992) suggests that the high species diversity in the area allowed for communities to remain more stable than areas where people specialize their subsistence on a smaller set of plant resources.

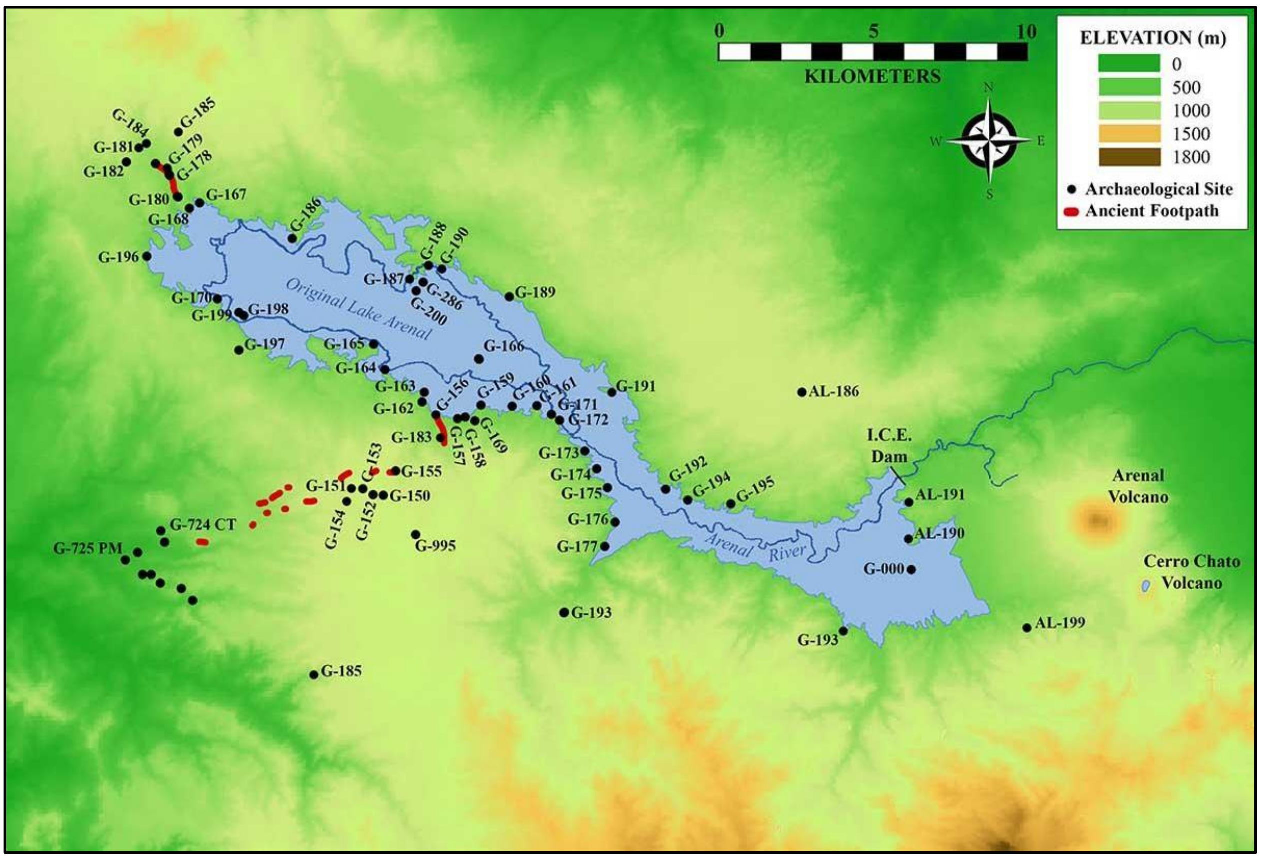


Figure 5-14: *Map of the Arenal region showing the archaeological sites, ancient footpaths, and outline of the original lake prior to the construction of the ICE dam, which was completed in 1980 (modified from Sheets 1994a and Egan 2019). The elevation map was created using Shuttle Radar Topography Mission (SRTM) data collected by NASA.*

Early archaeological work in the Tilarán-Arenal region included a few smaller salvage projects in the 1960s and 70s that used both survey and excavations. In 1969 George Metcalf carried out a small excavation of a site found during construction of an observatory north of the volcano that revealed ceramic sherds, a celt, and some chert stone flakes. In 1977, Aguilar excavated some test pits on the eastern edge of the lake at the El Tajo site as part of construction of the Sangregado dam (Aguilar 1984). The project uncovered ceramics and organic material such as human bone and casts of vegetation thanks to the preservation conditions created by the sudden burial of fine-grained tephra from Arenal Volcano.

Later, the Guanacaste-San Carlos Corridor Project worked to explore a potential trade route between the Caribbean and Pacific drainages as it passed through the Cordillera (Lange 1982-1983: 93). Multiple scholars have suggested (Lange 1982, Ryder 1982, Sheets 1994a) that both sides of the continental divide were largely independent from each other in terms of their ceramic development. Ceramics recovered from multiple projects showed that the region had some connections with the Atlantic area, but the majority of ceramics resembled traditions from Greater Nicoya (Creamer 1983, Finch 1982, Ryder 1982). Early survey projects (Finch 1982, Norr 1979, Ryder 1982) focused mostly on cemetery or funerary sites since they contained either large mounds or enough stone architecture to be readily visible through vegetation, but a few habitation sites were found when located near a cemetery.

The Proyecto Prehistórico Arenal (PPA) is the longest ongoing project in the region, which began in 1984 directed by Payson Sheets. The primary focus of the PPA has been to understand settlement patterns in this tropical setting as well as adaptation to hazardous volcanic environments using a variety of methodologies including remote sensing, survey, excavation, and volcanology (Sheets 1994a: 15). One of the major objectives of the work was to "determine the variation in site locations, in chronology, and in site functions within the area" (Sheets 1994a: 15). During the 1980s, the project conducted an extensive survey and excavation primarily around the perimeter of Lake Arenal, which had undergone a dramatic expansion beginning in 1975 when the hydroelectric dam was constructed on its southeastern end. Both cemetery and habitation sites were surveyed and excavated along the Lake Arenal shore and close to the continental divide, leading to the documentation of sites from the Formative period to the Spanish Conquest (Figure 5-14). After the PPA's survey work in the 1980s, 24 Tronadora phase, 46 Arenal phase, 33 Silencio phase, and 24 Tilarán phase archaeological sites were documented (Mueller 1994). Many of these sites were occupied for multiple chronological phases. Prior to this work, habitation sites were largely undocumented in the Cordillera (Mueller 1994: 51). These early field seasons explored research on stratigraphic and chronological relationships between settlements, site-patterning, subsistence strategies, and the establishment of ceramic chronologies (Sheets 1994).

Sites in Central America tend to be located on elevated ground close to sources of fresh water, and this is true as well for Arenal based on the sites documented by the PPA (Mueller 1994: 67). Elsewhere in Costa Rica, cemetery sites are primarily located on high ground, yet in Arenal both funerary and domestic activities are located on hilltops or ridges. Throughout the archaeological phases within the region, sedentary occupations were concentrated near permanent streams and the ecotonal south shore of the present day Lake Arenal (Sheets 1994b: 314). The distribution of archeological sites around the lake suggests that people preferred living in the drier life zones that surrounded the lake, yet the residents would have had access to a variety of ecological zones and resources. Yet, a good part of this patterning could be a result of where wave action has removed tephra layers and aided in the visibility of archaeological materials. Additionally, the proximity or distance from Arenal Volcano impacts the productivity of archaeological research. The closer one gets to the Arenal Volcano, the thicker each deposit from each eruption becomes. Each tephra layer is thicker to the southwest with distance, because the immense blast of tephra was pushed by winds from the northeast (Egan 2019). The most productive area for archaeological work is about 20-35 km from Arenal Volcano because thinner deposits even farther from the volcano do not preserve well over time and thicker (yet manageable) deposits preserve archaeological material.

Table 5-2: *Chronological phases of the Cordillera in Arenal (Egan 2019, Hoopes 1994a).*

Chronological Phases of the Arenal Sequence	
Tilarán	1300-1400 CE
Silencio	600-1300 CE
Arenal	500 BCE – 600 CE Early: 500 BCE - 100 CE Late: 100-600 CE
Tronadora	2000-500 BCE Early: 2000-1700 BCE Late: 1700-500 BCE
Fortuna/Archaic	4000-2000 BCE
Paleoindian	11500-7000 BCE

Even though the region has been depicted as relatively stable through time, chronological phases have been created to depict periods of broad regional practices within Arenal (Table 5-2) based on degree of sedentism, ceramic, lithic, and radiocarbon data, which result in five main archaeological phases (Egan 2019, Hoopes 1984, 1994, Sheets et al. 1991, Sheets and Mckee 1994, Stern 2003). The following sections will discuss each of these phases and their associated archaeological sites and materials. According to Sheets (1994b), not a single eruption of Arenal Volcano can be linked to a change or transition in archaeological phases, suggesting that significant cultural change was not linked to ecological shifts or forced migration and reoccupation due to the damage caused by volcanic episodes. This is not the case elsewhere, such as with the eruption of Ilopango Volcano in El Salvador or of Popocatépetl and Xitle Volcanoes in Central Mexico (Plunket and Uruñuela 2008, Sheets 2002, Urrutia-Fucugauchi et al. 2016).

5.4.1 The Paleoindian Period

Since the Paleoindian period (11,500 to 7,000 BCE) people have been living in the Arenal region, initially as nomadic groups of hunters and gatherers (Alvarado and Soto 2008, Sheets 2008). The Paleoindian phase is marked entirely by the presence of a Clovis point found in the lake near site G-164 Sitio Bolívar on the southern end of Lake Arenal (Figure 5-15, Sheets 1994). However, no other evidence for this early occupation has been recovered thus far in the Arenal region, therefore the time range is an estimation. Numerous Paleoindian artifacts have been found at the sites of Florencia and Gaurdiria in the Turrialba Valley of the Caribbean Watershed of Costa Rica (Pearson 2002, 2017, Ranere and Cooke 2021, Snarskis 1979).

Figure 5-15: *Photographs of the Clovis point recovered within the lake off the shoreline near G-164 Sitio Bolívar made from local chalcedony. Photographs courtesy of John W. Hoopes.*

5.4.2 The Fortuna Phase

The Fortuna phase (4,000 to 2,000 BCE), which is a term specific to this region that is synonymous with the Archaic, marks the arrival of preceramic sedentary villages or campsites with permanent structures that are visible archaeologically (Hoopes 1984, Sheets 2008, Sheets and McKee 1994). This phase also includes regular evidence for early use of maize and other cultivars. Most of the village sites that were established during this period in Arenal continued to be occupied through the final archaeological phase before the conquest, the Tilarán period (Sheets 1994b: 314). The PPA recovered surface finds, excavated debitage, and a campsite associated with this phase (Sheets 1994b: 314). Stratigraphically, the Fortuna phase is associated with Un. 65 and below, also known as the Aguacate formation. Aguacate is composed of a dark orange moist clay that resulted from early eruptions of Arenal Volcano (Egan 2019: 109, Sheets 1994a: 18). The layer has undergone extreme weathering and compaction, thus forming a heavily mixed clay material. Excavations at the site G-163 Tronadora Vieja uncovered a campsite containing two hearths that were located between structures, a lithic workshop area, and dozens of boiling stones used for cooking that dated to this time period (Bradley 1994a:73). Additionally, an archaic bifacially flaked projectile point was located here during a shoreline survey (Bradley 1994a: 76).

5.4.3 The Tronadora Phase

Next, the Tronadora phase (2000-500 BCE) begins with the emergence of more sedentary villages, permanent structures, simple chipped and ground stone tools, and more elaborate ceramics (Hoopes 1987, 1985, 1994a, Sheets 1994a, Sheets 2008). Although rare, groundstone metates are oval in shape with three legs. A total of 24 village sites dating to the Tronadora Phase have been identified around the Lake Arenal shore (Mueller 1994:55). Villages had house structures that were circular in plan and averaged about 5 m in diameter (Sheets 2011). Houses presumably had thatch roofs supported by poles (as evidenced by post holes) and the floors were compacted soil. Tronadora phase villages were apparently quite dispersed, with low artifact densities and individual houses maintaining large open spaces between them (Hoopes 1987, 1994a, Sheets 2011). Sheets (1994a: 21) suggests that the spread of sedentary villages during the Tronadora phase could be due to an increase in maize based agriculture, but he admits that the Arenal residents likely did not really focus on agriculture but rather had a diverse subsistence strategy incorporating both wild and domesticated foods. Sheets (1994b: 321) argues that sedentary settlements in the Arenal region were established based upon the exploitation of a rich tropical rain forest containing a diverse assemblage of floral and faunal resources for subsistence rather than a motivation to be located near agricultural fields filled with domesticated foods.

Tronadora phase cemeteries contain secondary burials in rectangular pits located within villages and adjacent to house structures (Bradley 1994). Jon Hageman (2016: 215) notes that burials associated with habitation sites were situations where “the dead continue to look after the living, and the living after the dead.” These burials do not show any differentiation between individuals in terms of status. They were only occasionally accompanied by pottery offerings (Sheets 1994b: 314).

Figure 5-16: *Examples of the ceramics recovered from the Arenal region that date to the Tronadora phase. From left to right: Tonjibe Beige, Tronadora Incised, Zetillal Shell-Stamped, Tajo Gouge-Incised, Tigra Groove-Punctate, and Atlantic Red-Filled Black (photos courtesy of John W. Hoopes).*

The pottery from the Tronadora phase was relatively distinctive with strong regional traditions including elaborate decoration of both incising and painting (Figure 5-16). *Tecomate*-shaped vessels were the most dominant during this phase, which are quite large with heavy rims. Other forms include tall cylinders and short jars. Decorations included grooved incision, heavy punctation, shell stamping, and painted strip appliqués. Hoopes (1994: 161) suggests that the Tronadora phase ceramics resemble Formative pottery from both northern South America and southern Mesoamerica, noted in punctate and incised decorations. There is a gradual transition from Tronadora to Arenal phase ceramics where the two different ceramic traditions can be found intermixed within the same paleosol, suggesting no clear break between these time periods (Egan 2019: 113, Hoopes 1994a).

The G-163 Tronadora Vieja village site along the southern shore of Lake Arenal contains the most extensive remains dating to this chronological phase as well as the earliest known house structure in Costa Rica (Figures 5-17 and 5-18). The site was first recovered during the PPA’s lakeshore survey in 1984 and is named for its proximity to the nearby town of Old Tronadora, which is now submerged by the lake (Hoopes 1987:43). This village was likely just one of many scattered throughout the area during the second millennium BCE. The site is only about a kilometer to the east of one of this dissertation’s study sites, Sitio Bolívar, and is also situated along the southern shore of Lake Arenal. Occupation at Tronadora Vieja was extensive, dating from 3500 BCE to 1 CE, and the Tronadora phase structures dates to approximately 1800 BCE

(Bradley 1994a). Multiple circular structures ranging in diameter from 4 to 6 meters composed a household at this village site. The post holes were large and evenly spaced, suggesting structures were semi-permanent rather than temporary.

Figure 5-17: *Photographs from the 1985 excavations at G-163 Tronadora Vieja (courtesy of John W. Hoopes).*

Figure 5-18: *Reconstruction of the Tronadora Vieja site, which is the earliest sedentary village that has been excavated in Costa Rica. The site had multiple thatched structures of various sizes, a pathway through the village, and a variety of activity areas. Redrawn and imagined from Sheets 1994b Fig 17-3, original drawing by Larry King.*

The village site also had evidence for lithic manufacture as well as food preparation within hearths located in the exterior spaces of the structures, noted by the concentration of boiling stones. Features at the site included multiple structural floor surfaces (circular), postholes, bell-shaped storage pits, hearths located outside of structures, and stone paved inter-structure surfaces. Notable finds here during the Tronadora phase include thermally fractured rocks or cooking stones, numerous ceramic sherds, lithic debitage, flakes, and cores, a polished stone pendant, mano and metate fragments (Bradley 1994a). This site exemplifies how ancient households in the Arenal region utilized a main structure in addition to numerous smaller specialized structures that were used likely for food storage or processing (Bradley 1994a: 86).

Tronadora Vieja was the only archaeological site from this chronological phase with paleoethnobotanical remains identified. The villagers here definitely incorporated maize into their diets, as evidenced by phytolith, pollen, and macrobotanical remains (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994). Remnants of carbonized jícaro (*Crescentia alata* Kunth) were found, the hollowed out fruit of this plant could have been used as a container or vessel. Piperno (1994) identified phytoliths from this phase belonging to palms, wild grasses, ferns, and the yellow annona (*Guatteria*) tree. Clary (1994) was also able to identify through palynological analysis the remains of wild sedges, Amaranthaceae, and Malpighiaceae. These results provide a limited view of Tronadora phase subsistence practices, with primarily maize, Amaranthaceae herbs, and the Malpighiaceae and *Guatteria* fruits depicting the edible plants available to the village residents.

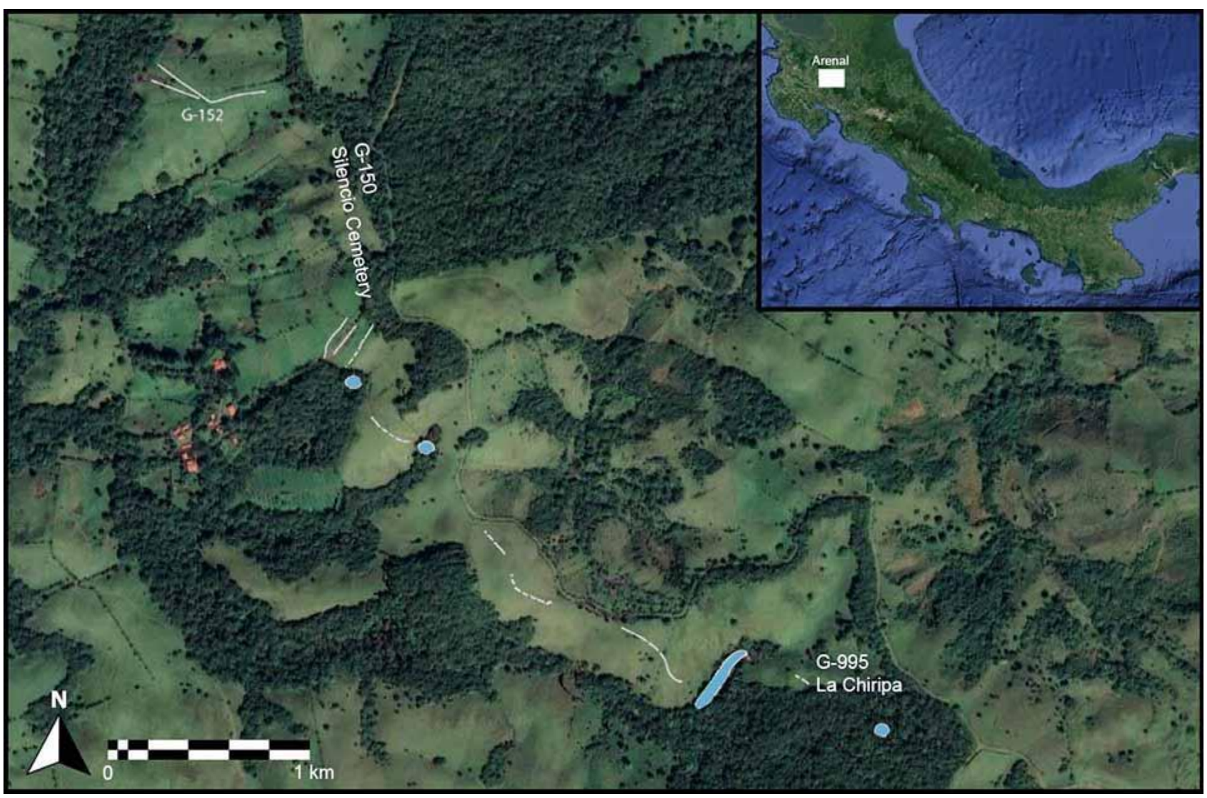


Figure 5-19: *Map of G-995 La Chiripa, the related footpaths (white lines), springs (blue features), and the nearby site of G-150 El Silencio cemetery (modified from Egan 2019).*

In 2016, the Proyecto Prehistórico Arenal focused on the continuation of confirming footpaths through excavations of those identified previously via remotely sensing imagery. During the excavation of segments of ancient footpaths, two culture-bearing levels were encountered beneath the pathways that were not anticipated. Wood charcoal and scattered ceramics were encountered in a paleosol below the horizon of the processional footpath, and further below that the edge of a domestic structure (G-995 La Chiripa) was discovered within the deepest layer of tephra from the Arenal Volcano that preserves cultural material in this region. This segment of the footpath connects the El Silencio cemetery, the nearby Río Chiquito, and also with every spring in the area (See Figure 5-19), clearly demonstrating that the pathway connected past peoples with areas of cultural significance. La Chiripa itself is situated roughly 500 m uphill from a natural spring, and resultant stream, that would have been a valuable source of water for its inhabitants when it was occupied.

Several post holes were found by the excavators in 2016 within Un. 61, alerting them of the presence of a domestic structure dating to the Tronadora phase. The post holes were in surprisingly good condition and the floor surface, created by simply compacting the volcanic ash layer, was unusually well preserved. This paleosol was not suddenly buried by another layer of volcanic ash; another paleosol composes the layer directly above it. This suggests that the structure was deliberately buried by the residents after it was abandoned (Sheets personal comm.). Due to the exceptional preservation and antiquity of this structure, the project returned in 2018. These excavations of the Tronadora phase house structure and paleoethnobotanical recovery efforts form the first portion of this dissertation study. Its location is among the small foothills of the Arenal valley that are today mainly used as cattle pasture, located along the continental divide south of Lake Arenal. Details of the 2018 excavations and research design will be described in the following chapter.

5.4.4 The Arenal Phase

The Arenal Phase (500 BCE - 600 CE) marks some major shifts compared to the other phases. During this time there is a peak in population density, along with more sophisticated ceramics (Figure 5-20), more elaborate metates, and a spatial separation between villages and cemeteries (Sheets 1994: 21). The quantity of archaeological sites, their sizes, and the frequency of datable ceramics are the highest during the Arenal phase (Sheets 1994b: 315). As with the Tronadora phase, domestic structures continue to be circular in shape with thatched roofs and cooking hearths located directly outside.

Lithic tools show little change during this period, other than the specialized metates with ovoid grinding surfaces and three conical leg supports. Manos were commonly of a long cylindrical shape that was larger than the metate itself. The highest amount of thermally fractured debitage was recovered from Arenal phase sites, with Tronadora phase being a close second. Other lithic materials from this period include general debitage, bifacial and unifacial flakes, flaked cores, percussion blades (Sheets 1994).

Figure 5-20: *Examples of the ceramics recovered from the Arenal region that date to the Arenal phase. From left to right: Mojica Impressed, Charco Black-on-Red, and Guinea Incised (photos courtesy of John W. Hoopes).*

Many ceramics from this phase show strong similarities to those from the Greater Nicoya region (Lange et al. 1984), but still retain significant local characteristics including linear brushed painting and stamped decoration (Hoopes 1987, Hoopes 1994a: 177). Charco Black-on-Red, Huila Zoned Punctate, Zelaya Painted, and Carillo Polychrome are all examples of pottery forms associated with the Greater Nicoya region (1994a: 188). The dominant ceramic form were necked jars, but medial-flange bowls, complex-silhouette bowls, and both solid and hollow rattle supports are also present. Many ceramic features found at G-164 Sitio Bolívar suggest contact and communication with the Caribbean Lowlands region around 500 CE, including decorated hollow supports with anthropomorphic adornos, zoomorphic appliqués on vessel rims, and wide-mouthed tripod bowls (Hoopes 1994a: 188).

Cemeteries from the Arenal phase revealed primary burials in stone-lined elongated pits, often including grave goods such as celts, that were covered with intentionally smashed river stones, metates, and ceramic vessels (Sheets 1994b: 315). Burials during the Arenal phase became more intricate, involving feasting and other ritual activities, and were often located on prominent ridges above the settlements. Elsewhere in Costa Rica, cemetery sites are also primarily located on high ground, yet in Arenal both funerary and domestic activities are located on hilltops or ridges as at Sitio Bolívar, demonstrating that the residents desired habitational structures situated on the ridge, although at a slightly lower elevation (Mueller 1994: 67).

The more elaborate funerary rituals in this phase suggest an increased level of inequality among residents, a pattern that can also be seen in southern Central America during this period as well (Hoopes 2005). After 500 CE, processional footpaths were built to connect settlements and cemeteries so that the dead could be readily visited (Sheets 2011, Sheets and Sever 2007). Travel along these footpaths was "ritually mediated into travel precisely along the same path, in single file, in as straight a line as possible" (Sheets and Sever 2007: 161). This resulted in the erosion of paths into a deep trench several meters in depth that restricted view of the surroundings until one arrived at the special destinations, most notable springs, villages, or cemeteries. Sheets and Sever (2007) argue that these paths created and perpetuated social memory across their landscape.

Three paleosols are associated with the Arenal phase, each interrupted by a period of volcanic activity (Egan 2019: 115): Un. 50, Un. 53, and Un. 54. Of these, Un. 53 is found at G-164 Sitio Bolívar and G-995 La Chiripa also has materials collected from Un. 54.

G-164 Sitio Bolívar is the remains of an Arenal phase village located on a small peninsula on the southern shore of Lake Arenal, about 1 km northeast of the modern town of Tronadora and 5 km from La Chiripa (Hoopes and Chenault 1994a). It is named for Quebrada Bolívar, a small drainage to the west of the site which today forms a calm lagoon (Hoopes 1987:100). The site extends northward into an area that is now covered by the lake, with the entire village likely encompassing about 2.5 ha, containing both a cemetery and domestic structures. When the village was occupied, it would have overlooked the lake or marsh to the north. The Proyecto Prehistórico Arenal (Hoopes and Chenault 1994a) excavated several units in 1985 and found that the shoreline was a domestic activity area of the village, while the ridgetop was a locus of funerary activities that had been disturbed previously by looters. Excavations revealed thousands of artifacts, including tripod vessels, spindle whorls, greenstone lithic tools, and several fire pits filled with ceramic sherds, charcoal, fire cracked rock, flaked lithic debris, and ollas (Figure 5-21).

The excavated midden at Sitio Bolívar contained wood charcoal, jícaro gourd fragments (*Crescentia alata*), nance seeds (*Byrsonima crassifolia*), palm seeds (*Scheelia*, *Acrocomia*, or *Elais*) and three maize kernels (*Zea mays*) (Mahaney, Matthews, and Vargas 1994). The macrobotanical remains along with the numerous ground stone tools recovered such as manos and metates suggest mixed cultivation and processing of annual maize alongside tree crops. Microbotanical remains of wild sedges, wild grasses, palms, *Heliconia*, and Amaranthaceae depict a glimpse of the ecological setting of the village settlement (Clary 1994, Piperno 1994).

Figure 5-21: *Image of Operation E at G-164 Sitio Bolívar when it was excavated in 1985, located on the ridge top of the peninsula, demonstrating the high density of ceramic material (photo courtesy of John W. Hoopes).*

All of the excavated structures at Sitio Bolívar were circular in plan and varied in size between $7m^2$ to $24m^2$. These structures mark a continuation from Tronadora phase construction style yet are distinct from structures in the nearby Caribbean Lowlands region which were rectangular with river cobble foundations. Sitio Bolívar is important because it does not reveal direct evidence for social ranking or a society organized along the lines of chiefdoms (Hoopes 1988, 1991). There is clear evidence for a network of communication and exchange within Greater Nicoya, but within a context of a decentralized political organization.

The perimeter of the site today has largely been destroyed by alternating lake levels, however the lake has revealed newly identifiable structures through exposed post holes along with thousands of diagnostic ceramic sherds covering the surface (Figure 5-22). In 2021, I conducted new excavations at this village site in order to gather a paleoethnobotanical collection from a domestic structure in the Arenal phase to compare to the Tronadora phase structure at La Chiripa. The details of that excavation will be described in Chapter 6.

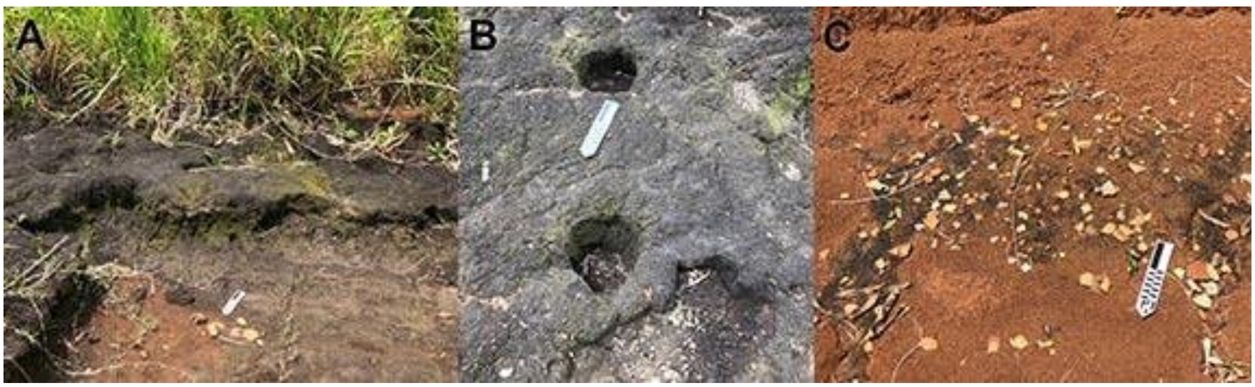


Figure 5-22: *Photographs taken during a lake shore survey of G-164 Sitio Bolívar in 2019 that show exposed post holes (A and B) and a dense presence of ceramic sherds on the ground surface (C) as a result of erosion caused by wave action of Lake Arenal. Photographs by author.*

5.4.5 The Silencio Phase

In the next phase, human population declined with fewer and smaller sites (600-1300 CE) (Sheets 1994a: 20). Various artifacts became more elaborate including polychrome ceramics as well as chipped and ground stone tool manufacture. Metates during the Silencio phase became more blocky and rectangular with shorter legs yet with even more elaborate surface decoration (Sheets 1994b: 317). The decoration on metates was found sometimes on all surfaces, suggesting that these tools were not necessarily utilitarian implements but symbolic. The polychrome decoration and fine incision that are dominant on the pottery (Figure 5-23) suggests a high level of interaction with the Greater Nicoya region during this time, but an increase in local ceramic types (such as Jiménez) also occurred (Hoopes 1994a: 192). Some of the ceramic sherds at the El Silencio site may even represent vessels that were acquired through trade from Greater Nicoya. Vessel forms include jars and open bowls with both polychrome and monochrome incised decoration.

Figure 5-23: *Examples of the polychrome and finely incised ceramics recovered from the Arenal region that date to the Silencio phase. From left to right: Belén, Altiplano, Papagayo, Mora, and Jiménez (photos courtesy of John W. Hoopes).*

Subterranean stone-lined burial cists formed from flat-fracturing, natural, volcanic stone slabs (*lajas*) began to appear, but cemeteries continued to be separate and more distant from the village than they were during the Arenal phase (Sheets and Sever 2006). Although the slabs used in the cist tombs were local, the construction techniques are identical to those found in the Central Highlands and Caribbean Lowlands regions (Snarskis 1984). Common grave goods included polychrome vessels, elaborate metates, and even a small gold avian pendant. Paths that connected villages, springs, cemeteries, and sources of stone have been located using remote sensing imagery (Sheets 1994: 21). The stone cist graves at their hilltop location continue to resemble funerary practices from the Caribbean Lowlands, Central Highland, and Diquís regions (Bradley 1994, Drolet 1984, Snarkis 1984).

The cemetery site G-150 El Silencio, which is situated along the continental divide, is associated with this phase. Labor investment, complexity of construction, location, and the types of artifacts included within graves at El Silencio reveal clear status differences between individuals interred at this cemetery site (Bradley 1994b). All higher-status burials were male (Sheets 1992). Notable artifacts recovered from these burials include greenstone beads, a gold avian pendant, and decorated and undecorated tripod metates (Figure 5-24) (Bradley 1994b, Chenault 1994, Mueller and Chenault 1994). A charcoal sample from the tomb in which the gold avian pendant was found dated to 145 (244) 338 CE (Mueller and Chenault 1994: 284), which is a quite early appearance of goldwork compared to the other regions discussed above. Stylistically, the pendant exhibits a mixture of metal working traditions. The arch of the wings is associated with the Diquis region whereas the overall size and shape resembles eagle pendants found exclusively in the Central Highlands and Caribbean Lowlands (Lothrop 1963, Mueller and Chenault 1994: 283, Snarskis 1981b). Burials at El Silencio also contained boiling stones, hammerstones, cores, flakes, celt flakes, and biface fragments (Bradley 1994b). Skeletal preservation at the site is poor, but stable carbon isotope analysis of multiple bone fragments from 8 of these burials revealed that less than 12% of the diet of these individuals consisted of maize (Bradley 1994b: 117, Friedman and Gleason 1984). A network of footpaths lead to this cemetery, connecting nearby villages around Lake Arenal. This demonstrates that there was a great deal of interaction between villages within the region and that people would frequent the burial locations to visit and remember their ancestors. Various artifacts found at the site suggest domestic activities or post-interment feasting rituals at the cemetery.

Figure 5-24: *A selection of artifacts recovered from the G-150 El Silencio cemetery site including a decorated metate, an avian gold pendant, and greenstone beads (from Chenault 1994: 262, Mueller and Chenault 1994: 282-283).*

Paleoethnobotanical remains from El Silencio cemetery were the most diverse among the sites studied during the initial PPA investigations. Carbonized maize cupules and a common bean (*Phaseolus*) were recovered, in addition to an abundance of pollen grains from various tropical plants (Clary 1994, Mahaney, Matthews, and Vargas 1994). Pollen from wild sedges, grasses, asters, elms, nettles, and orchids provide a view of the surrounding vegetation. More intriguing is the evidence of edible taxa identified through the palynological work, including maize, beans, Amaranthaceae herbs, avocado (*Persea americana* Mill.), walnut (Juglandaceae), and peppers (piperales) (Clary 1994).

Examples of other sites dating to the Silencio phase include G-151 Neblina, G-152 Las Piedras, and G-153 El Jefe Suerte (Hoopes and Chenault 1994b). All of these sites are located less than a kilometer from the El Silencio site. Both the Las Piedras and Neblina sites were apparently repositories for natural stone slabs (*lajas*), which were used in construction of the stone-cist burials at El Silencio. The features at El Jefe Suerte indicate domestic activities, but no living surface or structure was detected.

5.4.6 The Tilarán Phase

Finally, in our temporal sequence, the Tilarán Phase (1300-1500 CE) is marked by less of an affiliation with Greater Nicoya and more similarities to the Central Highlands and the Caribbean Lowlands regions (Sheets 1994b: 317). Population continued to decline with settlements of small hamlets becoming even more dispersed. The Tilarán phase does not seem to produce the earlier sophisticated decorations, with no elaborate polychrome ceramics. Pottery is large, coarse, and monochrome with more modeling, appliqué (including zoomorphic appliqués) and other plastic techniques (Figure 5-25) (Hoopes 1994a: 199). Notably, it does not include polychrome types typical of Greater Nicoya and has more affinities with pottery of the Caribbean Watershed to the east (Hoopes 1994b).

Figure 5-25: *Examples of the ceramics recovered from the Arenal region that date to the Tilarán phase (photos courtesy of John W. Hoopes).*

Dos Armadillos (G-154) was the main archaeological site with a component dating to the Tilarán phase (Hoopes and Chenault 1994b). No architectural features were visible during the horizontal excavations, apart from a single possible post hole. Notable finds at the site include ground stone metate fragments, boiling stones, chipped stone flake debitage, a zoomorphic ceramic support, and monochrome ceramic sherds. Botanical remains from the site include jícaro rind fragments, maize kernels, avocado seeds, palm fruits, unidentified wood charcoal, and indeterminate fruit remains. Additionally, a small cemetery and habitation at G-155 La Peraza site dates to the Tilarán phase (Bradley 1994b: 121). Three burials were encountered during the limited survey, excavations, and posthole testing. Unlike at G-150 El Silencio, these burials were not lined with stone and had only a few associated ceramic vessels.

5.5 A Paleoethnobotanical View of the Arenal Region

Paleoethnobotanical investigations are still a developing discipline in Costa Rica, with the majority of published paleoethnobotanical data resulting from the unintentional recovery, and therefore non-systematic sampling, of preserved botanical remains due to a limited knowledge about methodological practices (Blanco Vargas and Mora Sierra 1995, López-Rojas 2024). That said, the Proyecto Prehistórico Arenal (PPA) was actually a bit of a pioneer in this regard when it conducted paleoethnobotanical collection in the Arenal area in the 1980s, including both microbotanical and macrobotanical investigations. However, the team focused on judgmental sampling methodologies, where samples were primarily collected from areas such as hearths that were already suspected to contain preserved organic material (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994). The results of this are summarized in Table 5-3 and have been detailed throughout the above discussion of chronological phases. The PPA had an objective to determine the subsistence strategies of past people in the Arenal area using evidence from carbonized remains, pollen, phytoliths, stable carbon isotope analysis of bone, and use wear analysis of ceramic, ground stone, and chipped stone artifacts (Sheets 1994: 15). Based on the phytolith data, Piperno (1994: 292) notes a reduction of forest indicators and increase in weedy grasses which show that tropical forest clearance accelerated after 500 BCE, starting with the Arenal phase. Over time, the macrobotanical assemblage suggests an increased emphasis on cultivated foodstuffs and a decreased focus on gathered food resources (Mahaney, Matthews, and Vargas 1994).

Major cultigens such as maize, beans, and squash were represented in each archeological phase through both macro and micro evidence. This matches well with the suggestion that staple foods in Pre-Columbian Costa Rica included maize, beans, root and tree crops such as avocado and manioc (Snarskis 1981). Although evidence for maize in the Arenal region can be found in nearly every archaeological phase since the Archaic Period Fortuna Phase, its presence is not necessarily an indicator of its use as a primary staple food for these inhabitants. Maize is more likely to preserve as archaeological evidence than many other foods because of the form in which it is cooked and often carbonized and the implements that can be used to process it (manos and metates) are made out of a sturdy ground stone that will survive, even if fragmented, for millennia (Horn et al. 2016). Furthermore, the frequencies of manos and metates at archaeological sites in the Isthmo-Colombian area are much lower than at sites in Mesoamerica. Additionally, the purpose of the elaborate metates discussed in section 5.2 is still debated, whether it be more utilitarian or ceremonial. Such artifacts have less evidence of use wear on their surfaces, which are commonly decorated elaborately. Stable isotope studies on human bones from the El Silencio cemetery site also indicate maize as a minor component of dietary patterns for the area, with less than 12% of carbon coming from C-4 photosynthetic pathway plants such as maize (Friedman and Gleason 1984, Norr 1991, Sheets 1994b: 321). This cemetery site dates to between 600 and 1300 CE, suggesting that maize agriculture was not especially prominent in the area during that period. The domestic structures at La Chiripa and Sitio Bolívar date to much earlier time periods than this isotopic data, suggesting that cultigens such as maize could have been even less prominent in the diet throughout all phases in this region. Thus, maize likely has been overemphasized in subsistence reconstructions of Costa Rica and the region more broadly. While maize can be planted and yield great quantities of food for populations, it is vulnerable to environmental hazards and susceptible to issues of erosion, leaching, droughts, diseases, and pests. Harris (1973) notes that seed crop agriculture is less stable than root crops because of its tendency to cause environmental degradation.

Other plant taxa that depict the environmental setting were identified throughout the various time periods encountered during excavations such as wild grasses, sedges, palms, herbs, as well as some trees, shrubs, and vines. Identified plant material from fruit trees suggest that some level of agroforestry may have been present, as demonstrated by the nance (*Byrsonima crassifolia*) found from Arenal phase contexts and avocado (*Persea*) from later Silencio and Tilarán phase contexts.

While the archaeological site is certainly much farther north, botanical assemblages collected from El Gigante rockshelter in southwestern Honduras are applicable to southern Central America. Macrobotanical remains from the rockshelter show a stable diet recorded through millennia that included avocado , bottle gourd (*Lagenaria siceraria*), hog plum (*Spondias*), agave (*Agave americana* L.), and Sapotaceae fruits (*Manilkara* and *Sideroxylon*) (Figueroa and Scheffler 2021). Avocado was a consistent component of the plant assemblage from roughly 11,000 to 1,000 BCE, demonstrating the arboriculture practiced in the area starting in archaic times. Avocado also appears in multiple phases in Arenal, suggesting that arboriculture was also a strong component of this region.

The previous small-scaled paleoethnobotanical investigations at Arenal are of limited representative value, yet provide an important starting point in a diachronic reconstruction of the subsistence strategies of the prehistoric peoples of the Arenal area (Mahaney, Matthews, and Vargas 1994:310-311). While helpful, the scope of these data are limited because archaeobotanical methods have improved greatly in the 40 years since these studies. Collection practices here largely yielded judgmental samples only collected when botanical remains were already visibly noticeable during an excavation. Concerning the macrobotanical results, flotation samples were often incredibly small with a volumes of a half liter - whereas standard methodological practices today suggest a blanket sampling strategy that collects material from all excavation contexts and a starting sample volume of at least 10 liters of soil per square meter of excavation (Pearsall 2015: 81).

While impressive and pioneering for the time in which it was conducted, this paleoethnobotanical data set has a limited view of evidence for the subsistence practices of the indigenous people of Arenal. Therefore, our knowledge is limited regarding how their dietary practices were in their ever-changing landscape. Broad climatic trends obtained through palynological analysis of the greater Isthmo-Colombian region will be compared to the macrobotanical data within the discussion Chapter 8, but palynological data does not provide evidence for direct engagement with plants by past peoples. Vegetation in tropical rainforests, such as those in the Arenal region, can have a very high species diversity and biomass, which allows for numerous alternatives to cultivation for subsistence purposes (Sheets 1994a). A strong paleoethnobotanical sampling strategy needed to be used to determine what alternatives to agriculture were utilized in this region in the past. The methodologies employed in this dissertation will be outlined in Chapter 6.

Table 5-3: *Summary of previous paleoethnobotanical results in the Arenal region (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994). ● indicates phytolith remains, ○ indicates pollen remains, ■ indicates macrobotanical remains.*

Tronadora Phase 2000 - 500 BCE	**Arenal Phase 500 BCE - 600 CE**	**Silencio Phase 600 - 1300 CE**	**Tilarán Phase 1300 - 1400 CE**
Cultigens			
●○■ Maize (*Zea mays*) ■ Jícaro (*Crescentia alata*)	●■ Maize (*Zea mays*) ■ Jícaro (*Crescentia alata*)	●○■ Maize (*Zea mays*) ○■ Common bean (*Phaseolus*)	■Maize (*Zea mays*) ○ Common bean (*Phaseolus*) ■ Jícaro (*Crescentia alata*)
Grasses and Sedges			
○Wild sedges (Cyperaceae) ●○Wild Grasses (Poaceae)	○Wild sedges (Cyperaceae) ●○Wild Grasses (Poaceae)	○Wild sedges (Cyperaceae) ●○Wild Grasses (Poaceae)	○Wild sedges (Cyperaceae) ○Wild Grasses (Poaceae)
Herbaceous			
○ Amaranthaceae	○ Amaranthaceae ● *Heliconia*	○ Amaranthaceae ○ Asteraceae	○Asteraceae
Palms and Ferns			
●■ Palm (Arecaceae) ● Fern (*Trichomanes*)	●■ Palm (Arecaceae)		■ Palm (Arecaceae)
Trees, Shrubs, Vines			
■Croton (*Croton*) ○ Malpighiaceae ● Yellow Annona (*Guatteria*)	■ Nance *(Byrsonima crassifolia)*	○ Avocado (*Persea*) ○ Elm (*Ulmus*) ○ Mimosas (Mimosoideae) ○ Melastomataceae ○ Nettles (Urticales) ○ Orchid (*Bauhinia*) ○ Spurge (Euphorbiaceae) ○ Peppers (piperales) ○ Walnut (Juglandaceae)	■ Avocado (*Persea*) ○ Nettles (Urticales) ○ cf. Cycadaceae ○ Peppers (piperales)

Table 5-4: *Chronological phases of the Arenal region with brief summaries of key archaeological findings noted including settlement, house structure, burial, ceramic, and lithic patterns (Egan 2019, Sheets and McKee 1994).*

Paleoindian 11500-7000 BCE	**Fortuna/Archaic** 4000-2000 BCE	**Tronadora** 2000-500 BCE	**Arenal** 500 BCE-600 CE	**Silencio** 600-1300 CE	**Tilarán** 1300-1400 CE
Settlements					
Nomadic	Dispersed campsites	Sedentary villages	Large sedentary villages Peak population density	Sedentary villages Population declined	Small, dispersed hamlets Population declined
House Structures					
None detected	No structures detected, hearths exterior of any possible structures	Circular structures, multiple structures in a household, compacted soil floors, pole supports/thatch roofs, hearths exterior to structures	Circular structures, multiple structures in a household, compacted soil floors, pole supports/thatch roofs, hearths exterior to structures	None detected	None detected
Burials					
None detected	None detected	<u>Location:</u> within villages, adjacent to structures <u>Features:</u> secondary burials, elongated pits, few grave goods	<u>Location:</u> separate from villages on hilltops, yet connected by footpaths <u>Features:</u> stone-lined elongated pits, grave goods of metates and ceramic vessels	<u>Location:</u> separate and distant from villages on ridges, yet connected by footpaths <u>Features:</u> stone-lined cists with *lajas*, grave goods of metates, gold pendants, greenstone beads, ceramic vessels	<u>Location:</u> separate from villages <u>Features:</u> simple intrusions with single vessels
Ceramics					
None detected	None detected	<u>Forms:</u> tecomates, large heavy rimmed vessels, tall cylinders, short jars <u>Decoration</u>: grooved incision, painted, punctuation, shell stamped, strip appliqués	<u>Forms:</u> necked jars/ollas, tripod bowls, rattle supports <u>Decoration</u>: incision, painted, shell stamped, zoomorphic appliqués	<u>Forms:</u> necked jars/ollas, open bowls <u>Decoration:</u> elaborate polychrome with affinities to Greater Nicoya, monochrome, incision	<u>Forms:</u> large and coarse <u>Decoration:</u> monochrome, incision, appliqués (including zoomorphics)
Lithics					
Clovis point	Stemmed bifacially flaked projectile point, core reduction, boiling stones	Oval 3-legged metates, boiling stones, flakes, cores, debitage, polished pendant	3-legged elaborate metates with ovoid grinding surfaces, long cylindrical manos, boiling stones, greenstone, flakes, cores, debitage	Rectangular metates with more elaborate surface decoration, boiling stones, hammerstones, cores, flakes, celt flakes, biface fragments	No ground stone detected, boiling stones, flake cores, flaked debitage, river cobbles

5.6 Continuity in the Arenal Region

Despite environmental perturbations, the Arenal area shows greater continuity and less evidence of drastic population declines compared to other highland areas of Central America (Mueller 1994: 68). Table 5-4 summarizes the key archaeological findings of each of the chronological phases discussed within the Arenal region. Based on archaeological investigations in the area, cultural traditions have persisted for millenia without being drastically altered in terms of settlement, subsistence, and technology patterns (Sheets 1994b, 2008). Ceramic and artifactual changes can be used as a proxy for culture change. At Arenal, the cultural phases last for several centuries and sometimes millenia, whereas in the Maya area cultural phases sometimes only last decades. The people of Arenal continually lived in relatively small egalitarian groups that supposedly did not rely heavily on agriculture for their subsistence needs (Sheets 2008). Both the use of boiling stones to cook food and the core-flake technology used in lithic manufacture continued until the Spanish Conquest (Sheets 1994b: 314). Sheets (1992: 34) believes that the low population densities, autonomous villages, and the tropical rainforest setting that supplied abundant wild foods allowed for the maintenance of these settlements and cultural stability long term. Mueller (1992, 1994) agrees and suggests that the low population density and diverse ecological setting were major factors in the stability through time, allowing for continual sources for subsistence and material needs. Sheets (1994b: 323) also points out that the majority of goods found at the village sites in Arenal are local in origin, demonstrating less of a dependence on long-distance trade for materials. Goods that do indicate trade within Arenal sites are more symbolic in nature than utilitarian, such as gold pendants and polychrome vessels (Chenault and Mueller 1984, Hoopes 1984, Sheets 1994b).

The archaeological sites involved in this study were occupied during the Tronadora Phase (G995 La Chiripa) and the Arenal Phase (G164 Sitio Bolívar), thereby exploring a transition in the region where population increased significantly, culinary traditions began to include more elaborate ceramics and ground stone tools, and cemeteries became ideologically and physically separate spaces from domestic areas. Thus, the paleoethnobotanical samples collected from these two sites provide a significant contribution towards our understanding of the food-related practices and plant-based resources over the *longue durée* in Arenal. The following chapter will provide details about the archaeological excavations at both of these sites and the paleoethnobotanical collections strategies employed in this dissertation study.

CHAPTER 6

RESEARCH DESIGN:
ARCHAEOLOGICAL EXCAVATIONS AND PALEOETHNOBOTANICAL METHODOLOGIES

To gain a diachronic perspective of the use of botanical resources in the Arenal region, two different archaeological sites with domestic structures will be compared in this study (Figure 6-1), both from the same geographic region and representing settlements of peoples who were regularly impacted by eruptions of the Arenal Volcano. The paleoethnobotanical samples collected from the two different archaeological excavations in the region represent the Tronadora (2000-500 BCE) and Arenal (500 BCE - 600 CE) time periods within this lake region, which were described within the previous Chapter 5. The first site, G-995 La Chiripa, includes a recently discovered household structure located on a ridgetop along the continental divide that was occupied quite early within the Arenal region's time sequence, circa 1450 BCE. The second site, G-164 Sitio Bolívar, is a village settlement with many house structures along the shore of Lake Arenal that flourished from 300 BCE to 600 CE.

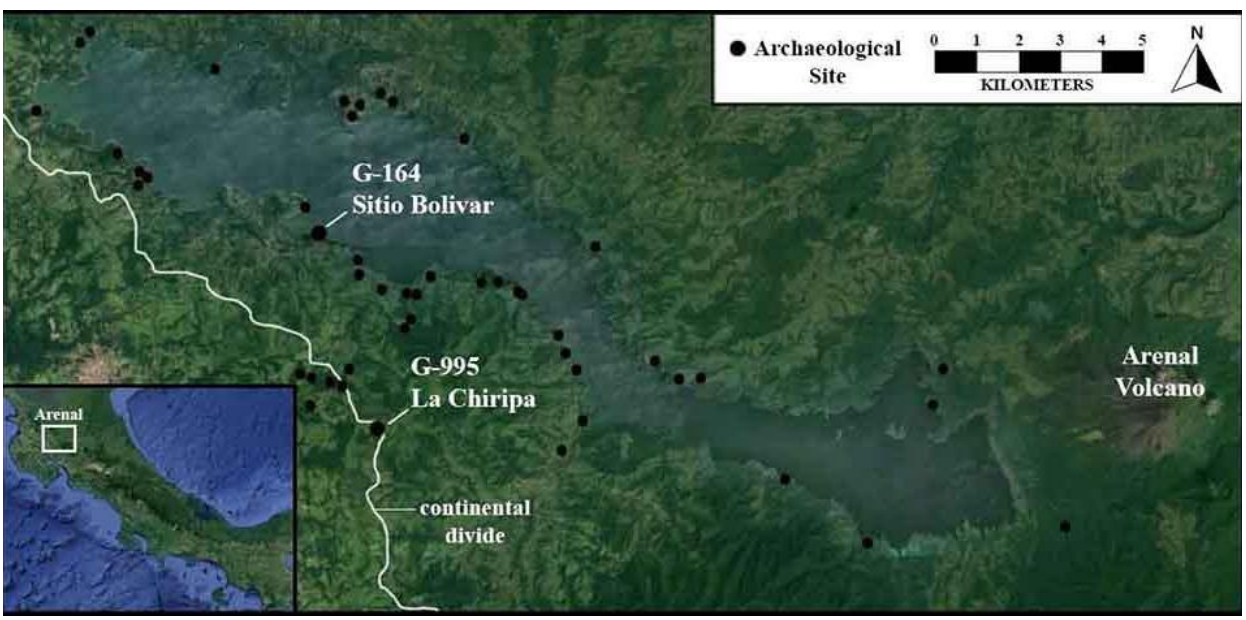


Figure 6-1: *Map of the Arenal Area with the two main archaeological sites included within this study highlighted amidst all other known archaeological sites of the lake region (base maps from Google Earth).*

La Chiripa was fully excavated as part of the Proyecto Prehistórico Arenal's (PPA) recent investigations that were funded through the National Science Foundation from 2016 to 2019. As a member of this archaeological team, I was in charge of the collection and analysis of any plant remains preserved on the floor surface of the house structure as well as within all cultural strata encountered in excavations about the feature. The Sitio Bolívar village site was first excavated and partially documented as part of the same project in 1985 (Hoopes and Chenault 1994), but much of the site has since been washed away from the current active alternating water levels of Lake Arenal. The wave action has exposed previously unknown structures at Sitio Bolívar, many of which will also be destroyed in the next few years. In 2021, I led archaeological excavations at G-164 Sitio Bolívar in order to collect a comparative set of paleoethnobotanical samples from a domestic setting later in time than the La Chiripa settlement and attempt to recover archaeological evidence from domestic areas of this site before they are destroyed.

In this chapter, I discuss the archaeological investigations at both of these sites and the rationale behind the methodologies implemented during the horizontal excavations. I present the findings of each project while in the field, including the stratigraphic levels, the various features that were encountered, as well as the ceramic and lithic artifacts recovered. Full reports of the La Chiripa field work will be published in an upcoming issue of the Vinculos journal, and the details of the Sitio Bolívar fieldwork can be found in Appendices K, L, and M. The paleoethnobotanical components of each project will be detailed to explain how preserved plant material was recovered from each site and domestic structure. Finally, I detail the laboratory methodologies employed to identify macrobotanical material that was extracted from the paleoethnobotanical samples, the results of which will be presented within Chapter 7.

6.1 Archaeological Excavations at G-995 La Chiripa

As discussed in Chapter 5, previous archaeological research of the Proyecto Prehistórico Arenal in 2016 focused on the excavation of segments of ancient footpaths that connected villages to cemeteries through challenging terrain that ranged in elevation from 500 to 1000 m asl (Sheets 2011:429). Beneath the pathway excavated in 2016 were two culture-bearing levels that were not anticipated. Wood charcoal and scattered ceramics were encountered in a paleosol below the horizon of the processional footpath (Un. 54), and farther below that, the edge of a domestic structure was discovered within the deepest layer of tephra from the Arenal Volcano that preserves cultural material in this region (Un. 61) (See Figure 6-2). This segment of the footpath connects the El Silencio cemetery, the nearby Río Chiquito, and with every spring in the area (See Figure 5-12), clearly demonstrating that pathways connected past peoples with areas of cultural significance. La Chiripa itself is situated roughly 500 meters uphill from a natural spring that would have been a valuable source of water for its inhabitants when it was occupied.

Several post holes were found by the excavators in 2016 [within the Un. 61 stratum], alerting the excavators to the presence of a structure. The post holes were in surprisingly good condition considering this stratum represents the earliest sedentary occupations in the region. The floor surface, created by compaction of a volcanic ash layer, was unusually well preserved as well, considering that this paleosol was not suddenly buried by a layer of volcanic ash; another paleosol composes the layer directly above it (Un. 60). This deposition suggests that the structure was inhabited for some time and then deliberately buried after it was abandoned (Sheets, personal communication). Due to the exceptional preservation and antiquity of this structure, the project returned in 2018. The first goal of the 2018 field season was to excavate the entirety of the house floor [within Un. 61] and to collect any botanical remains and organic residue that could have been retained within this volcanic ash layer. Additionally, the team would explore the level intermediate in time between the ancient footpath and the domestic structure floor surface (Un. 60) which contained ceramic fragments during previous investigations in 2016. PPA project member Andrés Mejía-Ramón also worked with a drone to obtain multispectral imagery of the surrounding area in order to better understand the network of ancient pathways surrounding the archaeological sites of the region.

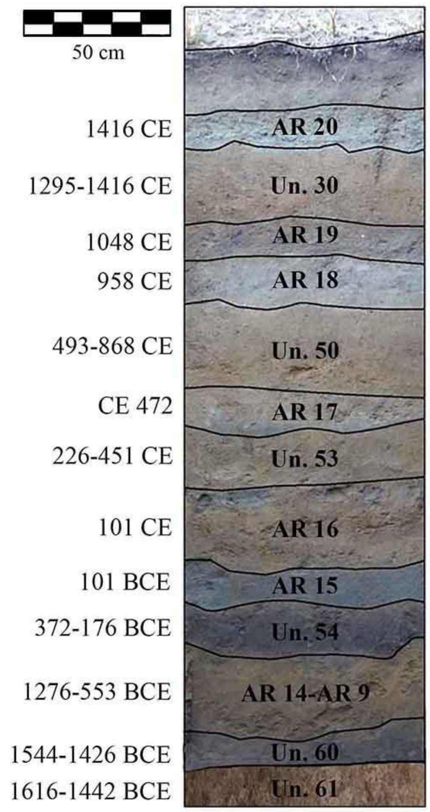


Figure 6-2: *Stratigraphic profile at G-995 La Chiripa (based on Egan 2019 and new dates presented within Appendix J). AR levels represent deposited sediment from an eruption of Arenal Volcano. Units (Un.) are cultural levels consisting of sediment buildup from people's occupation of the area between volcanic eruptions.*

After the humus layer, excavations at La Chiripa encountered 7 volcanic ash layers and 6 cultural paleosols ranging in temporal occupation from roughly 1416 CE to 1637 BCE (See Figure 6-2). Previous investigations at the site in 2016 revealed that all of the top horizons (Units 20, 30, 40, 41, and 50) were devoid of any evidence of human presence in the area, thus these culturally sterile layers were removed using backhoe equipment from an area totaling 9 by 10 meters. The backhoe only removed soil from these top few sterile layers (down to Units 50) so that any potential cultural material present would remain intact. This area would surely encounter the entirety of the house structure and perhaps any adjacent structures or features. Unfortunately, due to a high amount of rain, the time during the 2018 field season that could be devoted towards excavations was severely limited and the initial 9 by 10 meter excavation grid was reduced to an area of 3 by 4 meters to ensure that the team would be able to reveal the house structure before the end of the field season. Beginning with the culturally sterile Unit 50, the remainder of the horizontal excavations were done by hand according to natural rather than arbitrary levels using trowels and shovels. Each stratum was removed horizontally in sequence and subsequently sampled simultaneously over the entire excavated area since it represented a distinct phase of time.

Collection of soil samples designated for paleoethnobotanical analysis began with the culturally sterile volcanic layers of AR 16 through 15, which are strata composed of volcanic ash that resulted from eruptions of Arenal Volcano circa 101 BCE and CE 101 (see Table 4-2). Since La Chiripa is approximately 30 km West of Arenal Volcano, these two volcanic strata are thin and indistinguishable at this distance and were therefore combined for sampling purposes. Paleoethnobotanical material collected from this naturally deposited level will help to establish the background vegetation of the area. Unit 54 (372-176 BCE, Figure 6-3), the first cultural level systematically sampled during these investigations, is a well-developed dark soil that does contain small undecorated ceramic sherds (n=11), boiling stone fragments (n=7), and dispersed pieces of wood charcoal large enough to see with the naked eye. No cultural features were encountered from this level, but the presence of artifacts related to food preparation and consumption indicates that features were likely not far beyond the excavation unit. The third stratum sampled for paleoethnobotanical remains at La Chiripa was AR 14-9, which represents a series of culturally sterile levels of sediment resulting from six major eruptions of Arenal Volcano from 1276 through 553 BCE (see Table 4-2). The entire series of volcanic ash layers were indistinguishable at this distance from the volcano and were therefore combined for sampling and analysis purposes. Due to time constraints, a limited number of samples were taken from this culturally sterile layer (from every fourth square-meter quadrant). Next, Unit 60 (1544-1426 BCE, Figure 6-3), is a dense black paleosol that contained a high concentration of boiling stones (n=81, Figure 6-4), chert percussion flakes (n=8), a large flake core of basalt, a single round stone, and a single intrusive ceramic fragment. A single feature was identified within Unit 60 (Rasgo 1), defined by a cluster of boiling stone fragments.

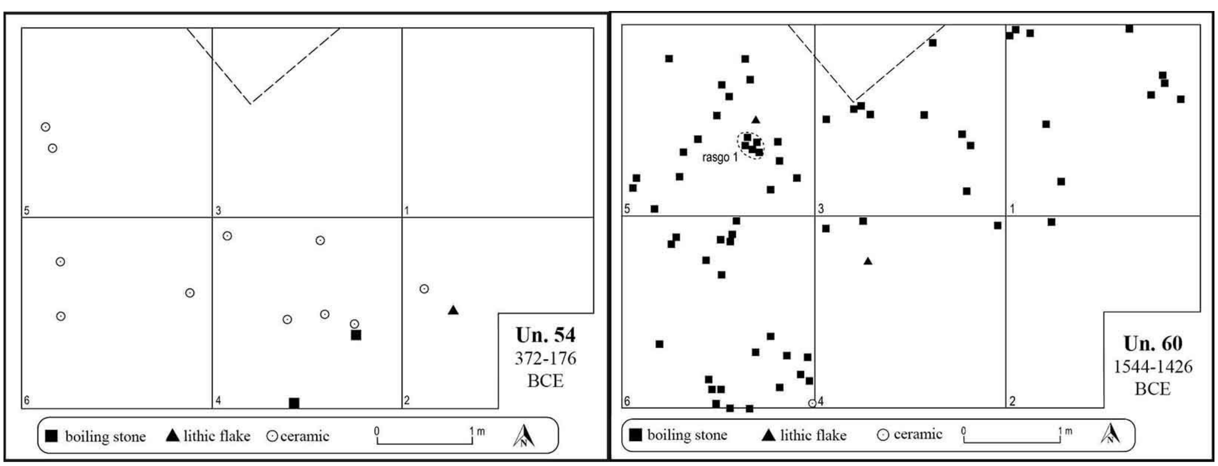


Figure 6-3: *Horizontal maps of the stratigraphic levels Un. 54 (left) and Un. 60 (right) at La Chiripa (drawn by Ricardo Vazquez).*

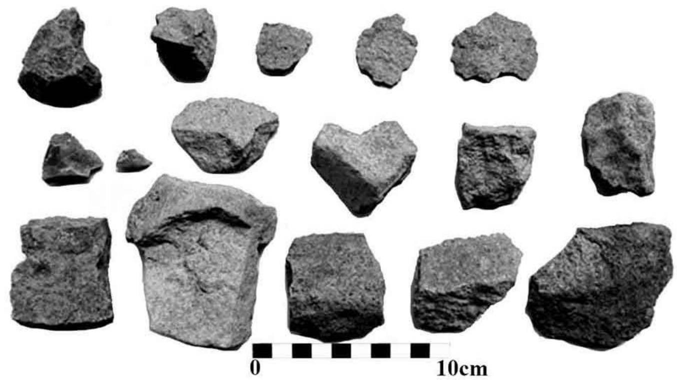


Figure 6-4: *Boiling stone fragments showing signs of oxidation and chert percussion flakes from Unit 60 (Photo by Payson Sheets).*

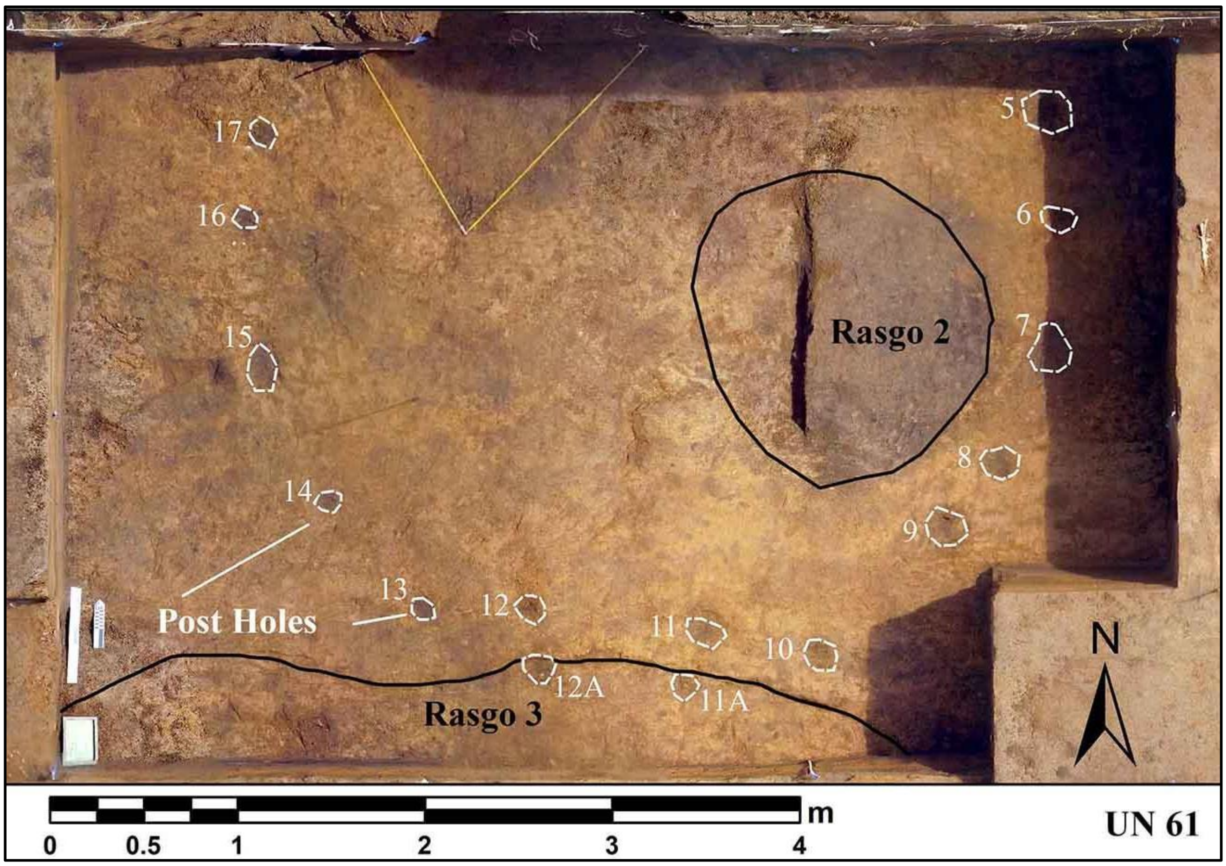


Figure 6-5: *Horizontal map of Un. 61, containing the Tronadora phase house structure. Features (Rasgos) and post holes of the structure are outlined.*

The floor of the house structure at La Chiripa was encountered within Unit 61 (1616-1442 BCE), directly atop Unit 65. The soil below Unit 61 is termed the Aguacate Formation (Unit 65) and consists of an orange clay that has been thoroughly weathered from earlier eruptions of Arenal Volcano (Egan 2019: 109, Sheets 1994a: 18). The clay is slippery and difficult to traverse, thus the inhabitants of the La Chiripa structure were taking advantage of the tephra of Unit 61 which provided a much more desirable surface to live upon for day to day activities.

The perimeter of the structure was defined by a total of 19 postholes (Figure 6-5 and Table 6-1). The first four were encountered in 2016 along the northern edge of the structure and then the remaining 15 post holes were revealed during the 2018 excavations and depicted an entire circular structure. Based on the location of the postholes, there were likely two additional posts in the north-eastern section of the structure that were not detected in 2016 (Vazquez, personal communication). Each of the post holes are quite similar in size (Table 6-1) with an average diameter of 13.9cm and an average depth of 22.1 cm. The post holes for the most part were spaced evenly about a half meter apart from each other. Two smaller post holes (11A and 12A) on the southern edge extend beyond the circular feature to create an entryway that was likely topped by its own awning. Directly beyond the entrance, towards the south, was a compacted surface sloping away from the structure and providing drainage of any rainwater (Rasgo 3). The orientation of the structure was towards the southern cardinal direction, perhaps due to the presence of the natural spring just down the hill.

Table 6-1: *Post holes discovered during the 2018 excavations of La Chiripa. The average depth of the post holes was 22.1 cm and the average diameter was 13.9cm. Post holes 5, 13, and 14 contained a boiling stone fragment. Post hole 5 also contained an intrusive ceramic sherd.*

Post Holes at G995 La Chiripa (1384-1108 BCE)							
No.	**Diameter (cm)**	**Depth (cm)**	**Volume (L)**	**No.**	**Diameter (cm)**	**Depth (cm)**	**Volume (L)**
5	10	24	1.0	**12**	11	20	3.0
6	10	28	2.0	**12 A**	15	27	3.0
7	20	16	3.0	**13**	14	16	2.0
8	15	31	3.0	**14**	12	26	3.0
9	24	19	2.0	**15**	15	16	3.0
10	17	25	3.0	**16**	11	17	1.5
11	11	15	1.0	**17**	12	30	3.0
11 A	11	14	1.0				

Located just east of the central area of the structure was Rasgo 2, a hearth that was dug into Unit 61 after the house structure was abandoned. The feature was filled with a darker soil and a gradient of boiling stones, with larger stones at the bottom of the feature and smaller fragments located towards the top. This hearth feature, along with all of the post holes dated to an earlier time period than both Un. 60 and Un. 61 (1384-1108 BCE compared to 1616-1442 BCE, see Appendix J). This demonstrates that the house structure may have been occupied for a couple of centuries, since the dates obtained from the post holes indicate when the structure was ultimately abandoned and the voids left from the wooden posts filled in with sediment. Since the radiocarbon dates obtained from the hearth feature match those from the post holes, it is likely that some sort of parting ceremony took place when the house was abandoned and the residents at that time perhaps had a feast to commemorate their ancestors and the longevity of this place they called home. Ceremonies performed decades or centuries after the cessation of activities within this building could represent a collective memory built upon this space (Dussol et al. 2019: 12). Fires and hearths have played a central role in termination rituals, as has been documented archaeological elsewhere in the Americas (e.g. Clayton et al. 2005, Dussol et al.

2019, Guderjan 2004, Pagliaro et al. 2003, Stanton et al. 2008). Analysis of the paleoethnobotanical remains recovered from fire ceremonies associated with abandonment behaviors in the households at the Maya city of Naachtun (Dussol et al. 2019) will provide an interesting comparison to the materials from this study within the discussion of the results.

6.2 Paleoethnobotanical Recovery at G-995 La Chiripa

Table 6-2: *Summary of paleoethnobotanical collections from the 2018 field season at G-995 La Chiripa.*

Strata	Time Period	No. of Samples					Total Volume
		Flotation	Screen	Manual	Phytolith	Pollen	Liters
Arenal Phase (500 BCE – 600 CE)							
AR 16-15	100 BCE to 100 CE	18	18	0	18	4	358.0 L
Unit 54	500 BCE to 100 CE	23	23	16	22	6	452.0 L
Tronadora Phase (2000-500 BCE)							
AR 14-9	1456 to 500 BCE	6	6	0	6	6	120.0 L
Unit 60	1692 to 1456 BCE	23	23	70	23	6	458.0 L
Unit 61	1792 to 1523 BCE	98	0	13	38	4	372.5 L
Total		**168**	**70**	**99**	**107**	**26**	**1760.5 L**

Relatively few macrobotanical recovery efforts have been conducted in Costa Rica, as this project is the first *systematic* investigation that incorporated regular and consistent paleoethnobotanical sampling into its research design in Arenal. This meant that the best method of recovery of ancient plant remains within this particular region was unknown prior to these investigations. Prior paleoethnobotanical studies in the Arenal region were deemed to be limited in productivity (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994), but did employ a judgmental rather than systematic form of collection. Therefore, five types of paleoethnobotanical collection strategies were implemented during the 2018 field season at La Chiripa in order to recover botanical remains: flotation, wet screening, manual hand-picked collection, phytolith, and pollen. Paleoethnobotanical samples were collected from cultural strata (Units 54, 60, and 61) and any volcanic tephra stratum encountered directly above any cultural stratum (AR 16-15 and AR 14-9). Since some layers of soil and tephra are thinly distributed, eroded, and indistinguishable (such as layers AR 19 through 9) many of them were combined and grouped into one "layer" during excavations for sampling purposes. Excavations just a few kilometers closer to the Arenal Volcano would likely be more distinguishable for most if not all of these tephras, since they would be thicker deposits. The number of samples collected per strata is displayed in Table 6-2 below. All samples were taken from 1x1m quadrants and labeled with their distance from the site datum based on their south-west corners. This systematic sampling strategy and collection of samples from all of these stratigraphic levels allows for analytical procedures to delineate chronological and cultural relationships between and among materials in adjacent areas (Lennstron and Hastorf 1995). Such a strategy facilitates comparisons between deposits above, below, and adjacent to each other, thus ensuring the most complete depiction possible of the plant assemblage preserved at this site that is free of any preconceived ideas of where remains would be located. Due to time constraints and this time-intensive form of analysis, only the macrobotanical (seeds, achenes, fruits and wood charcoal) samples have been analyzed and presented in this manuscript and the microbotanical (pollen and phytolith) samples can be analyzed in future work to complement these results.

6.2.1 Paleoethnobotanical Sample Collection

A total of 168 flotation and 70 screen samples were collected during the 2018 field season. Flotation samples were mostly collected by excavators and overseen by project member Andres Mejia-Ramon (Figure 6-6). It is impossible to predict which locations will contain preserved plant material (Pearsall 2015:74). Additionally, simply knowing that a specific context did not contain any plant material is also informative. Therefore, samples designated for flotation and screening were taken as a composite from every square meter of excavation and were instructed to be 10 liters each in volume. This is known as a “blanket sampling” or “grid sampling” strategy that collects soil from all excavation contexts, in which paleoethnobotanical sampling is part of the routine and research design during excavations (Pearsall 2015:74-76, Maier and Harwarth 2011). The sampling area was always scraped off with a clean trowel prior to collection to ensure that any modern contaminants that may have blown into the excavation were not collected. In order to get a finer resolution of the floor of the structure, samples taken from Un. 61 at La Chiripa were taken from each 0.5 square meter and were 5 liters in volume. Additionally, separate samples were taken from cultural features, such as the concentration of boiling stones in Un. 60 (Rasgo 1), the hearth in Un. 61 (Rasgo 2), the entryway into the structure in Un. 61 (Rasgo 3), and the postholes of the structure in Un. 61.

Initially, paleoethnobotanical collection efforts included samples designated for screening using geological sieves (4mm, 2mm, 0.5mm). These samples were taken from the same locations as the samples designated for water flotation and of the exact same volume (10 liters each) in order to provide a comparison of recovery methodologies. Water flotation can bias recovery to favor certain plant parts that can survive being engulfed in water without dissolving (Chiou et al. 2013). Typically, it is thought that more wood charcoal can be recovered through screening than from water flotation. Therefore, passing additional samples through geological sieves was incorporated into the initial research design as an experiment to determine the most ideal method of recovery for this region and specifically this archaeological site.

Flotation and screen samples were placed into durable plastic bags, labeled on both the exterior and with a label card within the interior of the bag, and transported to the field house to be processed. Label cards were printed on rite-in-the-rain paper so that they could survive the tropical weather and included the sample number, date, collector’s name, volume of the sample, and distance from the site datum. Since the samples were quite sizable and heavy, their transportation required the assistance of an off-road vehicle rented from a local auto shop in Tilarán.

Figure 6-6: *The excavation team collecting samples from the floor surface of Un. 61 at La Chiripa.*

When visibly noticeable carbonized material was encountered during excavations, it was collected, stored in aluminum foil, and then placed in durable plastic cups to protect the specimen from fracturing further prior to analysis. Ninety-nine of these types of samples were collected. While this type of collection ensures that such specimens are collected and ultimately preserved, it also prevents any taxon identified within these manual samples from being incorporated into any sort of statistical analyses because the sample collection is heavily biased towards larger charcoal fragments. These samples could, however, contribute towards the overall ubiquity of plant taxa through an analysis of presence and absence.

Samples designated for microbotanical analyses were also collected throughout excavations. A few samples of sediment were collected from each stratum designated for analyses of pollen and phytolith remains (0.5 L). Microbotanical samples were collected from the southwest corner of each square meter of any sampled context. All microbotanical samples were collected using freshly cleaned trowels and the surface of the sediment was scraped clean immediately prior to collection to avoid contamination. Sediment designated for microbotanical analysis were immediately placed into sterile plastic bags, labeled, and a small amount of rubbing alcohol added to prevent microbial activity that could destroy any pollen in the sample. All microbotanical soil samples are currently in storage at the McCown Archaeobotany Laboratory and are available for future analysis.

6.2.2 Processing the Paleoethnobotanical Samples in the Field

Water flotation of soil samples allows for the recovery of all size classes of macrobotanical remains without the bias of in situ recovery that relies on the visibility of materials to the naked eye, and therefore makes quantitative analysis of the results appropriate (Pearsall 2015: 44-46). Soil samples were collected throughout excavations to recover macrobotanical remains such as seeds and wood charcoal that can later be identified based on their morphological and anatomical characteristics. Water flotation eases the separation of plant materials from their sediment matrix in the excavations because organic remains will float to the top when submerged in water due to their lighter specific gravity.

To process the flotation samples, I constructed a machine assisted flotation system with the help of a local welder in Tilarán, Ronald Vargas. This machine was a Siraf-style water flotation tank (Figure 6-7) that used pressurized water flow (tap pressure) to agitate the soil matrix within water, and provided a systematic and detailed recovery of any macro organic materials preserved within the soil samples. The processing of samples followed the outline provided by Pearsall (2015). Water flowed continuously into the 55-gallon tank via a garden hose connected to a water tap. The water exited directly beneath the heavy fraction basket, which was lined with a mesh screen. Water exited the tank as overflow into a light fraction bucket, whose bottom is also lined with mesh screen material. Because a mesh screen fine enough for a detailed recovery was not obtainable in Tilarán, a fine mesh fabric (0.2 mm opening) was placed both in the light fraction collection bucket and the inner basket of the tank for the heavy fraction. Any organic material within the soil samples placed into the inner basket will float up to the surface and exit the top opening and will be collected in the mesh fabric lining the light fraction bucket.

Each sample's volume was measured again before being deposited into the flotation tank in order to ensure an accurate measurement of each sample. This revealed that the range of sediment volume collected by excavators was actually between 8 and 11 liters for samples instructed to be 10 liters in volume. Each sample was carefully deposited into the flotation tank, gently agitated by water pressure, and then visible carbonized remains floating in the water were encouraged either by hand or with the assistance of a hose to exit the tank through the upper spout and subsequently get collected within the light fraction bucket. The flotation process for each sample lasted between 30 minutes and 2 hours; the time necessary for each sample varied based on the size of the sample and the abundance of carbonized material present. A record of the flotation and screening of samples is available in Appendix A. An average of eight samples were floated per day. The water in the flotation tank was always emptied and refilled at midday to keep the buildup of silt at the bottom of the tank to a minimum.

The poppy (*Papaver somniferum* L.) seed test is a common form of testing the efficiency of recovery of flotation systems in the Americas (Pearsall 2015, Wagner 1982). Wagner first selected poppy seeds for such tests of recovery because they are not native to the Americas (thus they should not appear archaeologically within the prehispanic samples to begin with) and the seeds are quite small in size (0.7-1.4mm). This size is comparable to some of the smallest possible seeds of interest that could be found within the flotation samples such as tobacco (0.5-0.7mm in length). However, there are seeds even smaller such as vanilla (0.3mm in length), which is why the mesh cloth used in the machine had an opening of 0.2mm. At La Chiripa, ten samples in total had 100 charred poppy seeds added before being processed with flotation in order to test the recovery rate of the flotation process. The seeds were mixed into the soil before the sample was submerged into water, in order to best replicate the journey that an archaeological seed would have to endure during processing. This test revealed that the flotation system had an average recovery rate of 94.7%, or a range of 81 to 100 seeds, demonstrating that the vast majority of plant remains within the samples would be collected and analyzed. This is on the high end of the possible outcomes when compared to other published recovery rates as detailed in Pearsall's (2015: 94) Table 2.6: A Comparison of Seed Recovery Efficiency.

Figure 6-7: *The flotation tank system at La Chiripa: A) The main tank showing the placement of the support rods for the inner basket and the rubber tire sealing the light fraction exit and preventing water from exiting the tank below the heavy fraction basket. B) The main tank with the heavy fraction basket inserted in place. C) Interior of main tank with a view of the water spout with its support rod and the exit pipe below to empty the tank's contents. D) The flotation tank with heavy fraction mesh and light fraction mesh held in place using clothespins. E) View of the flotation tank when a sample is being processed within. F) View of the entrance and exit piping configuration. The entrance uses a splitter so that some water can also enter a small hose to spray the sample contents during processing. G) View of the flotation tank while being operated by project member Andrés Mejía-Ramón. The system was donated to the Museo Nacional de Costa Rica at the end of the field season.*

Figure 6-8: *Light fraction samples hung on a clothesline within the bodega to dry.*

Once a soil sample is processed using water flotation, it results in two fractions: 1) a light fraction which contains any material that floated and was subsequently collected off the top of the tank (small botanical remains), and 2) a heavy fraction of material that sunk to the bottom of the collection tank. The heavy fraction often contained smaller artifacts including lithics and ceramics, and additional botanical material that is either larger or too encased in sediment or clay to float to the water's surface. Both fractions were collected in cloth mesh (0.2mm opening); the light fraction that was then hung on a clothes line (Figure 6-8) and heavy fraction samples laid out on newspaper in the shade to dry. Light fractions took only a couple days to dry, whereas heavy fraction samples often needed over a week to become completely dry. Due to space and time limitations, only 1 liters' worth of heavy fraction samples was saved (roughly 20% of the total sediment) and laid upon newspaper in shaded areas in order to dry more quickly. All light fraction samples were successfully shipped to the UC Berkeley McCown Archaeobotany Laboratory and the heavy fraction samples remained in Costa Rica to be analyzed during the 2019 field season in order to avoid excessive shipping costs. Once dried, each heavy fraction sample was passed through a series of geological sieves (3mm, 2mm, and 1mm) and subsequently analyzed using a low-powered AmScope stereomicroscope (20x-40x) and an LED lamp while in the field (Figure 6-9). All sizes greater than 1mm were sorted with any present botanical remains being extracted, weighed, recorded, and shipped to the UC Berkeley for identification using higher powered microscopy. Sediment less than 1 mm was not analyzed from the heavy fraction due to time constraints.

Operation of the flotation tank is labor intensive, thus other project members, volunteers, or hired personnel often assisted with the paleoethnobotanical processing in the flotation tank in order to be as efficient as possible. Processing archaeological samples using water flotation is not yet widely practiced in Central America, meaning there is still much to be understood about past foodways and plant-human interactions in the region. Therefore, it was fortunate that a representative from the Museo Nacional de Costa Rica (Julio Sanchez) learned the system and helped process samples as well. This was an excellent opportunity to train a local Costa Rican archaeologist who can now aid in the recovery and processing of the botanical data elsewhere in the country.

Figure 6-9: *Sorting and extraction of botanical remains from the heavy fraction took place during the 2019 season at the field house. Samples were sufficiently dried on newspaper before being passed through a series of geological sieves for analysis.*

Figure 6-10: *Author processing water screened samples using a series of geological sieves (4mm, 2mm, 0.5mm).*

During the field season in July of 2018 the weather was exceptionally wet with heavy rainfall. This meant that the soil samples designated for screening were too moist to reasonably pass through fine geological sieves. For this reason, sieve samples were processed using a water screening method in which sediment was passed through the geological sieves with the assistance of water from a hose (Figure 6-10). Carbonized botanical remains were collected from each size fraction and sent to UC Berkeley for further analysis. However, water screening the soil samples was biased towards remains visible to the naked eye, clearly yielded far fewer plant material than water flotation, and the sediment was too coarse and clay-rich to reasonably pass through the sieves even with water. Because of these observations and due to time restraints, samples designated for water screening were not collected from the final stratum (Unit 61).

6.3 Archaeological Excavations at G-164 Sitio Bolívar

The main objective of the 2021 archaeological excavations of Proyecto Prehistórico Arenal at G164 Sitio Bolívar was to locate an Arenal phase domestic structure that could serve in comparison to that which was excavated at G995 La Chiripa (the Tronadora phase structure). In 2019, Sheets, Mejía-Ramón, and Slotten observed exposed domestic structures along the lakeshore at Sitio Bolívar during an informal survey (see Figure 5-15). Thus, the 2021 excavations intended to recover what was possible from these exposed habitational areas before they were completely washed away by the lake's wave action.

Figure 6-11: *Photo of the area where structures were visible on the shoreline during a survey in July 2019, but are not accessible due to the high water level of the lake in October of 2021. Photograph by author.*

Due to the COVID-19 pandemic, the original schedule of the project had been significantly delayed and the time of year that excavations could occur had changed. This meant that the conditions at the site were not as expected and the water level of Lake Arenal had risen significantly since the initial survey in 2019, making access to the structures along the lake shore impossible because they were now beneath the lake water. In an effort to maintain the goals of the project and implement a paleoethnobotanical collection of domestic structures, an initial survey and series of test pits were necessary to proceed. In order to access the area of the site that was observed in 2019, the project members traveled by boat to the peninsula in order to begin as close as possible to the location where structures were observed previously in 2019 (Figure 6-11). Once on shore, a direct path was cleared through the vegetation to the most accessible portion of the closest road so that subsequent visits to the site would not require transportation by boat. This path did not encompass the entire peninsula, but simply provided access to the site.

The fieldwork began with the clearing of a trail around the perimeter of the peninsula in order to identify areas of interest for excavations. Hoopes and Chenault (1994) noted that at Sitio Bolívar the domestic areas of the village are located at lower elevations closer to the lakeshore, and the funerary portions of the site were situated at higher elevations atop the ridge of the peninsula. Therefore, the initial survey of the site cleared a path along the perimeter of the peninsula in search of an area that appeared ideal for both habitation in the past and archaeological excavations in the present, i.e. flat areas of land close to the lakeshore, with minimal vegetation cover. The chosen location of the first two test pits was towards the tip of the peninsula since that was near where Sheets and colleagues had excavated domestic structures at the site previously in 1984 along the lakeshore at an altitude of 540 masl. Two test pits (2 x 1 m) were placed at the northwestern edge of the peninsula and excavated simultaneously: Op. F and Op. G (Figure 6-12). Both were excavated in arbitrary levels of 20cm in depth, using shovels until they reached either a sterile layer (Aguacate or Un. 65) or an area of interest indicating household activity.

Figure 6-12: *Google Earth image showing the locations of the 2021 excavations (Op. F and G) in comparison to those from 1984 (Op. A - E) at G-164 Sitio Bolívar.*

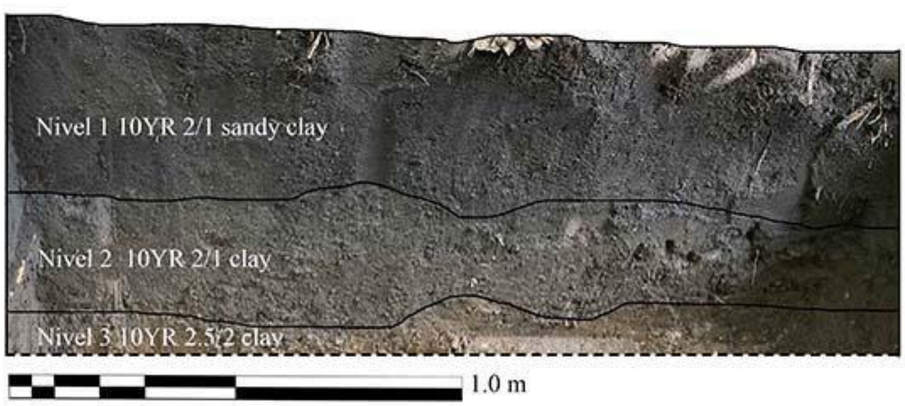


Figure 6-13: *Stratigraphic profile of Op. G. This test operation did not reveal any evidence of a domestic structure.*

Op. G did not reveal any evidence of a structure and the stratigraphy of each wall was unclear (Figure 6-13), suggesting that the area had been altered dramatically by either the lake water or farming activity during the latter half of the 20th century indicating a plow zone. Ceramic and lithic fragments were recovered throughout each level of this operation, but since no evidence of a domestic feature or structure was detected this operation was not expanded further.

An abundance of carbon was encountered at a depth of about 100 cmbd in Op. F, which initiated the collection of soil samples designated for flotation for the project. Shortly after the excavators noted that the soil was difficult to work with and quite compacted, suggesting the presence of a floor surface. At a depth of 120 cmbd two post holes were encountered along the eastern wall of Op. F, as indicated by dark circular areas of soil change. Excavations continued along the western edge of the test pit as an effort to locate the aguacate formation (Un. 65) in order to orient the excavators stratigraphically, but a third post hole was also encountered on the western side of the pit within 20 more cm in depth so the decision was made to expand this operation before excavating further below to lower strata. Miraculously, the project team found a structure within the very first test pit (Op. F). No further test pits were initiated during the field season and all work expanded from the test pit of Op. F, since that is where post holes were discovered.

Excavations continued according to natural levels (rather than arbitrary as was used during the initial test pit investigation) with expansions of this operation in order to understand the extent of the structure (Figure 6-14). The first expansion was a 2x2 meter section (Subop. 2) to the north of the test pit (now Subop. 1). The placement of Subop. 2 was designed to investigate if the post holes of the structure continue as a curve eastward or westward, since post holes 1 and 2 were aligned relatively north-south. Post hole 4 was encountered in Subop. 2, but at a stratum closer to the surface than the previous post holes, thus documenting multiple structures and a reoccupation of the site at a later time.

Excavations of Op. F proceeded according to natural or cultural levels, meaning that a change in level was created when a soil change was detected based on texture or color: resulting in a total of 6 stratigraphic levels (Table 6-3, Figures 6-14 and 6-15). Stratigraphic levels were given sequential (generic) names (Nvs. 1 through 6) until radiocarbon dates could confirm the time periods associated with each stratum. Ultimately, the radiocarbon dates revealed that all sampled strata dated to the same time period (430-540 CE, Appendix J), which corresponds to the known Unit 53 (see Table 4-2 and Figure 6-2). The arbitrary level designations were kept and will be used as such throughout this manuscript.

Table 6-3: *Stratigraphic sequence of Op. F at Sitio Bolívar.*

G164 Sitio Bolívar Op. F Stratigraphic Sequence				
Stratum	**Munsell #**	**Munsell Color**	**Texture**	**Inclusions**
Nv. 1	10YR 2/1	black	Sandy Clay Loam	no
Nv. 2	10 YR 3/1	very dark gray	Silty Clay Loam	no
Nv. 3	10YR 2/1	black	Sandy Clay Loam	2% 2.5Y 5/3 very fine
Nv. 4	10YR 2/2	very dark brown	Sandy Clay	2% 10YR 4/3 very fine
Nv. 5	7.5YR 2.5/1	black	Clay	5% 10YR 6/2 very fine, 2% 2.5YR 4/8 very fine
Nv. 6	10YR 3/3	dark brown	Clay	no

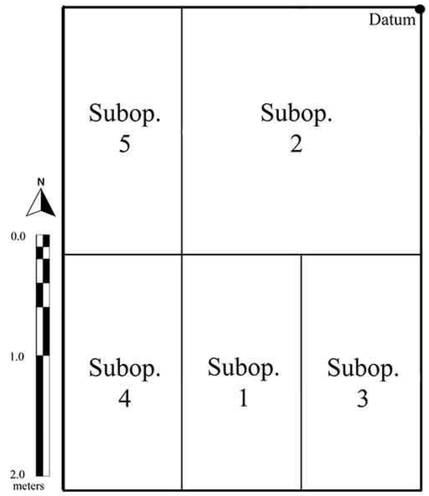


Figure 6-14: *General map of the Op. F excavations at Sitio Bolívar with the sub-operations marked. See Figure 6-16 for a more detailed version including artifacts and features.*

Eventually the initial test pit (Op. F) was expanded into 5 sub-operations and a 4 by 3 meter excavation, (Figure 6-14) from which a total of 10 post holes were identified and were numbered based on the order in which they were discovered (Table 6-4). Subsequent sub-operations were placed in order to expose both the interior of the structure (Subop. 3), as well as the exterior (Subops. 4 and 5). Based on previous work at the site (Hoopes and Chenault 1994), the exterior areas surrounding structures is where midden deposits or cooking areas such as hearths would be located, both of which would contain intriguing information considering that the main objective of the excavations is to recover botanical remains and ideally evidence of food consumption. The design of the extensions of Op. F thus allowed for horizontal excavations of both interior and exterior areas of the structure within Nv. 5, the bottom most stratum of excavations (Figure 6-16). Time did not allow for the operation to be expanded further to expose the entire extent of the structure.

Table 6-4: *Post holes discovered during the 2021 excavations of Op. F at Sitio Bolívar.*

Post Holes at G164 Sitio Bolívar Op. F					
No.	**Level**	**Dist. from Datum (m) (center of post hole)**	**Diameter (cm)**	**Depth (cm)**	**Volume (L)**
1	Nv. 5A	S 2.90, W 1.14	14	24	1.0
2	Nv. 5A	S 3.57, W 1.09	8	8	0.5
3	Nv. 5C	S 2.77, W 1.84	12	23	2.7
4	Nv. 4	S 1.76, W 1.23	8	10	1.0
5	Nv. 5A	S 0.45, W 0.81	11	28	3.5
6	Nv. 4	S 3.40, W 0.06	13	18	1.0
7	Nv. 5B	S 2.90, W 0.82	9	17	2.0
8	Nv. 5B	S 3.65, W 0.76	11	15	2.0
9	Nv. 5B	S 3.75, W 2.71	15	23	3.5
10	Nv. 5C	S 1.81, W 1.23	20	25	3.0
		Average	**12.10**	**19.10**	**2.02**

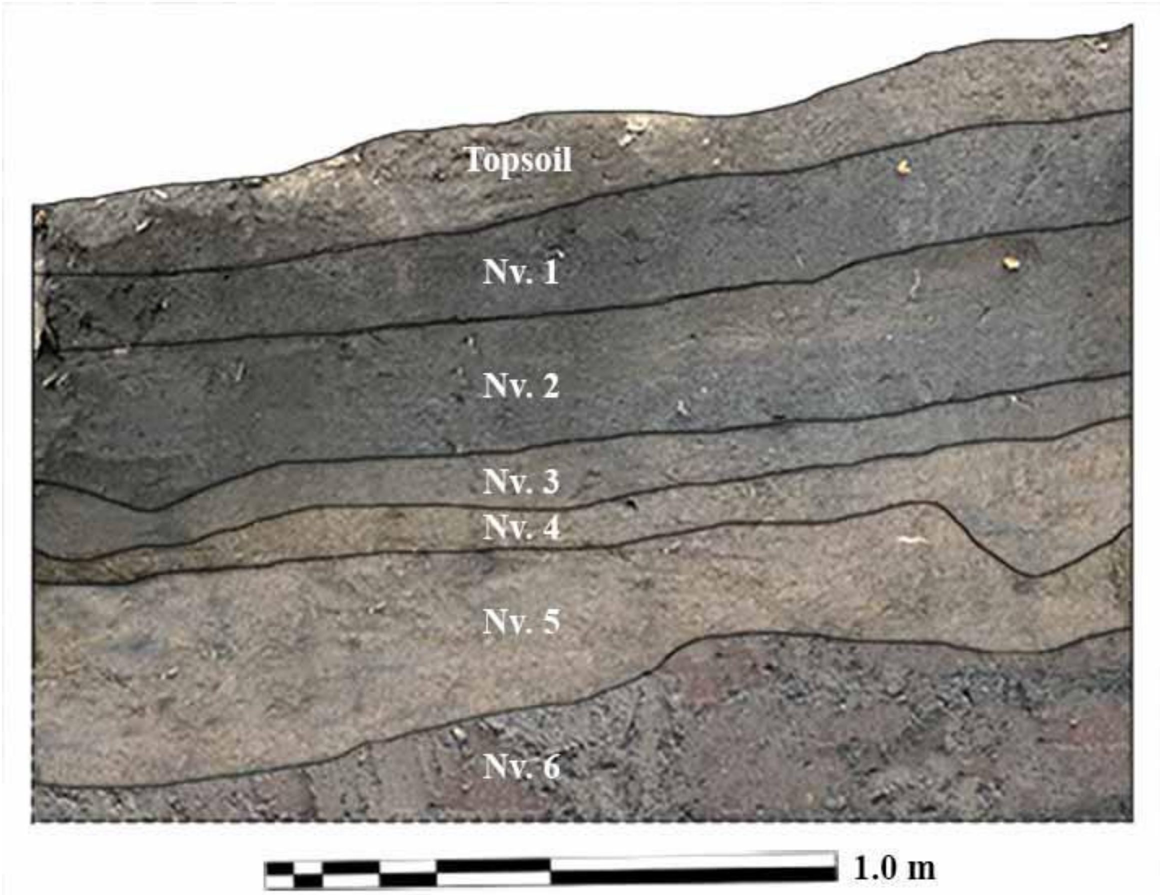


Figure 6-15: *Profile map of the northern wall of Op. F at Sitio Bolívar. Paleoethnobotanical samples were collected from Nv. 3 through Nv. 6, when present within the excavation. A detailed description of each stratigraphic level at Sitio Bolívar can be found within Appendix K.*

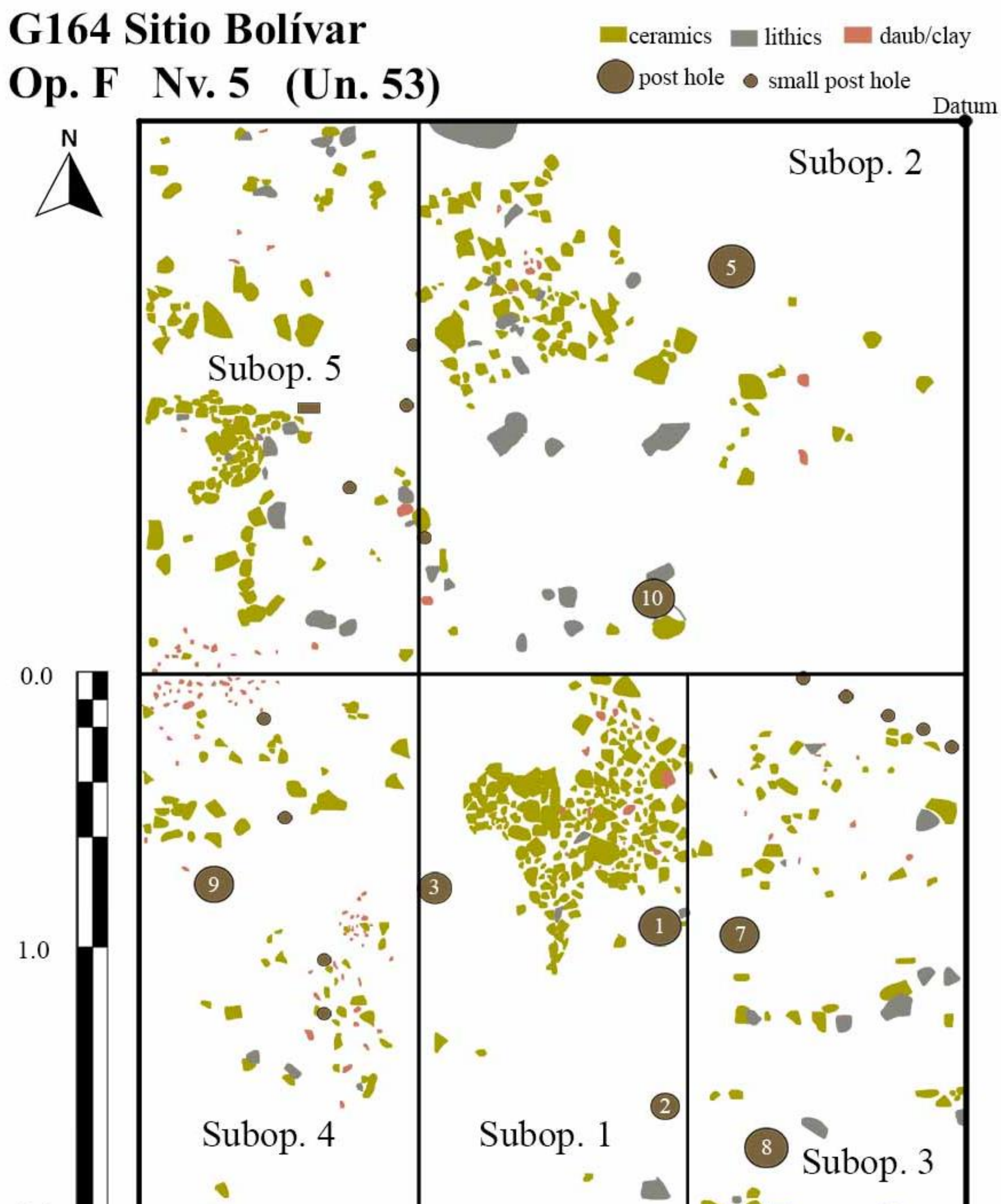


Figure 6-16: *Plan map of Op. F Nv. 5 (Un. 53) at Sitio Bolívar with ceramics, lithics, clay/daub, and post holes illustrated (post holes are numbered according to when they were encountered during excavations). All material from the sublevels A, B, and C are combined in this view.*

The first 50 to 70 cm of sediment was removed relatively quickly using shovels until the black sandy clay loam soil of Nv. 3 was encountered, passing through the topsoil. Excavations began to use trowels instead of shovels, screening of soil switched from the larger 2cm screen to the finer 4mm screen, and paleoethnobotanical samples were collected from every square meter. Carbon began to be noticeably present in this stratum as well and was collected in vials when encountered during excavation or at the screening station if a soil sample designated for flotation was already collected from such a space. Below this layer was Nv. 4, a very dark brown sandy clay, which contained two post holes which represented a more recent structure other than the main one encountered within Nv. 5. The presence of multiple structures stratigraphically demonstrates that the peninsula was of great interest to the past residents. So much so that they apparently returned to the same exact location repeatedly through time to construct their residences, a practice which is also exemplified by the ancient footpaths followed by Sheets team throughout the Arenal region (Sheets 2011).

Nv. 5 was the stratum of most interest since it contained the most post holes and a compacted sediment, which indicated the structural floor and lived surface of the domestic occupation. Due to the thickness of this level, it was split into three arbitrary sub levels of 10cm each (5A, 5B, and 5C). This allowed for sampling of paleoethnobotanical remains to be separated based on the top of the level versus the middle and bottom to show change through time. A total of eight post holes were encountered throughout this level that likely represent more than one single structure based on their arrangement (See Figure 6-16). Post holes 1, 2, 7, and 8 form what is likely a porch or doorway into a structure, which align well with post holes 5 and 11 to form a structure that has an interior in the eastern direction. Post holes 3 and 9 do not align well with the other post holes from this stratum, and therefore likely are from a separate structure or perhaps a windbreak wall feature. Additionally, fourteen smaller post holes were discovered from this stratum that could be remnants of walls, wind breaks, fencing, or doorways (Figure 6-17). As can be viewed in the profile of this operation (Figure 6-15), there was a sharp decline just west of the postholes, demonstrating that the interior of the structure was built upon a flat terrain but the exterior had a steep slope. This terrain further suggests that the interior of the structure was towards the east of the aligned post holes.

Figure 6-17: *Small post holes (upper section of photograph) in Op. F Subop. 3 Nv. 5 that could be remnants of walls, wind breaks, fencing, or doorways. Ceramic sherds are located in the bottom right corner in situ.*

The majority of artifact fragments of the project were recovered from this stratum, as it is the cultural layer during which this site was mainly occupied. This will be visualized in the results chapter within Figure 7-1. Carbon was recovered throughout the level and was quite abundant in all sub-operations. Concentrations of clay deposits, both un-fired and fired, were present throughout the operation and are likely fragments of daub (Figure 6-18). The majority were of the yellow-red color (10YR 6/2 and 2.5YR 4/8) similar to that of the aguacate formation, but occasional fragments were of a dark brown color (7.5YR 3/3). The soil from this entire level had fine to medium inclusions of the orange-red clay, the larger concentrations are noted in red on the plan map of this level (Figure 6-16).

Figure 6-18: *Left: Image of the soil composition at Sitio Bolívar that was observed throughout Nv. 5, demonstrating the frequent inclusions of fired clay material. Right: Unformed fired clay fragments of wall daub recovered from Op. F, Nv. 5B.*

Ceramic fragments collected during the 2021 field season at Sitio Bolívar amounted to 4,519 elements, a dramatic increase from those recovered from La Chiripa, because that house was aceramic. The vast majority of the ceramic fragments were recovered from Nv. 5, the level with the Late Arenal phase structure (See Figure 7-1 in the results chapter). All diagnostic ceramic types recovered were identified to the Arenal Phase and typological identifications included Bocana Incised Bichrome, Cervantes Incised, Charco Black-on-Red, Espinoza Red-Banded, Las Palmas Red-on-Beige, Guinea Incised, Mojica Impressed, Los Hermanos Beige, Los Hermanos Beige Espinoza Variety, Los Hermanos Beige Cervantes Variety, and Red Rim-Orange Body (Figure 6-19). The same findings by Hoopes (1994) at Sitio Bolívar were true for the 2021 excavations within Op. F: excavations collected a large assemblage that was dominated by Los Hermanos Beige (n=336), Charco Black on Red (n=121), and Mojica Impressed (n=116). No complete vessel was recovered, but the assemblage did include a variety of forms. The most frequent form of ceramic sherds recovered from excavations were body sherds (n=3559), followed by rims (n=574), unformed clay (n=147), supports and other unique forms (n=48), and handles (n=14). Interesting ceramic fragments include supports with zoomorphic faces (avian and possibly mammalian or reptilian) and a hollowed, conical support that makes a rattling sound (Figure 6-20). The dominance of ceramics and unfired clay within the excavation at Sitio Bolívar suggest that this site perhaps produced the material, however, no context indicating direct production was identified. Since the paleoethnobotanical remains are the focus of this investigation, ceramics from Sitio Bolívar are described in further detail in Appendix L.

Figure 6-19: *Example sherds of each ceramic type recovered from the 2021 excavations at G-164 Sitio Bolívar from Operation F.*

Figure 6-20: *Unique ceramic fragments recovered from Nv. 5 of Op. F, including zoomorphic faces and a hollowed support.*

A total of 444 lithic artifacts were recovered from Operations F and G at Sitio Bolívar including 328 boiling stones, 75 debitage fragments, some scrapers and knives made from quartzite, a green stone pendant, a ground stone handle, and a ground stone mano (Figure 6-21). The majority of these lithic materials were likely used to process food. The boiling stones, just as at La Chiripa, dominate the assemblage and demonstrate that indirect boiling would have been the primary way for these residents to cook their food. The knives and scrapers could have been used to cut fruits and vegetables or even to process animals, whether that was to cut meat off of bones or scrape hides. While a full metate was not recovered, the ground stone handle and mano allow us to assume that some foods were processed and prepared on a metate.

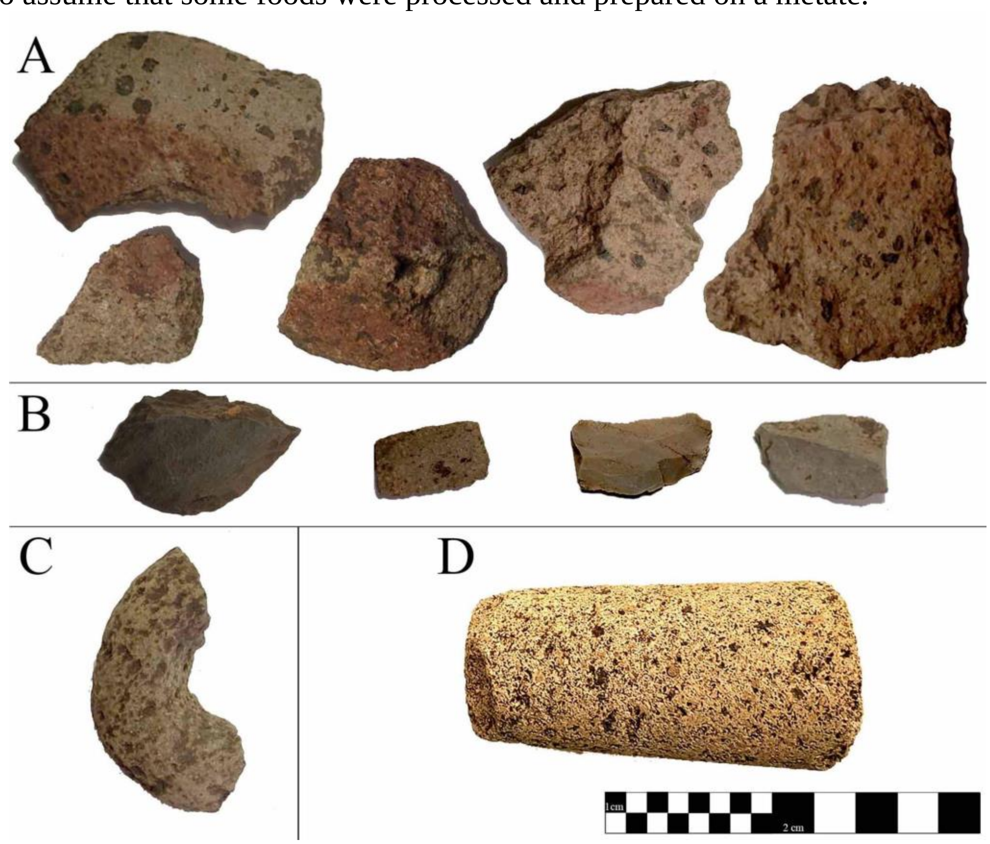


Figure 6-21: *A selection of lithic artifacts recovered from Op. F at Sitio Bolívar: A) boiling stones showing oxidation from being heated, B) knives and scrapers, C) a ground stone handle, and D) a ground stone mano.*

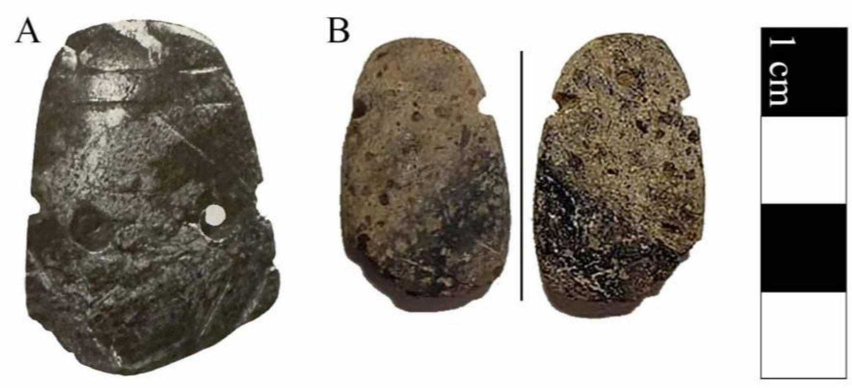


Figure 6-22: *Greenstone pendants recovered from G164 Sitio Bolívar. A) Op. A (Recovered in 1984, Mueller and Chenault 1994:281). B) Op. F (both front and back pictured, recovered in 2021).*

While not made of jadeite, the polished greenstone pendant was probably produced with techniques similar to those employed by prehistoric Central Americans in the carving of jadeite figures (Mueller and Chenault 1994: 279). The pendant found at Sitio Bolívar was recovered from Nv. 5B within the south quadrant of Subop. 5 (Figure 6-15) and resembles the form of the half-celt avian pendants described by Mueller and Chenault (1994: 279-281), one of which was recovered from Op. A at Sitio Bolívar (Figure 6-22). The pendant from Op. F does not have any imagery or incised lines but has the same mottled coloring, relative placement of notches, and is only slightly smaller in size than the pendant from Op. A. The pendant also shows some evidence of burning and was discarded among a concentration of broken ceramic and lithic fragments, likely forming one of the many midden deposits within this operation.

Lithic materials from Sitio Bolívar are described in further detail in Appendix M.

6.4 Paleoethnobotanical Recovery at G164 Sitio Bolívar

Just as at La Chiripa, soil samples were collected systematically throughout excavations at Sitio Bolívar. Both microbotanical and macrobotanical collection strategies were implemented during the 2021 field season at Sitio Bolívar. All samples were numbered in the order that they were collected. In order to use the same numbering system as at La Chiripa, sample numbers of flotation and microbotanical samples correspond to the same context/location, with flotation samples beginning with 1### and microbotanical beginning with 3###.

6.4.1 Paleoethnobotanical Sample Collection

A total of 137 flotation samples were collected during the 2021 fieldwork (Table 6-5) and were collected by all project members (Figure 6-23). Paleoethnobotanical sampling began at Nv. 3, because the levels above were considered to be too altered/disturbed from previous lake wave action and agricultural use at the site in the recent past. A total of 10 liters of soil was instructed to be collected as a composite for flotation from each square meter of excavations. Occasionally, due to a high density of artifacts in a particular location or a rapid soil change, a lesser volume was necessary. For Nv. 5, which contained the structural floor and majority of post holes, all samples were collected from 0.5 by 0.5m sub-quadrants in order to get a higher resolution of data (just as was done at La Chiripa). However, unlike at La Chiripa, the samples from this level were still instructed to be 10 liters in volume rather than 5. Due to time constraints at the end of the fieldwork, samples collected from Nvs. 5C and 6 were taken only from 1x1m quadrants. Additional samples designated for flotation were collected from post holes. The sampling area was always scraped off by at least 2-4 cm with a clean trowel prior to collection to ensure that any modern contaminants that may have blown into the excavation or entered via the archeologist's shoes were not collected. Flotation samples were placed into durable plastic bags, labeled on the outside, with a full label card placed inside. Samples were carried back to the field car because the site was not accessible via an off-road vehicle like at La Chiripa, which required an expansion of the site trail to allow passage via wheelbarrow since the samples were too sizable to efficiently carry by hand.

Table 6-5: *Summary of paleoethnobotanical collections from the 2021 field season at G164 Sitio Bolívar.*

Strata	**Type of Paleoethnobotanical Collection**				
	Flotation		Screened	Phytolith/Pollen	Starch
	No. of Samples	Volume (L)	No. of Samples	No. of Samples	No. of Samples
Nv. 2	-	-	1	-	1
Nv. 3	11	36.5	4	2	-
Nv. 4	15	84.0	13	11	2
Nv. 5	109	514.5	69	96	13
Nv. 6	2	10.0	3	1	-
Total	**137**	**645**	**90**	**110**	**16**

Figure 6-23: *Project volunteers Anthony Azofeifa and Nicole Quinteros collecting soil samples designated for flotation at Sitio Bolívar in 2021.*

Unlike at La Chiripa, all excavated soil removed from the Sitio Bolívar operations was screened through a geological screen as an effort to recover any and all archaeological material present within the excavations. A known total volume of this soil was unfortunately not recorded but is estimated to amount to roughly 10,000 L. Passing absolutely all sediment from the excavation through geological screens eliminated the need to take extra samples for this purpose, such as was operationalized at La Chiripa (which had resulted in extra transportation and displacement of soil from the archaeological site). This collection strategy also ensured greater visibility of archaeological materials (both artifacts and ecofacts). Soil from the topsoil level was passed through larger screens (2cm opening), and all soil from Nv. 3 and any subsequent strata below was passed through a finer geological sieve with an opening of 4mm using the aid of water pumped from the lake. The use of the finer 4mm screen began at Nivel 3 because it was the first stratum believed to not be disturbed or altered by recent farming activity or lake wave action. The use of water was necessary to pass the soil through screens because of how clay-rich the sediment was; and an endless supply of water was available in the lake, only approximately 10 meters west of the excavation operation (Figure 6-24).

Figure 6-24: *Image showing the close proximity of the excavation to the lake's edge.*

All iterations of the water pump required two project members to be stationed at the screen: one to physically pump the water and another to wash the soil and scan for archaeological material (Figure 6-25). Implementing an efficient screening setup using a water pump was not a simple feat and multiple versions were created throughout the field season. At first, the project utilized the same manual hand pump used by Shelton and White's (2010) flotation system, that is normally intended to remove water from boats or watercraft (Whale

Gusher Urchin manual Bilge Pump). Water entered the pump through a hose that was resting in the lake water and exited through another hose that emptied the water onto the geological screen. The hose entrance that was placed in the lake and tied to a post also had a filter on its end in the form of a fine mesh cloth in order to prevent any large objects from entering the pump system or contaminating the samples. A tear occurred in the rubber that suctioned water from this pump after the second day of use. This was the only pump of its kind that appeared to be available within a reasonable driving distance. Efforts were made to repair the tear, but after an inquiry with the store of purchase, the excavation team learned that the water pump was considerably old and likely was damaged easily due to its age. After some searching locally in the town of Tilarán, a creative solution presented itself at a local hardware store in the form of an oil pump intended for oil drums. A similar design was set up at the lake edge with this oil pump, which turned out to work with more ease than the previous design. However, it was eventually realized that because this pump was intended for use with oil, it required frequent applications of WD-40 to its main gear in order to operate effectively and smoothly.

Figure 6-25: *Water pump systems utilized to screen all soil from the 2021 excavations at Sitio Bolívar. Left: the initial hand-pumped bilge system attached to a wooden plank atop a bucket, Right: the ultimately successful oil pump system fixed to a large tree buttress of a chilamate tree (Poulsenia armata [Miq.] Standl.) along the lake edge, approximately 10 meters west of Operation F.*

Samples designated for microbotanical analyses were also collected throughout excavations, from the same locations as the flotation samples. Each of these samples was about 400ml in volume and was designated for phytolith, pollen, and pH analysis. The microbotanical collection strategy was designed and executed by volunteers Maria Lopez Rojas and Anthony Azofeifa, both of whom have conducted phytolith analysis at the Masters level for their own individual projects elsewhere in Costa Rica previously. All microbotanical samples were collected using freshly cleaned trowels and spoons using water and fresh, clean napkins. The surface of the sediment was scraped clean immediately prior to collection to avoid contamination and then placed into sterile plastic bags. The location of sampling for microbotanical samples was chosen carefully in order to avoid modern contamination from roots or clay-rich soil. Just as with La Chiripa, microbotanical samples were not analyzed for this dissertation but remain available for future analysis.

During excavations, when a ceramic or lithic fragment was recovered with visible residue present on its surface (n=16) it was placed in a bag immediately in order to avoid contamination. Based on field methods described in Pearsall (2015), each sample was first scraped within a sample bag with a fresh toothbrush to remove all visible residue (dry brush) and then secondly washed again within a separate sample bag using the same toothbrush and distilled water dispersed using a fresh pipette (wet brush). All residue and water was collected into a labeled bag and assigned a sample number beginning with #2XXX.

6.4.2 Processing the Paleoethnobotanical Samples in the Field

Unfortunately, the flotation tank built for paleoethnobotanical processing at La Chiripa was not available for use during the Sitio Bolívar field season in 2021, so in order to process the flotation samples I constructed an entirely new machine assisted flotation system. This machine was also a modified Siraf-style water flotation tank that used pressurized water flow via a water pump to agitate the soil matrix within water. The tank was constructed with the assistance of the same local welder in Tilarán who constructed the flotation tank that was used at La Chiripa in 2018. Inspired by Shelton and White (2010), the flotation system built during this season attempted to recycle the water using a system of three water tanks; a main flotation tank and two settling tanks (Figures 6-26 and 6-27). Water flowed continuously into the main 55-gallon tank via a hose connected to an electric water pump that rests in the second settling tank. Because the water pump did not provide an adequate pressure of water, an external hose was also used to agitate the sample within the heavy fraction basket which limited its efficacy of the recycling of water. The flotation system operated essentially in the same manner as the previous version. Water exited the tank as overflow into a light fraction bucket, which is lined with a fine mesh material with an opening of 0.2mm. The heavy fraction basket was now lined with a 0.5mm mesh screen. Any organic material within the soil samples placed into the inner basket would float up to the surface and exit the top opening and be collected in the mesh fabric lining the light fraction bucket.

Each sample's volume was measured again before being deposited into the flotation tank in order to ensure an accurate measurement of each sample (Figure 6-28). Due to the compaction of the soil while being stored, water displacement was used to measure the samples. This revealed that the range of sediment volume collected by excavators was actually between 4 and 7 liters, not 10 liters. This is much less volume than was collected at La Chiripa, but the discrepancy could be due to the use of water displacement to measure sample volumes at Sitio Bolívar. Each sample was carefully deposited into the flotation tank, gently agitated by water pressure, and visible carbonized remains floating in the water were encouraged either by hand or with the assistance of a hose to exit the tank and be collected in the light fraction bucket. The flotation process for each sample lasted between 20 minutes and 1 hour; the time necessary for each sample varied based on the size of the sample, the consistency of the soil matrix, and the abundance of carbonized material. An average of 12 samples were floated per day and were processed, stored, and analyzed in a similar manner to as at La Chiripa. The water in the flotation tanks was always emptied at the end of each day to keep the buildup of silt at the bottom of the tank to a minimum. A record of the flotation of samples is available in Appendix A.

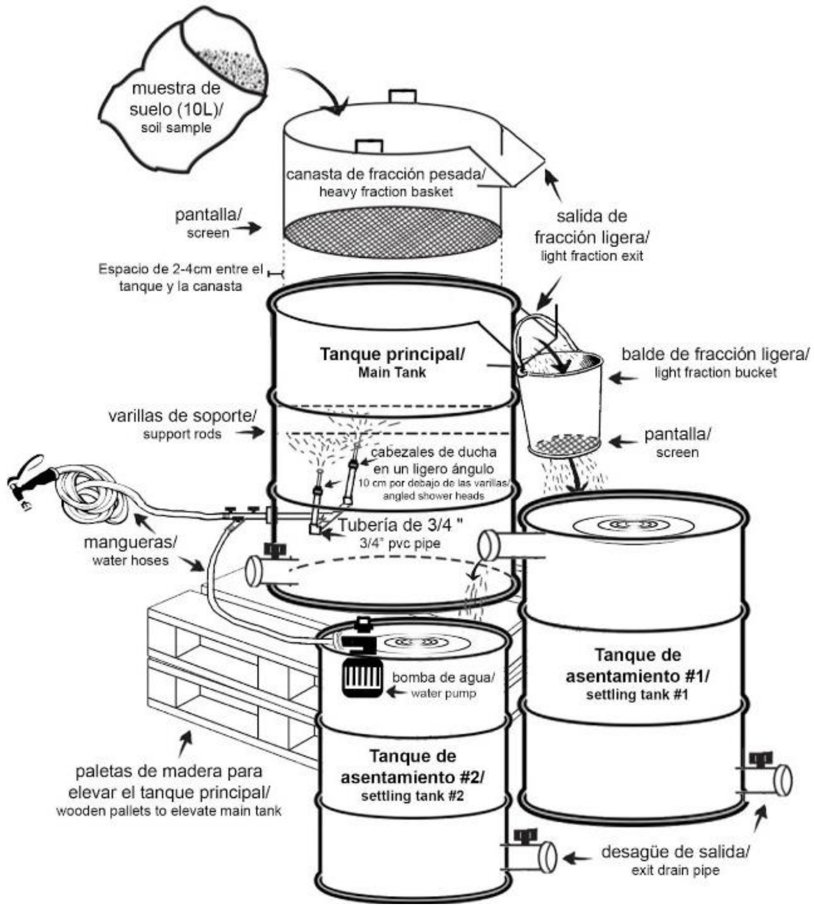


Figure 6-26: *Diagram of the flotation system constructed for use at G164 Sitio Bolívar in 2021. Once the field season was complete, the flotation tank system was donated to the Archaeology program at the University of Costa Rica.*

Figure 6-27: *Images showing the flotation tank system in operation, which made use of a series of settling tanks to recycle water.*

Figure 6-28: *Left: Measurement of soil samples using water displacement. Right: The bucket used for measurement of the sample is slowly poured into the main tank with the aid of a water hose.*

Each day, one sample had 100 charred poppy seeds added before being processed with flotation in order to test the recovery rate of the flotation process. Ultimately, the test did not yield as productive of a recovery rate as at La Chiripa, with an average of 82.3% and a range of 30 to 100 of the seeds recovered. A possible explanation to this difference in recovery could be that the flow rate of the water used for the flotation machine on the Sitio Bolívar field season was noticeably not as strong as at La Chiripa. Additionally, the majority of flotation samples processed as La Chiripa were done by myself, whereas at Sitio Bolívar a group of volunteers helped process the flotation samples with my assistance. These volunteers were all trained archaeology students and would rotate in their responsibilities among the different field laboratory tasks, but as has been mentioned previously, this form of paleoethnobotanical collection has not been implemented often in this geographical region. It is possible that this discrepancy in recovery rates between the two sites is a product of training new students (a worthwhile task in furthering the use of such methods archaeologically). Ultimately, the average recovery rate of poppy seeds at Sitio Bolívar is still acceptable and shows that the majority of organic remains were recovered.

Due to a greater abundance in time built into the research season, all contents of the heavy fractions were analyzed (compared to La Chiripa where time was limited and only 1 liter of the heavy fraction was scanned for botanical material). Initial sorting of the heavy fraction samples was completed during the lab portion of the field season. Each sample was passed through a series of geological sieves (4mm, 2mm, and 1mm) and subsequently analyzed using a low-powered AmScope stereomicroscope (20x-40x) and an LED lamp. All sizes greater than 1mm were sorted with any present botanical remains being extracted, weighed, recorded, and stored for future identification at the UC Berkeley McCown Archaeobotany Laboratory. Organic carbonized material was recovered from 115 of the 131 flotation samples from the heavy fraction.

6.5 Laboratory Methods: Identification of the Macrobotanical Remains

All of the macrobotanical samples that were collected from the excavation (flotation, screen, and manual) were sorted using either a Wild Herbrugg M5 light microscope (6-50x) or a AmScope SM-3T Trinocular Stereo Zoom Microscope (7X-45X). The sediment samples were divided into different size fractions using a series of geological sieves (4 mm, 2 mm, 1 mm, and 0.5 mm openings) and each fraction was then scanned for preserved plant remains. None of the samples were subsampled. Seeds and other plant remains were extracted from all of the size fractions. Only whole, identifiable seeds with distinguishing characteristics were extracted from the smallest size fractions (>1.0 mm and >0.5 mm). Wood charcoal remains were only extracted from the larger size fractions (4 mm and 2 mm), since it is necessary to have specimens large enough to snap into three anatomical cross sections and have enough of a flat surface remaining for identification purposes (Kabukcu and Chabal 2021:10). All plant remains were then divided into broad classifications (wood charcoal, geophytes, seeds, achenes, and fruits) and then identified to family, genus, or species level if possible. The identification process began with a physical recording of each specimen on data record sheets (Appendix B). Properties recorded for all organic material include the following: taxonomic plant name, plant part, quantity, weight. Additionally, qualitative observations such as preservation condition, firing conditions, and fragmentation were also recorded (Hubbard and al-Azm 1990).

Figure 6-29: *Laboratory equipment used during analysis and identification of macrobotanical remains. Left: Wild Herbrugg M5 light microscope (6-50x), Middle: Mettler Balance, Right: Hitachi TM-1000 Scanning Electron Microscope.*

Images of plant remains other than charcoal were taken with a OMAX digital camera attached to the stereo microscope. These images were taken to show the overall shape, size, texture, and morphological features of plant remains that would assist in an accurate identification. Seed characteristics used to identify seeds recovered archaeologically include size, shape, texture, attachments, position of attachment scars, and other surface features. All post-depositional processes were taken into account when analyzing the seed remains. Charring can cause the seed coat to be lost and can change the size and surface features of plant material. Heating and post-depositional processes can reduce seed size and distort distinguishing features (Wilson 1984).

Wood charcoal was initially sorted into broad taxonomic categories such as hardwood, softwood, or palm. Wood charcoal smaller than 2.0 mm was not examined further in this manner because wood charcoal smaller than this is generally unidentifiable even to broad taxonomic categories, let alone genus or species (Pearsall 2000: 107). Wood charcoal specimens were fractured by hand into transverse, radial, and tangential cross-sections when possible to observe identification features on a fresh, flat surface. Wood charcoal specimens were then imaged using a Hitachi TM-1000 Tabletop Scanning Electron Microscope in the Archaeological Research Facility at UC Berkeley at various magnifications (50x, 100x, 200x, and up to 1000x when necessary). Anatomical features used to identify the wood charcoal include the following: porosity, size and arrangement of vessels, vessels per mm2, axial parenchyma patterning, the presence of tyloses, size and arrangement of rays, and rays per mm. The presence of radial cracks or fissures and the relative angle of the rays was also recorded in order to interpret the condition of the wood prior to carbonization.

Taxonomic identifications were supported by comparative material in the reference collection of plants from Mesoamerica, Central America, and South America in the McCown Archaeobotany Laboratory at the University of California, Berkeley. Identification manuals and field guides also assisted in an accurate identification and description of specimens' morphologies, growth habits, and economic uses (Cappers and Bekker 2013, Condit et al. 2011, Cornejo and Janovec 2010, Delorit 1970, Fern 2022, Haber 2000a, 2000b, Lentz and Dickau 2005, Martin and Barkley 2000, Metcalfe and Chalk 1957, Standley 1884-1963, Vozzo 2004, Zuchowski 2007). For the wood charcoal specimen, a database of reference material was created using a list of the most common trees of Costa Rica obtained from Condit (et al. 2011) and reference images obtained mostly from Insidewood (Wheeler 2011, Wheeler et al. 1989), but were occasionally supplemented from other published sources (Gonclaves and Scheel-Ybert 2016, Leme 2016, Nagib Nassar et al. 2010, Roque et al. 2013). This amounted to over 400 slides of reference material for wood identification; each slide in the created database of trees from Costa Rica (Appendix Q) showcases a single species and its major anatomical characteristics that can be applied towards anthracological specimens (vessels, rays, parenchyma, tyloses). An additional version of the database was created that sorted the taxa based on their anatomical characteristics to ease the identification of charcoal material, much like a key used by botanists for identification of live plants. Wood charcoal was identified to the family, genus, and species level if possible based on these database. Species level identification was only reached if reference material was available for absolutely all possible species within the country and these species were distinguishable anatomically, or if only a single species exists within Costa Rica of that particular genus. Many species are not necessarily able to be differentiated within a genus based on their anatomical characteristics, so identification of woody taxa was most often made to only the genus level. Even some genera are too similar to distinguish anatomically, so identifications occasionally combined taxa at the genus level (for example *Nectandra* and *Ocotea*, which even the live trees of these genera are also difficult to distinguish). If a specimen was in poor condition or did not sufficiently match any of the reference material, even to the family level, it was deemed unidentifiable.

All taxonomic identifications were verified using *Tropicos.org* to ensure that the name is still accepted within the scientific community and also the *Sistema de Búsqueda de Colecciones Historia Natural* (biodiversidad.museocostarica.go.cr), operated by the *Museo Nacional de Costa Rica*, to ensure that the taxa is native to the region.

All botanical identifications for each paleoethnobotanical sample are available within the appendices. Appendix D includes a complete table of the samples collected from G-995 La Chiripa and Appendix E includes those from G164 Sitio Bolívar. Images of all identified taxa are also presented: see Appendix F for the woody taxa from La Chiripa, Appendix G for the seeds, fruits, and geophytes from La Chiripa, Appendix H for the woody taxa from Sitio Bolívar, and Appendix I for the seeds, fruits, and geophytes from Sitio Bolívar.

6.6 Conclusions

Although portions of this project were delayed due to the COVID-19 pandemic, the end result was still a great success. Paleoethnobotanical remains from several domestic structures representing a range of time periods in the Arenal region (Tronadora through Late Arenal) were collected, processed, and formed the first systematic paleoethnobotanical study of domestic structures in Costa Rica. Activity areas both within and outside of domestic structures were explored, leading to sampling from middens, hearths, structural floors, and post holes. An abundance of preserved botanical material was collected, demonstrating that macrobotanical studies in this tropical region can be productive and informative. The presence of multiple domestic structures within different stratigraphic levels at Sitio Bolívar corroborates the assessment by both Sheets (1994) and Egan (2019) that the Arenal region was incredibly important to the inhabitants, so much so that the population would return after volcanic events that temporarily disrupted their way of life despite the risks of future events.

How did the past inhabitants of Central America live day to day, achieve resilience to volcanic disasters, and remain connected to a cultural memory of their ancestors? Within Chapter 7, the macrobotanical data collected from G995 La Chiripa and G164 Sitio Bolívar will be presented in conjunction in order to assess the human-environmental interactions in the Arenal region through time. Within the discussion chapters 8 and 9, the botanical data will be assessed in a manner that provides invaluable information regarding ancient household practices, long-term residence stability, and environmental resilience in Pre-Columbian Central America.

Chapter 7

PALEOETHNOBOTANICAL RESULTS: OVERVIEW

The goal of this chapter is to outline the paleoethnobotanical results at La Chiripa and Sitio Bolívar. This will begin with a general overview of the data and the efficiency and effectiveness of the various macrobotanical collection efforts that were employed. The discussion will then review the datasets at each individual archaeological site, moving from the uppermost stratigraphic levels which are more recent in time, down through to the lower most levels which contain the domestic structures at each site. For each stratum, the botanical taxa that were identified, their frequencies in terms of ubiquity and standard densities, as well as their general spatial distribution will be presented.

7.1 General Overview of the Plant Data

Table 7-1: *Summary of standardized counts (quantity/L) and weights (g/L) of plant remains recovered from G-995 La Chiripa and G-164 Sitio Bolívar.*

			Wood Charcoal		Seeds & Achenes		Fruits		Maize Cupules		Geophytes	
			Qt./L	Wt./L	Qt./L	Wt./L	Qt./L	Wt./L	Qt./L	Wt./L	Qt./L	Wt./L
G995 La Chiripa	Flotation n=144 (1139.5 L)	Total Flotation	1.914	0.018	2.392	0.000	0.090	0.000	0.012	0.000	0.036	0.000
		Light Fraction	1.262	0.012	2.389	0.000	0.068	0.000	0.004	0.000	0.024	0.000
		Heavy Fraction	1.042	0.009	0.004	0.000	0.034	0.000	0.013	0.000	0.020	0.000
	Screened n=70 (600 L)		0.762	0.010	0.033	0.000	0.040	0.000	0.003	0.000	0.007	0.000
G164 Sitio Bolívar	Flotation n=137 (645 L)	Total Flotation	4.273	0.040	7.045	0.000	0.132	0.003	0.079	0.000	0.065	0.001
		Light Fraction	2.085	0.028	7.025	0.000	0.096	0.002	0.051	0.000	0.060	0.001
		Heavy Fraction	2.188	0.012	0.020	0.000	0.036	0.001	0.028	0.000	0.005	0.000
	Screened (all sediment ~21,000 L)		0.046	0.002	0.000	0.000	0.005	0.000	0.000	0.000	0.002	0.000

The sediment samples from La Chiripa and Sitio Bolívar yielded by far the largest (and perhaps most dense) paleoethnobotanical data set so far, not just the Arenal region, but for the entire country of Costa Rica as well. At La Chiripa a total of 144 flotation samples, 70 screen samples, and 109 manual samples (amounting to 1,739.5 liters of sediment sampled) were collected and resulted in the recovery of over 2,500 fragments of wood charcoal, 3,900 seeds and fruits, as well as 34 unidentified geophyte fragments. Sitio Bolívar yielded a similarly robust plant assemblage through the collection of 137 flotation samples and 88 manual/screened samples (amounting to 645 liters of sediment sampled through flotation), and resulted in the recovery of over 3,000 wood charcoal fragments, 4,700 seeds and fruits, as well as 67 geophyte fragments. Table 7-1 presents the standardized counts that have been calculated to show the sum of counts and weights per liter sampled.

The robustness of this paleoethnobotanical data is partially due to a systematic sampling strategy that collected from every square meter of excavations and incorporated a variety of collection methods (flotation, screened, and hand-picked manual samples) to recover preserved plant material from these domestic structures. Prior paleoethnobotanical investigations in the Arenal region (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994) were largely judgmental in their sampling methodology and the flotation samples extracted in the search of macrobotanical remains were likely too small to be productive (ranging from 500ml to 2.5L) given the poor preservation in this tropical setting. For example, 20L of sediment was processed from every square meter of the house floor at G-995 La Chiripa. These samples were 40x bigger than some of the samples collected in the 1980s from Arenal sites. Even though these samples were much larger than previous paleoethnobotanical investigations, I would suggest that future investigations pursue even greater volumes of flotation samples because the preservation in this area is not ideal and as this chapter will discuss, measures of the diversity of this assemblage suggest that the full diversity of the space was not realized through this sampling regime I completed. While there are volcanic eruptions every few centuries from Arenal Volcano, the tropical environment does not lead to great preservation of organic material. Neither of the archaeological sites in this present study were directly buried by a volcanic eruption, and thus did not benefit from any rapid burial and subsequent preservation such as is seen at sites like Joya de Cerén in El Salvador (Lentz and Ramírez-Sosa 2002, Slotten et al. 2020). The amount of seeds recovered per liter of sampled sediment for flotation from these sites is quite low at only 7.045 for Sitio Bolívar and 2.392 for La Chiripa (See Table 7-2). An even greater volume of flotation samples would be necessary in order to gather more meaningful information about the plant use at these sites in a study focused on macrobotanical seeds, achenes, and fruits, since the 20L per square meter from the house floor of La Chiripa proved to not be sufficient. Admittedly this may prove difficult in practical terms, since transportation of these samples was already challenging in this tropical setting and because some sampled contexts within this study (especially at Sitio Bolívar) did not actually contain more than 20L of sediment per square meter.

It is important to note however, that the numbers calculated in Table 7-1 incorporate all samples from both archaeological sites involved in this study, meaning that even the samples from layers of volcanic ash, which were sterile of cultural remains, are included. For this reason, Figure 7-1 presents this same data split among the different stratigraphic levels which were sampled. However, these numbers still do not approach substantial values, with the greatest occurrence being found within Nv.5C at Sitio Bolívar, with roughly 17 fragments recovered per liter of sampled sediment.

The AMS Radiocarbon dates from Sitio Bolívar revealed that all five stratigraphic layers that were sampled dated to the exact same time period during the Late Arenal phase (Un. 53 - 430-540 CE, see Appendix J), but samples from the La Chiripa site did represent multiple time periods ranging from 1616 BCE to 101 CE and included samples from culturally sterile stratigraphic levels of volcanic ash from eruptions of Arenal Volcano (AR 14-9 and AR 16-15). A breakdown of these standardized counts and weights at each site is visualized in Figure 7-1 to display the difference in these calculations between each stratigraphic level sampled. These graphs not only demonstrate the lack of material recovered from the volcanic ash layers of sediment, but also the intensity of use of plant material within the various culturally lived surfaces sampled.

Figure 7-1: *Standardized counts (quantity/L) and weights (g/L) of botanical remains recovered as well as the quantity of ceramic and lithic fragments per stratigraphic level at both La Chiripa and Sitio Bolívar. All levels at Sitio Bolívar date to the same time period of Late Arenal (Un. 53).*

At La Chiripa, Un. 61 represents the floor surface of the domestic structure (as determined by the compactness of the sediment during excavations), and the greater quantity of plant material recovered from this stratigraphic level corroborates this interpretation of the level as the floor of the structure. Un. 60 represents the build-up of material as people lived on that surface over time. At Sitio Bolívar, excavations revealed a compacted floor surface, numerous post holes, along with a higher concentration of artifacts such as lithic and ceramic fragments within Nv. 5 (See Figure 7-1). The depth of this level was so great (over 30cm in some sections) that it was split into arbitrary levels of 10 cm each. Figure 7-1 also demonstrates that at Sitio Bolívar, and to a lesser degree at La Chiripa, the stratigraphic distribution of artifacts such as ceramics and lithics is strikingly similar to the distribution of plant material. These stratigraphic distributions confirm the intensity in which each domestic structure was inhabited.

A comparison of the total standardized quantity of plant material and standardized weight of plant material recovered through the various forms of macrobotanical collection at La Chiripa and Sitio Bolívar can be seen in Figure 7-2, including analysis of both the heavy and light fraction that resulted from flotation in addition to the screened and manually picked samples. These graphs convey a few important points regarding the paleoethnobotanical data collected in this investigation. First, the interpretation of the paleoethnobotanical data will be biased towards a certain type of plant material depending on the type of data being compared. If comparison of the plant material focused upon the quantity or counts of items, the results would be skewed to elevate the presence of seeds and achenes within these domestic structures. For example, *Acmella* achenes sometimes would amount to hundreds of achenes with a single sample, whereas the wood charcoal from a guava tree may only amount to a couple fragments per sample. However, if the data is primarily compared using the weight of plant material recovered, this would skew interpretations to favor the heavier plant material such as all of the wood charcoal because the majority of the seeds and achenes recovered barely register any weight on a scale (even when measured to the nearest .0000g). Additionally, this paleoethnobotanical study is heavily dominated by charcoal analysis, so counts or weights may be too skewed by fragmentation effects (Newsom 2022). Some woods survive the burning process better than others, some are more prone to fragmentation, and wood can fragment during the recovery process (Arranz-Otaegui 2017, Asouti and Austin 2005). Therefore in order to fairly compare data that includes a variety of plant forms and has a significant amount of wood charcoal, ubiquity is the most appropriate measure. Ubiquity measures how present a taxon is within the sampled contexts and does not rely upon the counts or weight of plant material within a sample because these numbers are too influenced by the degree of preservation and differ greatly by plant taxa to be meaningful (Popper 1988). Charts depicting the distribution of plant taxa in this chapter will incorporate both ubiquity and standardized densities in order to present the data from each perspective. Asouti and Austin (2005) have demonstrated that charcoal fragment counts and weights are related parameters that have a tendency to covary, meaning higher weights tend to equate to higher specimen counts so each form of measurement is acceptable. Both parameters (weight and count) were recorded for all botanical specimens in this study whether they were seeds, achenes, fruit, geophytes, or wood charcoal so that the data is able to be compared to other studies and archaeological sites.

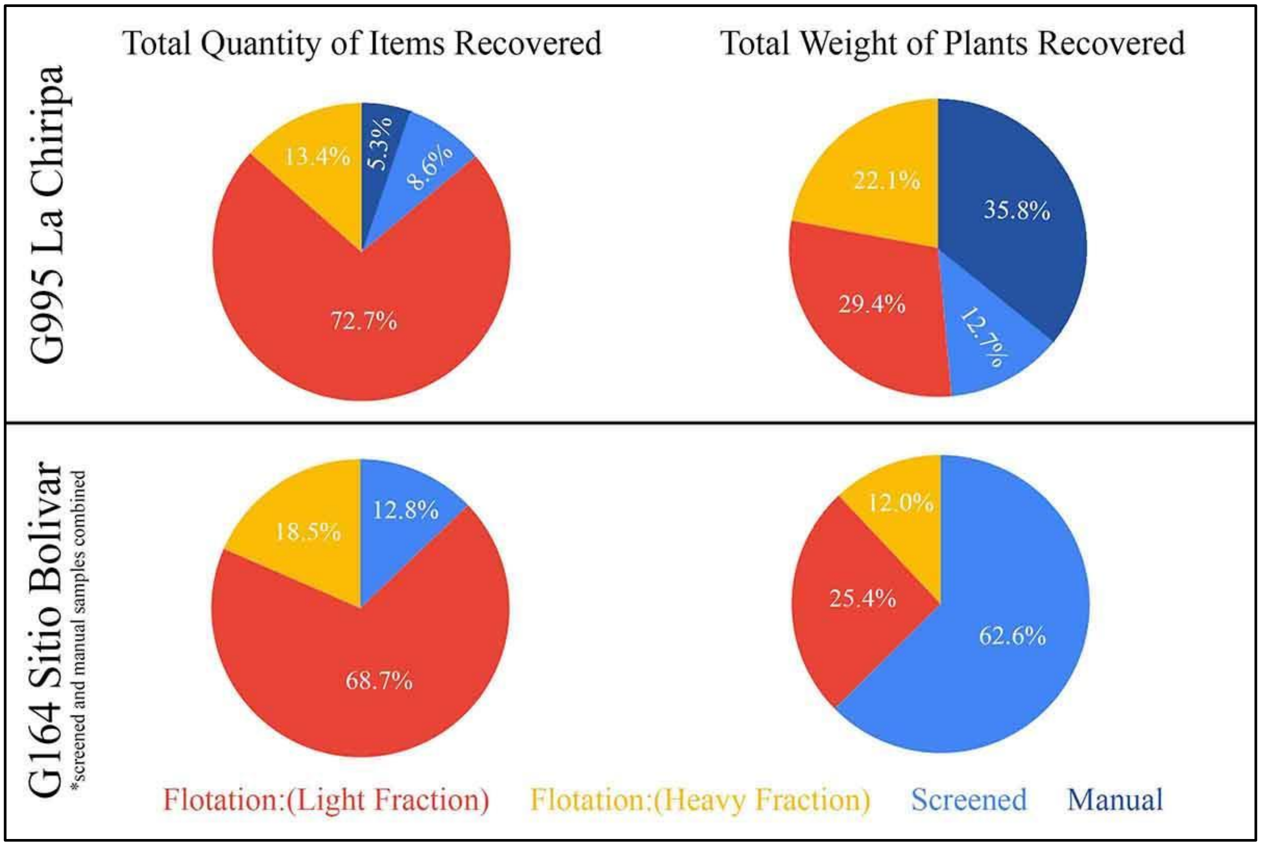


Figure 7-2: *A comparison of the total standardized quantity of plant material and standardized weight of plant material recovered through the various forms of macrobotanical collection at La Chiripa and Sitio Bolívar: flotation, screening using a geological sieve, and manual hand-picked samples. All sediment at Sitio Bolívar was passed through a geological sieve, so there are not any "manual" samples collected from that site.*

Another important takeaway when considering the paleoethnobotanical results from a broad perspective, is that all forms of collection contributed towards the results whether that was flotation, screening, or manual samples. This point is visible in both Figure 7-2 and 7-3. If any of these forms of collection were not implemented, this would have impacted the results and perhaps changed the overall presence of some of the plant taxa. For example, thirty-seven botanical genera at La Chiripa were only found within the heavy fraction flotation samples. If the heavy fraction samples were not analyzed (which is a semi-common practice if a project has a limited amount of time or funds to complete analysis), taxa such as *Ficus* (fig), *Dalbergia* (rosewood), and *Celtis* (hackberry) and would not have been known to have existed at La Chiripa. All of these taxa are well known in the Americas for various reasons. This result of all forms of collection contributing towards the final results could perhaps be a reflection of the quality of collection protocols. It is possible that the large amount of botanical genera that were uniquely identified within the heavy fraction is simply due to poor water circulation within the flotation tank that did not successfully agitate the water and sediment enough to allow the organic material to float to the surface and be collected within the light fraction. However, it is relevant to note that with clay rich soils as is the case at both of these archaeological sites, it is expected that some organic material may not be light enough to float if weighed down by heavy clay particles stuck to its surface. This issue can be overcome with approaches such as freezing the samples beforehand, soaking the samples in water for a longer period of time, or adding substances such as potassium hydroxide, hydrogen peroxide, sodium hexametaphosphate, or sodium carbonate to the water (Pearsall 2015, Tolar et al. 2010, Vandorpe and Jacomet 2007). Within this particular project, soil samples were soaked in water for an extra amount of time (ranging from 15 minutes to 1 hour) if the sediment was too compacted or clay rich, but it is possible that the addition of other methodologies could have further aided in the flotation of organic material. Tests of the recovery rate of these flotation tanks constructed specifically for these projects suggest that the machines functioned sufficiently well, as was discussed within Chapter 6.

Even the screened samples recovered plants unique to their sample type such as *Garcinia* (madroño) at La Chiripa or *Protium* (copal) at Sitio Bolívar. Investigations by Chiou et al. (2013) demonstrated the difference in results that can be obtained when dry sieving or floating sediment samples in the pursuit of macrobotanical remains. Therefore, I interpret these results as a testament to the importance of the incorporation of various collection methodologies. All of these forms of collection were principally implemented because of the lack of macrobotanical studies conducted in Central America and specifically within the Arenal region, therefore the best form of plant recovery at these archaeological sites had not yet been determined. Yet these results demonstrate that each form of collection contributed towards the whole. The light fraction flotation samples were more likely to recover small buoyant seeds that can't be readily detected with the naked eye, the heavy fraction was more likely to recover heavy pieces of carbon, and fragile plant fragments that would otherwise disintegrate when submerged in water were most likely to be recovered from a sample passed through a geological sieve.

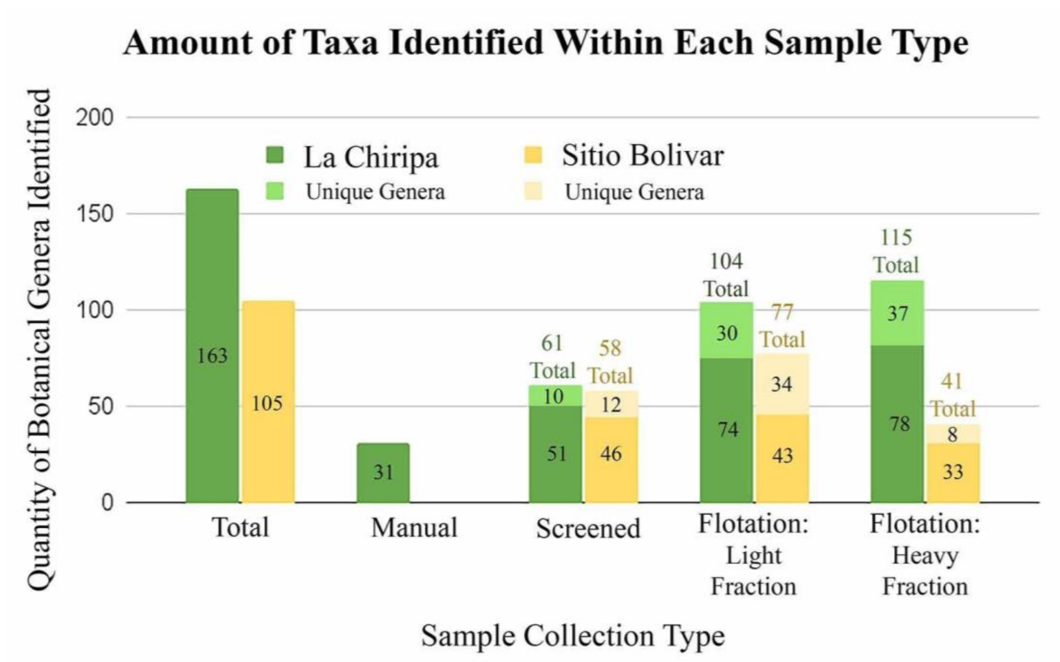


Figure 7-3: *A comparison of the plants identified within each type of macrobotanical sampling collection strategy to the level of genus at each archaeological site.*

7.2 Overview of the Identified Plant Remains

Between the two archaeological sites sampled within this investigation there is a high species richness (the number of taxa present) with a total of 194 distinct plants that have been identified from the macrobotanical remains. These plants come from a total of 74 different botanical families, 178 of which were identified to the genus level, and 59 to the species level. Compared to previous paleoethnobotanical investigations throughout the Americas, this forms an extraordinarily diverse assemblage that is a reflection of the tremendous diversity seen in Costa Rica today with approximately 11,500 known plant taxa (Kappelle 2016: 5, Obando 2002). Such a large amount of botanical taxa was not surprising from this paleoethnobotanical assemblage because modern investigations of the tropical forest structure within Costa Rica have recorded over 200 plant species from a single 1-ha plot (Lieberman et al. 1996). However, just because the environmental setting is incredibly diverse, it was not guaranteed that past human populations would have engaged with a similarly diverse set of plant taxa for their resource needs.

In terms of the condition of preservation, both sites are in actuality quite poorly preserved in terms of organic material. No faunal remains were recovered from either site, and these past villagers were likely not vegetarians. As discussed in the previous section, the standardized quantity of plant material recovered from the floor of the house structures was quite low at just 8.69 items per liter at La Chiripa and 17.21 items per liter at Sitio Bolívar, within samples that generally fell within the range of 5 to 10 liters in volume. Van der Veen and Fieller (1982) asserts that a minimum number of over 500 seeds should be identified within each sediment sample in order to be statistically relevant, and if that quantity is not achieved the sample volume should be increased. Thus, the preservation conditions at both sites did not aid in the recovery of such a diverse plant assemblage and a more robust sampling strategy with greater volumes of sediment sampled would have been ideal.

Ecologists have noted that as sample size increases, the number of taxa sampled increases as well (Lyman and Ames 2004). This increase will be rapid at first and then become more slow as the taxonomic richness approaches the true value for the assemblage at interest, with further samples becoming redundant and would not change the results (Lepofsky and Lertzman 2005: 176). While it is difficult to make comparisons to other studies because anthracological work in Central America is still rare, Scheel-Ybert's (2002:12-13) analyses of charcoal assemblages from Brazil offer another Neotropical perspective. In that assemblage, Scheel-Ybert found that the samples' concentrations were consistent with the extant vegetation after around 200 specimens were analyzed within a sample, concluding that 200 or 300 analyzed charcoal fragments is required to adequately represent extant flora per sample in Neotropical regions which are characterized by a high species richness. With this Scheel-Ybert's study in mind, it is already clear that these dataset of wood charcoal from Arenal, Costa Rica will not approach a consistent representation of extant vegetation because the average flotation sample only contained 15.14 charcoal fragments at La Chiripa and 20.12 fragments at Sitio Bolívar.

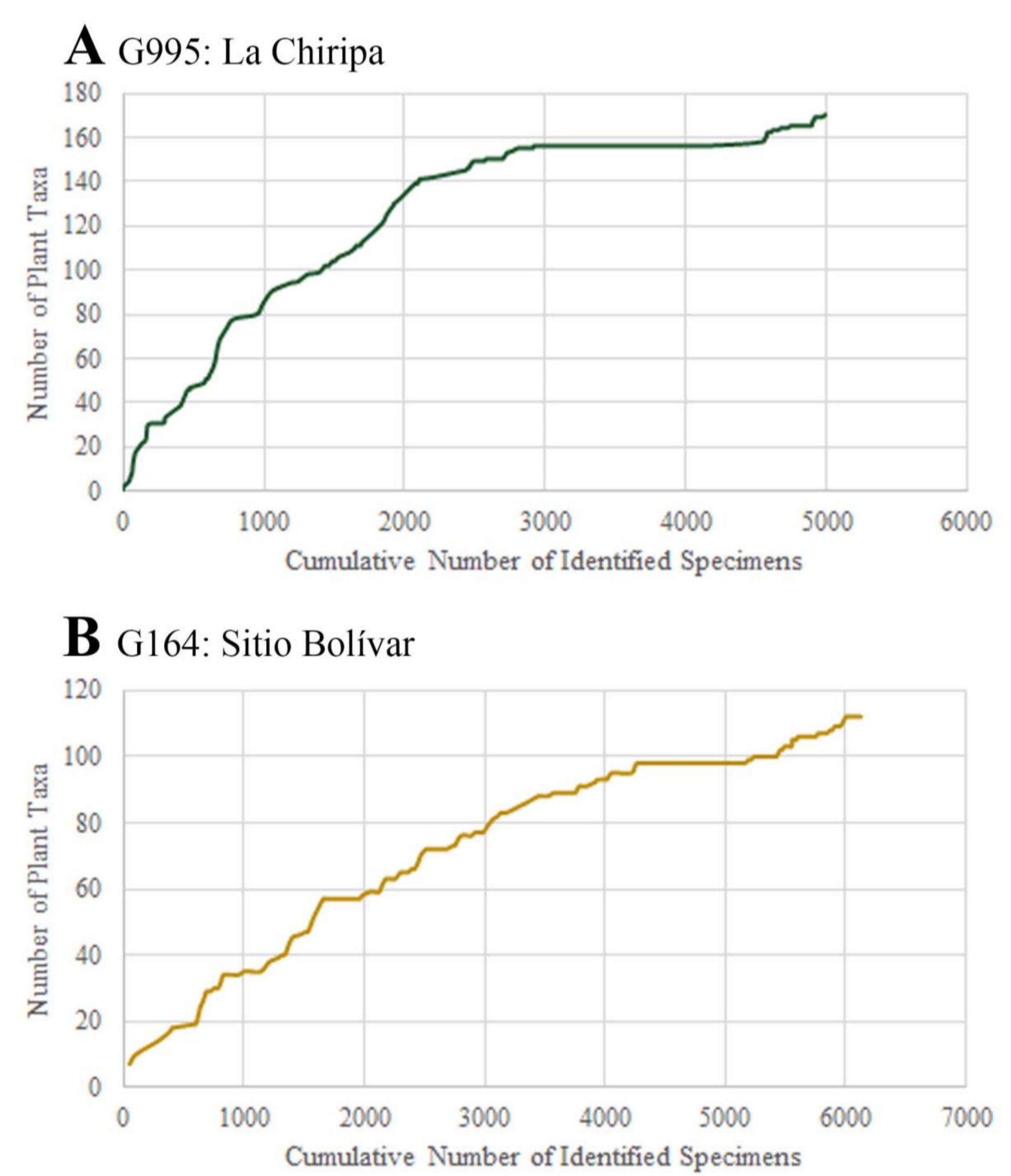


Figure 7-4: *Number of identified plant specimens by Number of identified plant taxa from the paleoethnobotanical assemblage from A) La Chiripa and B) Sitio Bolívar. These are taxon accumulation curves as described by Gotelli and Colwell (2001) and Lepofsky and Lirtzman (2005).*

Taxon accumulation curves from this study of the Arenal region which represent the total number of taxa obtained sequentially during the data collection process are shown in Figure 7-4 (modeled after Lepofsky and Lirtzman 2005). In Figure 7-4:A, which depicts the paleoethnobotanical remains at La Chiripa, it appears that the samples roughly level out or become more redundant after approximately 3000 plant specimens were identified to 156 different plant taxa, but the assemblage does keep increasing and ultimately ends at 170 identified plant taxa and 4993 identified plant specimens. Interestingly, Figure 7-4:B, which depicts the same concept but at Sitio Bolívar, never actually approaches an asymptote (the point where it begins to level as no new species are added) and displays a steady accumulation of identified plant taxa with the continual aggregation of identified plant material. What these two graphs demonstrate is that even though hundreds of plant taxa were identified at each site, neither of them have reached a true depiction of the diversity present at these archaeological sites because neither of the projections become truly level and stabilized. While it may seem absurd that these data set, which clearly depicts one of the most diverse plant assemblages identified from archaeological sites in Central America, is not complete, the taxon accumulation curves suggest that the sample size was not adequate and that further sampling or a greater volume of samples would provide a more accurate depiction of the plant diversity for this geographical region.

Nevertheless, the sampling strategy at both sites was aggressive in that it was systematic, various forms collection were utilized, and much greater volumes of material were collected compared to any previous investigation in the region. Another factor that resulted in this large paleoethnobotanical data set in terms of identification was the multiple forms of macrobotanical analysis employed. Preserved seeds, achenes, and fruits were extracted from the samples and identified with the use of a light stereoscope (7x-45x). Wood charcoal and parenchymatous fragments greater than 2mm in size were fractured into different anatomical views (transverse, tangential, and radial) and imaged using an Environment Scanning Electron Microscope (TM-1000) at magnifications ranging from 50x to 1000x for identification purposes. The identification of wood charcoal is still not common practice on archaeological projects in the Americas, although the practice is growing due to the greater accessibility of SEM instruments. As the results from La Chiripa and Sitio Bolívar demonstrate with over 100 genera of trees identified, the identification of wood charcoal greatly expanded our understanding of the plants these inhabitants interacted with in their daily lives. The trees represented by the wood charcoal were not just vegetation in the background of their lives but were resources that people interacted with daily for their various needs, as will be discussed further.

The dominance of woody taxa in the macrobotanical assemblage may be a result of preservation biases in this tropical setting where primarily carbonized plant materials are preserved in the archaeological record. Wood charcoal is one of the most common plant materials to be recovered at archaeological sites (Wright 2010), often due to its high probability of being exposed to fire when used as a source of fuel and its structurally durable composition. Plant resources used for other purposes are not necessarily given the opportunity to become charred since they may not serve a purpose that requires the use of fire. For example, 95 of the taxa identified from the macrobotanical remains between the two archaeological sites produce edible fruits, leaves, roots, or vegetative material. Of these taxa, 80 are represented in the form of wood charcoal fragments rather than by their edible plant parts such as fruits or leaves. What is notable here is that most of these edible plant parts are unlikely to be preserved because they are consumed in a way that does not ever expose the plant material to fire, thus minimizing the plant part's likelihood of becoming carbonized and remaining in the archaeological record. Analysis of wood charcoal at archaeological sites in the tropics helps to characterize a more complete depiction of plant resources in the past because the trees and shrubs in such areas can be utilized for a wide variety of needs in one's daily life.

7.3 Identified Plants From G-995 La Chiripa

From all of the sampled stratigraphic levels at La Chiripa a grand total of 170 distinct plants were identified from the macrobotanical remains, representing 65 botanical families and 156 genera. A comparison of these taxa to nearby forests will be discussed within the following Chapter 8. Appendix B contains the complete dataset and table of identified plant material within each sample at La Chiripa. Scanning Electron Micrographs and context maps for each identified woody taxon at La Chiripa are presented within Appendix F. Images of the seeds, achenes, and fruits and their respective context maps are presented both within Figure 7-5 and Appendix G. A complete table of the ubiquity measures for each identified taxa within each stratigraphic level at La Chiripa and their economic uses is presented within Appendix N. A general breakdown of the macrobotanical data for each stratigraphic level follows and a summary of general counts is presented within Table 7-2.

Table 7-2: *A summary of the botanical identification of the macrobotanical remains recovered from each stratigraphic level at La Chiripa, with the amount of taxa identified within each plant habit or form (trees, shrubs, cultivars, herbs, palms).*

Stratigraphic Level	**Time Period**	**Families**	**Genera**	**Trees**	**Shrubs**	**Cultivars**	**Herbs**	**Palms**
AR 16-15 (n=36, 358 L)	101 BCE - CE 101	13	13	7	3	0	4	0
UN 54 (n=46, 452 L)	372-176 BCE	37	54	37	12	1	7	1
AR 14-9 (n=12, 120 L)	1276-553 BCE	12	10	7	1	0	4	1
Post Holes and Hearth (n=29, 119.5 L)	1384-1108 BCE	48	94	78	20	3	3	1
UN 60 (n=46, 450 L)	1544-1426 BCE	50	103	80	21	3	4	1
UN 61 (n=69, 253 L)	1616-1442 BCE	43	55	46	8	1	7	1
Total		**65**	**157**	**107**	**39**	**3**	**13**	**1**

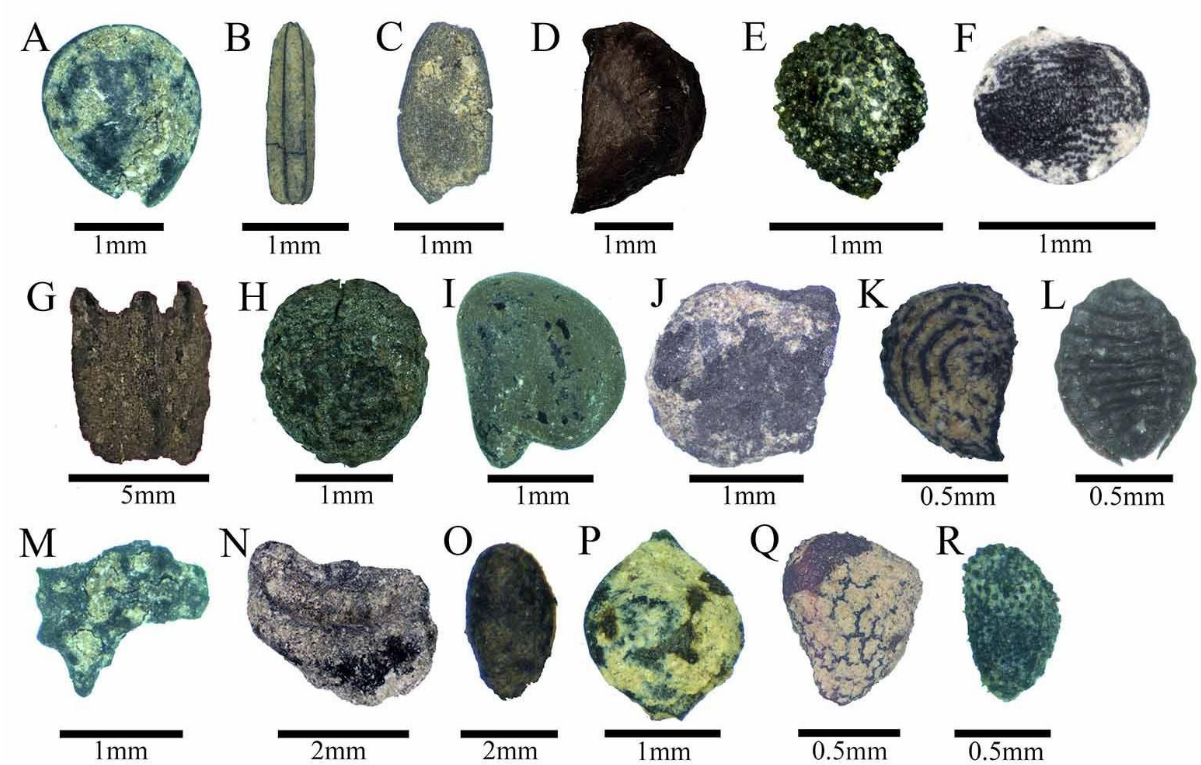


Figure 7-5: Photographs of identified seeds, achenes, and fruits recovered from G-995 La Chiripa including **A** *Chenopodium* sp. (quinoa) seed, **B** Asteraceae (sunflower family) achene, **C** *Acmella* sp. (paracress) achene, **D** *Melampodium* sp. (blackfoot daisy) achene, **E** *Drymaria cordata* (chickweed) seed, **F** Caryophyllaceae seed, **G** *Terminalia* sp. (guayabillo) fruit, **H** *Sapium* sp. (milktree) seed, **I** *Crotalaria* sp. (rattlepod) seed, **J** *Phaseolus* sp. (common bean) cotyledon fragment, **K** *Mollugo verticillata* L. (carpetweed) seed, **L** *Oxalis* sp. (wood sorrel) seed, **M** *Passiflora* sp. (passion flower) seed fragment, **N** *Zea mays* (maize) cupule, **O** Poaceae (grass) seed, **P** cf. *Rumex* sp. (sorrel) seed, **Q** *Nicotiana* sp. (tobacco)seed, **R** *Cecropia* sp. (trumpet tree) seed.

7.3.1 AR 16-15 (101 BCE - 101 CE)

The first stratigraphic level that was sampled for paleoethnobotanical remains at La Chiripa was AR 16-15, which represents two culturally sterile levels of sediment resulting from eruptions of Arenal Volcano circa 101 BCE and CE 101. These two volcanic levels were indistinguishable at La Chiripa and were therefore combined for sampling purposes. Samples were collected from this level in order to portray the plants present within a culturally sterile layer directly above the first cultural level at the site (Un. 54). This level could be interpreted to reveal the background taxa or plants near the site that were carbonized and distributed across the landscape during volcanic events. Alternatively, the taxa within this stratum could represent intrusive material that has been displaced out of its original context. However, there were not any indications of bioturbation within the sampled stratigraphic levels at La Chiripa, thus these plants are more likely representative of the landscape in the immediate surroundings of the site.

A total of 15 taxa were identified from AR 16-15 (see Table 7-3) and represent herbaceous plants, fruit trees, as well as other trees and shrubs. The majority of these taxa were recovered throughout the excavations within the different time periods and contexts sampled, with the exception of the shrubs *Amphipterygium* (cuachalalate) and *Warszewiczia* (wakamy) which only appear within this stratum. It is interesting to find such a culturally significant plant as *Theobroma* (cacao) within this level. Cacao was present in every single stratum that was sampled at La Chiripa, both cultural and sterile, indicating the tree's strong presence on the Arenal landscape through time and suggesting that past people encouraged and maintained its growth for many centuries.

Overall, the presence of plant material within the stratum AR 16-15 was sparse and concentrated towards the perimeters of the excavation (Figure 7-6). Since the project personnel occasionally encountered an excavation pit filled with water from a recent thunderstorm when beginning the day's work, it is likely that any buoyant material such as organic remains on the surface would become displaced, as appears to be the case with this stratigraphic unit's botanical results which concentrate where the water pooled.

Table 7-3: *Identified plant taxa from AR 16-15 at La Chiripa, from 36 sediment samples amounting to a total of 358 liters.*

AR 16-15 (101 BCE - 101 CE)			
Herbs	**Fruit Trees**	**Other Trees**	**Shrubs**
Asteraceae	*Brosimum* sp.	*Aspidosperma* cf. *australe*	*Amphipterygium* sp.
Crotalaria sp.	*Terminalia* sp.	*Cornus* cf. *florida*	*Warszewiczia* sp.
Drymaria cordata	*Theobroma* sp.	*Escallonia* sp.	cf. *Viburnum sp.*
Poaceae	*Trophis* sp.	*Zanthoxylum* sp.	

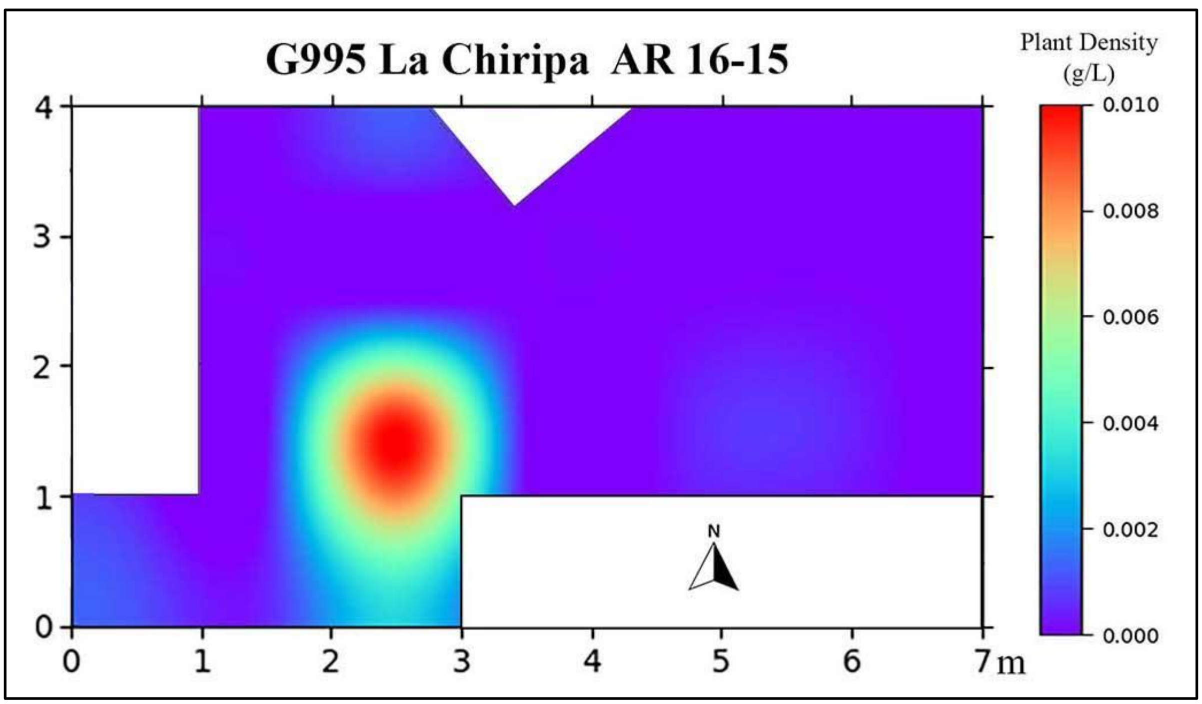


Figure 7-6: *Distribution of plant material recovered from AR 16-15 at La Chiripa represented*

through plant densities (grams per liter).

7.3.2 Un. 54 (372 and 176 BCE)

The first cultural level that was sampled for paleoethnobotanical remains was Un. 54, which dates to between 372 and 176 BCE. This stratigraphic level did not contain any features, but excavations did recover numerous artifacts including 11 ceramic sherds, 6 boiling stone fragments, and a natural stone shaped for use as an axe. Botanically, this level contained 59 plant taxa overall, representing 37 families and 54 genera which resulted from 46 sediment samples amounting to a total of 452 liters (Table 7-4). The density of the plant remains within Un. 54 are not heavily concentrated in any specific location (Figure 7-7) and do not reveal any features or activity areas, corroborating the excavation results of this level. There is a higher concentration of plant material in the south western coroner, which as mentioned earlier, may just be a byproduct of the heavy rains which redistribute buoyant material. Even though there are not any visible cultural features present and we cannot describe whether or not this space had any structures nearby, this level begins to highlight the strong presence of edible plant products featured at this La Chiripa. The macrobotanical assemblage recovered from Un. 54 exhibits a variety of herbaceous plants such as chickweed (*Drymaria cordata* [L.] Willd. ex Schult.), carpetweed (*Mollugo verticillata* L.), quinoa (*Chenopodium*), passion fruit (*Passiflora*), and wood sorrel (*Oxalis*). A single maize cupule and two unidentified geophyte fragments were recovered from Un. 54, which indicates that perhaps some form of food processing or even agricultural fields existed nearby. Additionally, 23 different trees and shrubs that bear edible fruits such as avocado, mamey, cacao, and ramon were recovered from this level in the form of wood charcoal. The presence of the remains of these fruit trees in a space without any cultural features indicates either that people were living in close proximity to this space or that people were managing the arboreal resources in this area enough to maintain and encourage the growth of useful fruit trees.

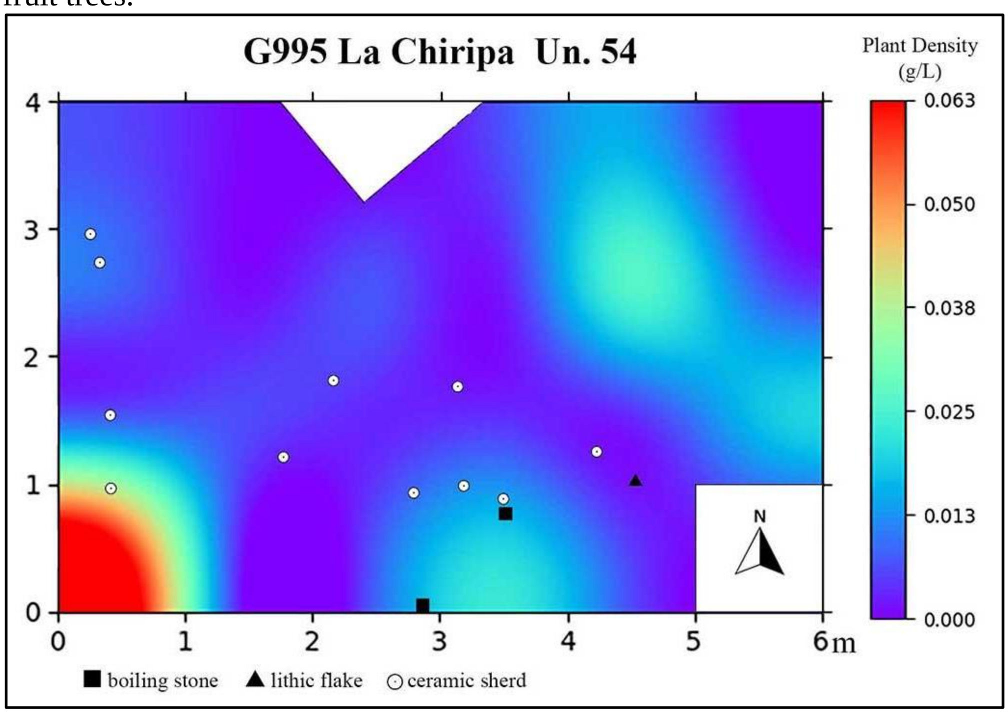


Figure 7-7: *Distribution of plant material recovered from Un. 54 at La Chiripa represented*

through plant densities (grams per liter). Symbols note the boiling stones, lithic flakes, and ceramic sherds also found within this horizontal space.

Table 7-4: *Identified plant taxa from Un. 54 at La Chiripa*, which resulted from 46 sediment samples amounting to a total of 452 liters that were either screened or floated.

Un. 54 (372-176 BCE)			
Herbs	**Fruit Trees and Shrubs**	**Other Trees**	**Shrubs**
Asteraceae	*Andira inermis*	*Acacia* sp.	*Calliandra* sp.
Chenopodium sp.	*Brosimum* sp.	*Aspidosperma* spp.	*Capparis* sp.
Drymaria cordata	*Casearia* sp.	*Bixa* cf. *orellana*	*Cosmibuena* sp.
Mollugo verticillata	*Cecropia* sp.	*Clidemia* sp.	*Palicourea* sp.
Oxalis sp.	*Cheiloclinium cognatum*	*Cornus* sp.	*Schinus* cf. *terebinthifolius*
Passiflora sp.	*Coccoloba* sp.	*Cupania* sp.	*Wimmeria* sp.
Poaceae	*Crescentia alata*	*Dalbergia* sp.	*Zygia* sp.
	Garcinia sp.	*Dendropanax* sp.	
Cultivar	*Hamelia* sp.	*Escallonia* sp.	**Palms**
Zea mays	*Hedyosmum* sp.	*Hieronyma alchorneoides*	Arecaceae
	Inga sp.	*Jacaranda* cf. *copaia*	
Root Crops	*Maclura tinctoria*	*Lonchocarpus* sp.	
unidentified geophytes	*Muntingia calabura*	*Nectandra/Ocotea*	
	Persea sp.	Rhamnaceae	
	Pourouma sp.	*Sapium* sp.	
	Pouteria sp.	*Sloanea* sp.	
	Psychotria sp.	*Swietenia* sp.	
	Randia sp.	*Tabebuia* sp.	
	Spondias cf. *mombin*	*Trichilia* sp.	
	Terminalia sp.	*Zanthoxylum* sp.	
	Theobroma sp.		
	Trophis sp.		

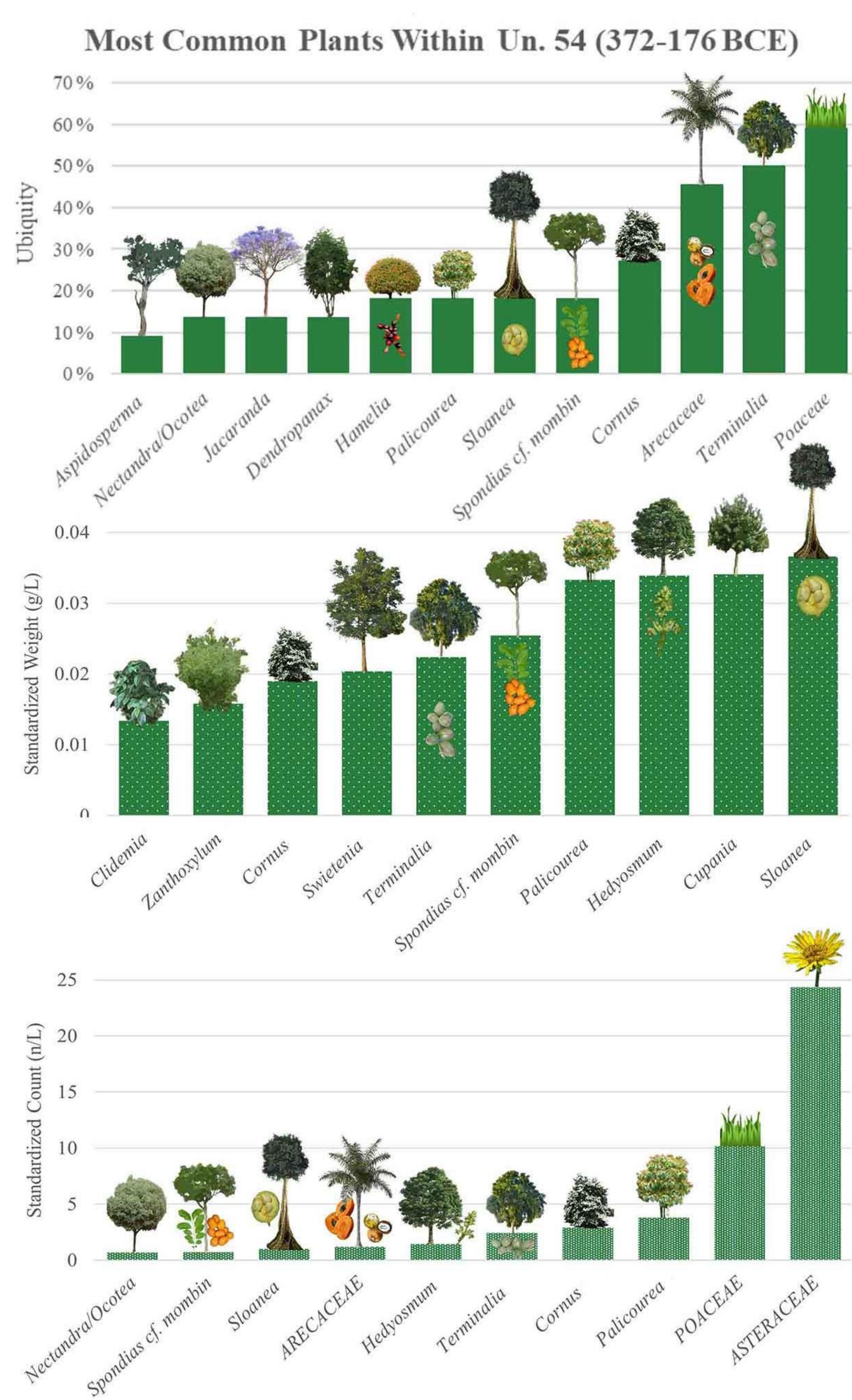


Figure 7-8: *Most common plant taxa recovered from Un. 54 at La Chiripa in terms of ubiquity, weight , and count. If the plant produces edible parts it is pictured within its bar.*

Cultural features are found both above (the Silencio phase footpath) and below (the Tronadora phase structure) this level stratigraphically, suggesting that people continually occupied the immediate vicinity of the La Chiripa site for thousands of years so it is not surprising to find many of the same plant taxa within this stratum as the others. The majority of the plant taxa of Un. 54 (90%) were also identified from other cultural stratum at this site, and their ubiquity measures within this stratum (Figure 7-8) follow closely with the same measures throughout time at La Chiripa. Thus, for the most part this stratum's botanical assemblage portrays a continuation of the same plant use regime for the region for millennia. If the Un. 54 plant assemblage is considered using standardized weight or count measures it does differ slightly from that of ubiquity, elevating the presence of trees such as *Hedyosmum* (sauquillo) and *Cupania* (candelillo). Plants unique to the Un. 54 stratum include the the *Lonchocarpus* (chaperno) tree and shrubs *Maclura tinctoria* (L.) D. Don ex G. Don (moro), *Randia* (rosetillo), *Cosmibuena* (tabaquillo), and *Zygia* (guabito de río). *Zygia* of this region grow almost exclusively along streams (as the common name guabito de río suggests), which is consistent with this space which is near multiple springs and the Río Chiquito.

7.3.3 AR 14-9 (1276-553 BCE)

The third stratigraphic level that was sampled for paleoethnobotanical remains at La Chiripa was AR 14-9, which represents a series of culturally sterile levels of sediment resulting from six major eruptions of Arenal Volcano from 1276 through 553 BCE. This entire series of volcanic levels were indistinguishable because each individual ash layer is quite thin at this distance from the volcano. Therefore, the sediment resulting from all of these eruptions was combined into one for sampling purposes. Due to time constraints, a limited amount of samples were taken from this culturally sterile layer (from every fourth square-meter quadrant). Paleoethnobotanical samples were collected from this level in order to portray the plants present within the culturally sterile layer in between the cultural layers (Un. 54 and Un. 60), just as was done with the volcanic level AR 16-15. The AR 14-9 stratum likely represents the vegetation surrounding the site that were carbonized and distributed across the landscape during volcanic events. The density of plant material within this stratum was quite low compared to any of the cultural levels, ranging from .0004 to .0031 grams per liter in each sampled context, and the distribution of the plant taxa across the stratum simply follows where sampling occurred (Figure 7-9).

A total of 13 taxa were identified from AR 14-9 (see Table 7-5) and represent herbaceous plants, palms, fruit trees, as well as other trees and shrubs. Almost all of these taxa were recovered throughout the excavations within the different time periods and contexts sampled, many of them were also found within the other culturally sterile level presented earlier, AR 16-15. *Adelia* (bagre), a small tree or shrub without any known cultural uses, is the only plant found exclusively within the AR-14-9 level. When the overall site ubiquity of each of these taxa is considered, 9 of these plants are within the top 12 most ubiquitous plants at La Chiripa. Thus, the botanical identifications from this level are a strong representation of the plant life surrounding the site overall throughout time. Half of these taxa were also present within the assemblage from the other sampled layer of volcanic ash (AR 16-15), providing further evidence that these plants had a strong presence surrounding the site.

__Table 7-5:__ Identified plant taxa from AR 14-9 at La Chiripa, resulting from 12 sediment samples and a total of 120 liters.

AR 14-9 (1276-553 BCE)			
Herbs	**Fruit Trees**	**Other Trees**	**Palms**
Acmella sp.	*Terminalia sp.*	*Adelia* sp.	Arecaceae
Asteraceae	*Theobroma* sp.	*Aspidosperma* sp.	
Poaceae		*Clidemia* sp.	
cf. *Rumex* sp.		*Cornus* sp.	
		Margaritaria nobilis	
		cf. *Sloanea* sp.	

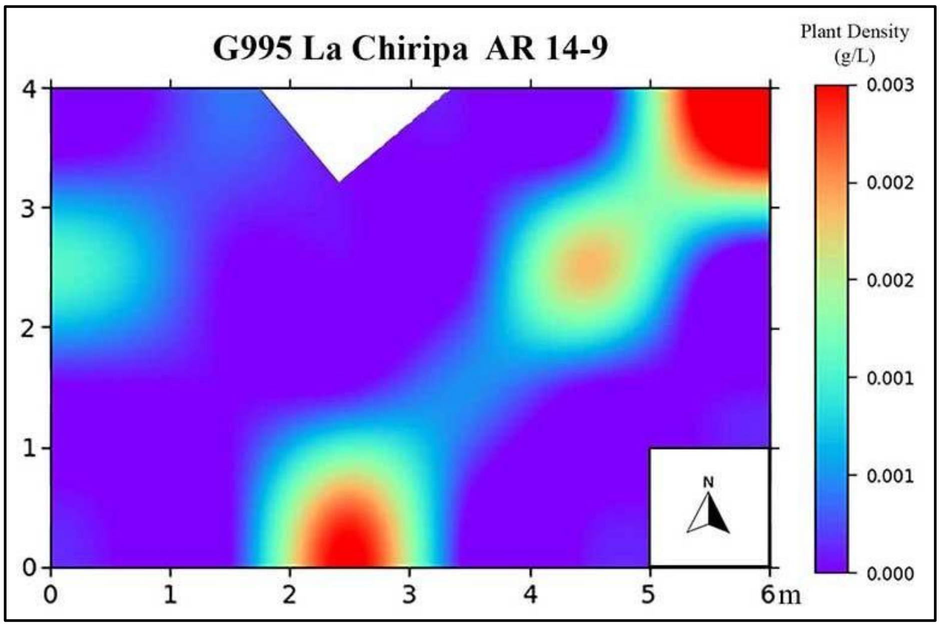


***Figure 7-9:** Distribution of plant material recovered from AR 14-9 at La Chiripa represented through plant densities (grams per liter). Paleoethnobotanical samples were only collected from every 4th sq. meter due to time constraints and consideration that this was not a level bearing cultural material.*

7.3.5 Un. 60 (1544-1426 BCE)

Below the culturally sterile layer of AR 14-9 and directly above the domestic structure was a layer of sediment (Un. 60) that dates to a similar time period as the floor of the structure (see Appendix J). This level is interpreted as accumulation of material over time as the house structure was inhabited, which according to the radiocarbon dates could have been an entire century. Paleoethnobotanical samples within Un. 60 revealed the identification of the most plant taxa compared to any other stratigraphic level at La Chiripa with 50 botanical families and 103 genera (see Table 7-6 for a full list of taxa). This is nearly double the amount of botanical genera identified from the floor of the structure itself. The Un. 60 stratum also contained the highest amount of artifacts at La Chiripa, with 83 boiling stones, 8 percussion flakes, and a large basalt flake core. It is interesting that even though the standard density of plant remains within Un. 60 was significantly lower than Un. 61 both in terms of quantity (3.28 versus 8.69) and weight (0.02g versus 0.04g), yet the identified taxa is substantially higher in Un. 60 than Un. 61 (Figure 7-1 and Table 7-2). This demonstrates just how diverse the plant assemblage was within the accumulated material from people living within this space compared to that of what was embedded within the floor of the structure.

Similar to every other level, the assemblage from Un. 60 is dominated by trees (80 genera) and shrubs (21 genera) with some cultivars (maize, beans, and manioc) and herbaceous plants (wood sorrel, *Acmella*, other asters, and grasses) as well. A great portion of these taxa produce edible plant parts such as fruits, seeds, and leaves. The most ubiquitous taxa within this stratum (Figure 7-10) tell a story of people who enjoyed the many fruit trees within their tropical forests such as guava, avocado, and cacao and managed their landscape to encourage such resources. Further details of the edible plant products will be discussed within Chapter 9.

Table 7-6: *Identified plant taxa from Un. 60 at La Chiripa, the lived surface above the floor of the domestic structure, resulting from 46 sediment samples amounting to 450 liters.*

Un. 60 (1544-1426 BCE)			
Herbs	**Fruit Shrubs**	**Fruit Trees**	**Other Trees**
Acmella sp.	*Ardisia* sp.	*Anacardium excelsum*	*Abarema* sp.
Asteraceae	*Gaultheria* sp.	*Andira inermis*	*Acacia* sp.
Oxalis sp.	*Herrania* sp.	*Annona* sp.	*Allophylus* sp.
Poaceae	*Morella* sp.	*Bellucia* sp.	*Aspidosperma* cf. *excelsum*
	Salacia sp.	*Bourreria* sp.	*Aspidosperma* cf. *megalocarpon*
Cultivars		*Brosimum* sp.	*Astronium graveolens*
Manihot sp.	**Other Shrubs**	*Bunchosia* sp.	*Calycophyllum candidissimum*
Phaseolus sp.	*Acalypha* sp.	*Campnosperma panamense*	*Carapa* sp.
Zea mays	*Bixa* cf. *orellana*	*Casearia* sp.	*Cassia* sp.
unidentified geophytes	*Calliandra* sp.	*Cecropia* cf. *peltata*	*Cedrela* sp.
	Capparis sp.	*Cheiloclinium cognatum*	*Copaifera* sp.
	Clidemia sp.	*Coccoloba* sp.	*Cornus* cf. *florida*
Palms	*Gliricidia sepium*	cf. *Crescentia alata*	*Cornus* cf. *peruviana*
Arecaceae	*Heliocarpus* sp.	cf. *Curatella americana*	*Coutarea/Exostema*
	Macrocnemum roseum	*Diospyros* sp.	*Cupania* sp.
	Palicourea sp.	*Eugenia* sp.	*Dalbergia* sp.
	Ryania speciosa	cf. *Ficus* sp.	*Dendropanax* sp.

	Other Shrubs (continued)	**Fruit Trees (continued)**	**Other Trees (continued)**
	Schinus sp.	*Garcinia macrophylla*	*Drymaria cordata*
	Sebastiania sp.	cf. *Genipa americana*	*Enterolobium cyclocarpum*
	Tecoma stans	*Hedyosmum* sp.	*Erythrochiton* sp.
	Wimmeria sp.	*Inga* sp.	*Faramea* sp.
		Miconia sp.	*Hasseltia* sp.
		Ouratea sp.	*Hieronyma alchorneoides*
		Parkinsonia aculeata	*Jacaranda* sp.
		Parmentiera sp.	*Licania* sp.
		Persea sp.	*Magnolia* sp.
		Pouteria sp.	*Margaritaria nobilis*
		Psidium sp.	*Melampodium* sp.
		Psychotria sp.	*Meliosma* sp.
		Quararibea sp.	*Nectandra/Ocotea*
		Sideroxylon sp.	*Perrottetia* sp.
		Simaba cf. *cedron*	*Platymiscium* sp.
		Simarouba amara	cf. *Sapindus saponaria*
		Spondias cf. *mombin*	*Sapium* sp.
		Tabernaemontana sp.	*Sloanea* sp.
		Tapirira sp.	*Swietenia humilis*
		Terminalia cf. *amazonia*	*Tabebuia* sp.
		Theobroma sp.	*Trema* sp.
		Trophis sp.	*Trichilia* sp.
			Viburnum sp.
			Weinmannia sp.
			Zanthoxylum sp.

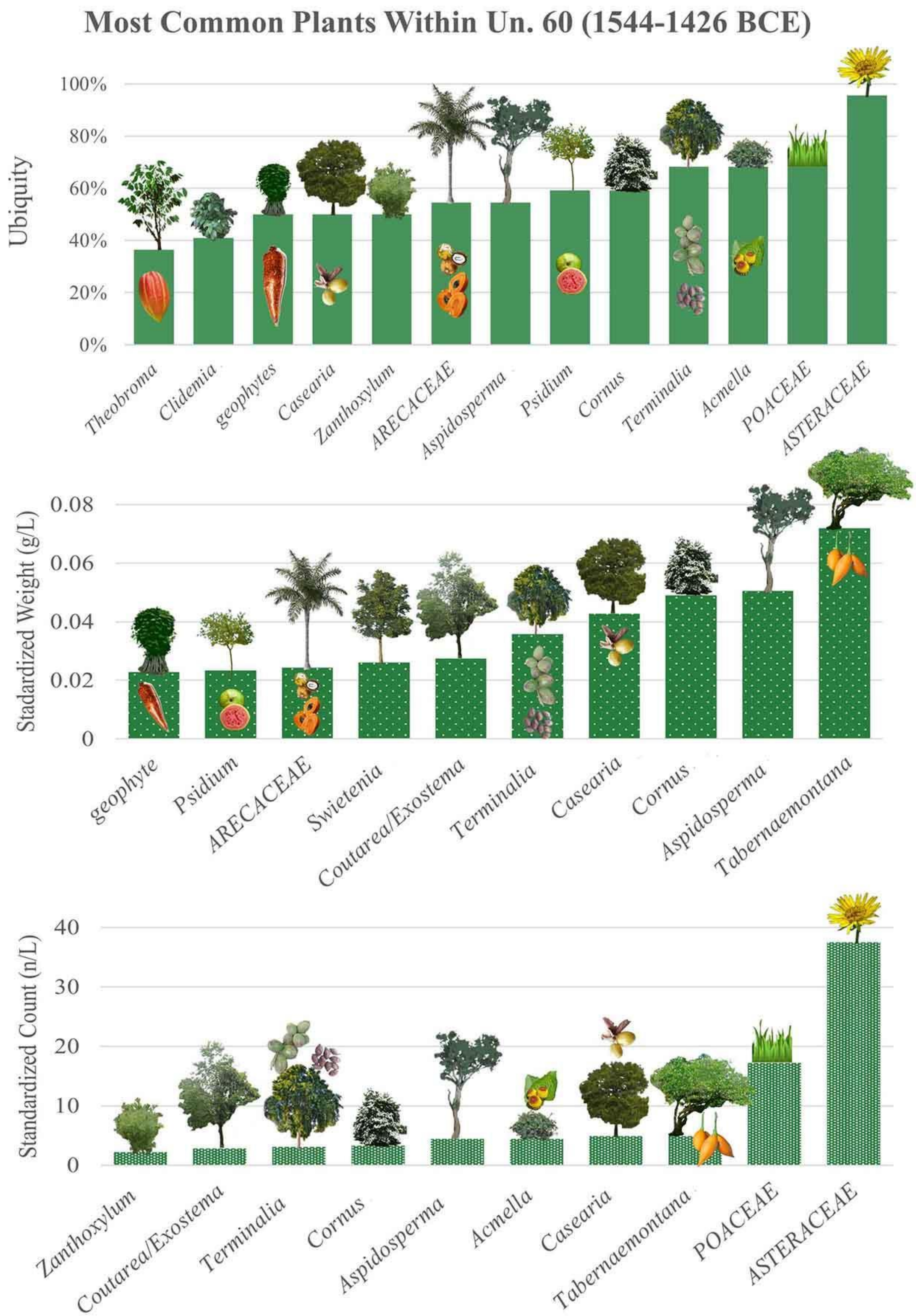


Figure 7-10: *The most common plant taxa recovered from Un. 60 at La Chiripa in terms of ubiquity, weight, and count. If the plant produces an edible part it is pictured within its bar.*

The distribution of plant material throughout this stratum when measured as densities (grams per liter) is concentrated more towards the southwestern portion of the excavation (Figure 7-11). When overlaid with the placement of the domestic structure, which is situated directly below, these concentrations are mostly located exterior to the structure. This aligns well with Barba's (Barba, personal communication) findings of chemical residues from the floor of the structure (see Figures 9-6 and 9-7), which suggested that refuse was deposited directly outside to the southwest of the house. Interestingly, the density of plant material within the only cultural feature recorded for this level (Rasgo 1, Figure 7-12) is low and is surrounded by high density values. This feature was a cluster of boiling stones and a large flake core of basalt (Sheets, personal communication). The lack of plant material within this feature shows that this may have simply been a storage space where the stones were deposited rather than used to cook food.

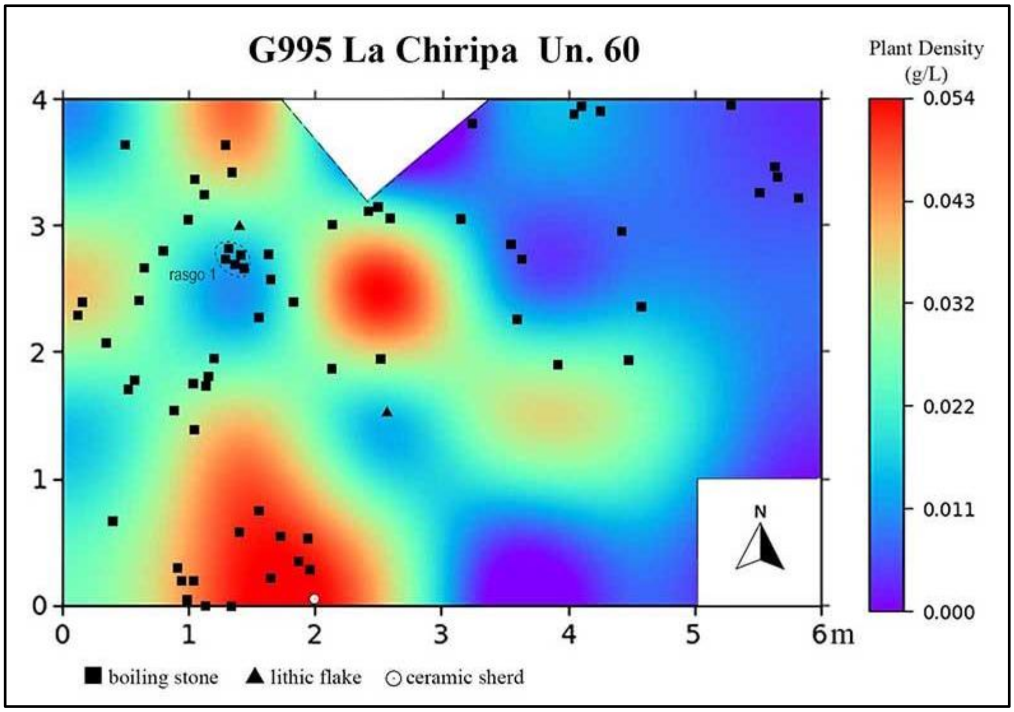


Figure 7-11: *Distribution of plant material recovered from Un. 60 at La Chiripa represented through plant densities (grams per liter).*

Figure 7-12: *Boiling stones and a basalt core from Rasgo 1 (Photograph by Payson Sheets).*

7.3.6 Un. 61 (1616-1442 BCE) - The House Structure

The floor of the domestic structure was formed out of compacted earth and contained lower amounts of plants compared to the level directly above (Un. 60), both in terms of plant densities (Figure 7-13) and the amount of identified taxonomic groups (Table 7-7). This could suggest that the floor of the structure was swept regularly, resulting in less material becoming entrenched in the ground surface. Nevertheless, identification of the macrobotanical remains from Un. 61 yielded 43 botanical families and 55 genera. As is consistent throughout the stratigraphic levels at La Chiripa, Un. 61 is heavily dominated by arboreal taxa and has a scattering of herbaceous plants and geophytes.

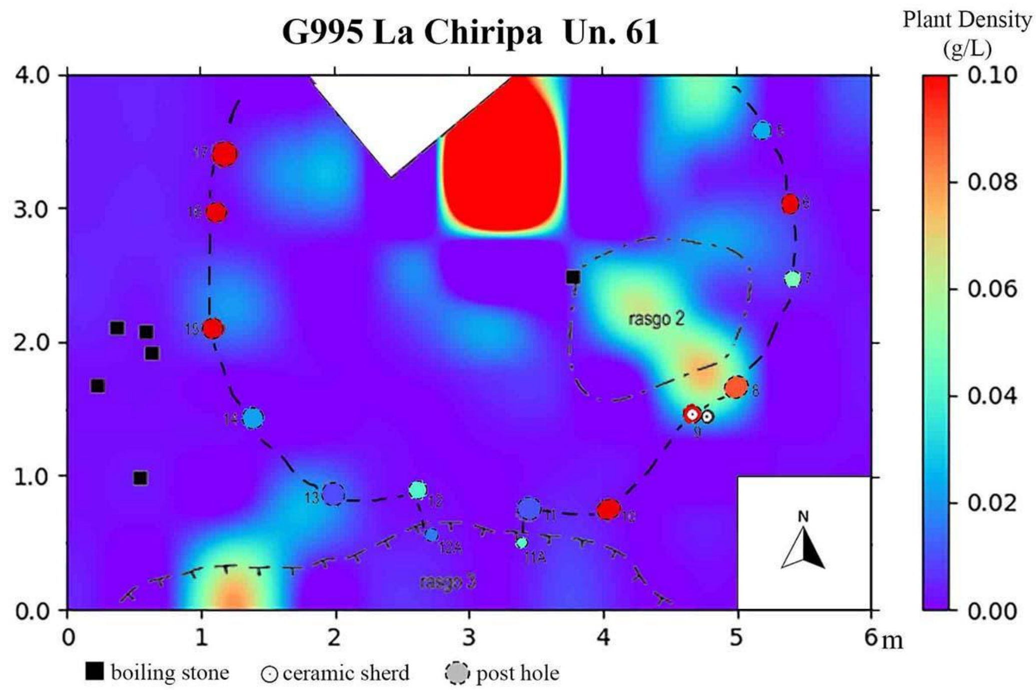


Figure 7-13: *Distribution of plant material recovered from Un. 61 at La Chiripa represented through plant densities (grams per liter). The outline of the hearth is rasgo 2, and the sloped entrance of the structure is rasgo 3. Since post holes were also sampled for paleoethnobotanical material, their respective plant densities are also portrayed.*

The distribution of plant material along the floor of the house structure represented through densities (grams per liter) reveals a few activity areas (Figure 7-13). Besides the hearth, which was already identified during the excavations, there are areas where people deposited their refuse: one location was in the north central area within the structure and the other is in the southwestern area, just outside of the house. The perimeter of the structure has lower density values and so does the area immediately outside of the entrance, suggesting that the ground surface and entryway were cleaned regularly to remove food or other materials that had fallen to the floor. Sweeping is an essential domestic activity in other areas of Central America; both the Maya and Aztec viewed regular sweeping of homes and other structures as crucial towards the maintenance of purity and health (Burkhart 1989:117, Knowlton 2016:325). The majority of the post holes were filled with a high density of carbonized plant material (Figure 7-13), but it is unlikely that any of the charcoal found inside of the post holes represent the wood species of the pole that once stood there, especially since 62 taxa were found within the post hole contexts. The average post hole yielded botanical remains from 8.7 different taxa and post holes 15 and 17 each included plant material from 23 different taxa.

Table 7-7: *Identified plant taxa from Un. 61 at La Chiripa, the floor of the domestic structure, resulting from 98 sediment samples amounting to a toal of 372.5 liters. This list does not include plant remains found within the hearth feature (rasgo 2) and post holes because those contexts dated to a more recent time period than the rest of the structure.*

Un. 61 (1616-1442 BCE)				
Herbs	**Fruit Shrubs**	**Fruit Trees**	**Other Trees**	**Other Trees (continued)**
Acmella sp.	cf. *Byrsonima* sp.	*Anacardium occidentale*	*Acacia* sp.	*Hasseltia* sp.
Asteraceae	*Gaultheria* sp.	*Bellucia* sp.	*Apeiba* sp.	*Jacaranda* cf. *caucana*
Mollugo verticillata	*Thevetia* sp.	*Bourreria* sp.	*Aspidosperma* cf. *excelsum*	*Margaritaria nobilis*
Nicotiana sp.		*Brosimum* sp.	*Avicennia* sp.	*Perrottetia* sp.
cf. *Rumex* sp.		*Cecropia* sp.	*Cavanillesia platanifolia*	*Platymiscium* sp.
Poaceae	**Other Shrubs**	*Coccoloba* sp.	*Ceiba* sp.	*Sloanea* sp.
	Capparis sp.	*Eugenia* sp.	*Clidemia* sp.	*Swietenia* sp.
	Heisteria sp.	cf. *Genipa americana*	*Cornus* cf. *disciflora*	cf. *Tachigali* sp.
Cultivars	*Palicourea* sp.	*Hedyosmum* sp.	*Coussarea* sp.	*Trichilia* sp.
unidentified geophyte		*Inga* sp.	*Coutarea/Exostema*	*Vochysia* sp.
		Manilkara sp.	cf. *Croton* sp.	*Weinmannia* sp.
		Parkinsonia aculeata	*Dendropanax* sp.	*Zanthoxylum* sp.
Palms		*Poulsenia armata*	*Escallonia* sp.	
Arecaceae		*Prunus* sp.	*Faramea* sp.	
		Psidium sp.		
		Simarouba amara		
		Simarouba glauca		
		Spondias cf. *mombin*		
		Symphonia globulifera		
		Tabernaemontana sp.		
		Theobroma sp.		

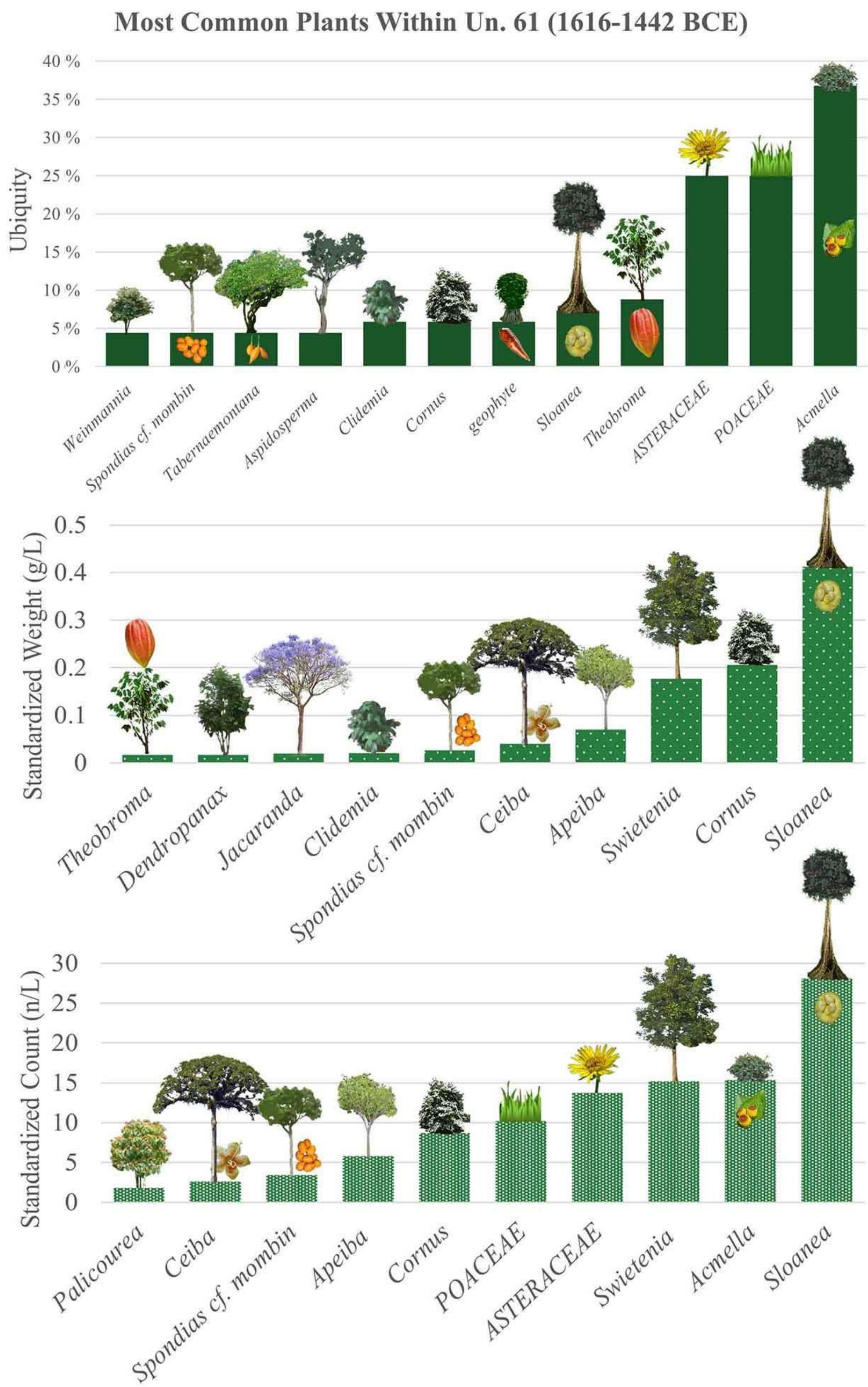


Figure 7-14: *The most common plant taxa recovered from Un. 61 at La Chiripa in terms of ubiquity, weight, and count. If the plant produces an edible part it is pictured within its bar.*

Ubiquity measures of Un. 61 actually reveal that this stratum was not as heavily dominated by fruit trees compared to the other stratigraphic levels and most plant ubiquities were low, with a presence of less than 10% (Figure 7-14). For example, within the stratum directly above (Un. 60), many arboreal taxa exhibited ubiquity measures greater than 40% (Figure 7-10). The most ubiquitous macrobotanical remains of this level were not wood charcoal, rather they were primarily achenes from the sunflower family (Asteraceae, ubiquity 37.8%), wild grass seeds (Poaceae, ubiquity 33.1%), and paracress achenes (*Acmella*, ubiquity 31.4%). The various herbs and weedy taxon found in this level are all common to disturbed areas and fields and could have been incorporated into meals as a flavoring.

Two carbonized tobacco (*Nicotiana* sp.) seeds were recovered immediately to the west of the hearth feature. Nicotiana is easily identifiable at the genus level, but species identification is difficult due to overlapping morphological attributes of the 95 known species (Adams and Toll 2000, Winter 2000). Because of this, it is unclear if the tobacco seeds at La Chiripa come from a domesticated or wild variety of tobacco. People have used tobacco plants almost exclusively as a psychoactive substance through the nicotine produced in the leaves (Tso and Jeffrey 1956), both wild and domesticated vanities (Rafferty 2021: 148-150). Evidence for tobacco in the Americas dates to 12,000 years ago, with numerous seeds found at a hunter-gatherer camp in the Great Salt Lake Desert (Duke et al. 2022). Tobacco seeds have also been recovered from Formative period contexts in northwestern Honduras (Morell-Hart 2011, 2022). Central American populations would have smoked tobacco and incorporated the importance of its smoke into religious, divination, and medical practices (Winter 2000). The plant could have been cultivated nearby since it tolerates most types of soil, but it wouldn't have appreciated the excessive rainfall that can be typical of the Arenal region. Seeds are the plant part of tobacco that are most often preserved in the archaeobotanical record but they do not contain nicotine. The recovery of preserved seeds implies that its use was associated with the plant's leaves and flowering stems, the parts with the intoxicant effect.

Paleoethnobotanical samples collected from a few contexts, specifically the hearth and post holes, within Un. 61 at La Chiripa collectively date to the same time period as each other (1384-1108 BCE), which is much more recent in time compared to the floor of the structure (1616-1442 BCE) (see Appendix J for the results of the AMS radiocarbon dates). Un. 60, which is directly above the floor of the structure, is likely the accumulation of material as the house was occupied over time; this level dates to 1544 to 1426 BCE. Thus, the hearth and post holes represent a time in which the house structure was abandoned and the holes left from the posts of the structure eventually filled in with sediment.

The hearth is placed centrally within the structure, which is not commonly found archaeologically within this region. Rather, in this region hearths tend to be exterior to homes (Bradley 1994a, 1994b, Hoopes and Chenault 1994), likely because dwellings were constructed out of flammable, organic material. For this reason, it is not surprising that the hearth actually dates to a more recent time period compared to the house structure. The hearth could be the remnants of an event where people paid tribute to and thought back to a time when their ancestors lived in this space after it was no longer inhabited. When grouped together, the hearth and post holes and their collective time period yielded botanical material from 48 families and 94 genera. The findings between the features are similar (Tables 7-8 and 7-9, Figures 7-15, 7-16, and 7-17), with 75 taxa found within the hearth and 62 taxa distributed between the 15 sampled post holes.

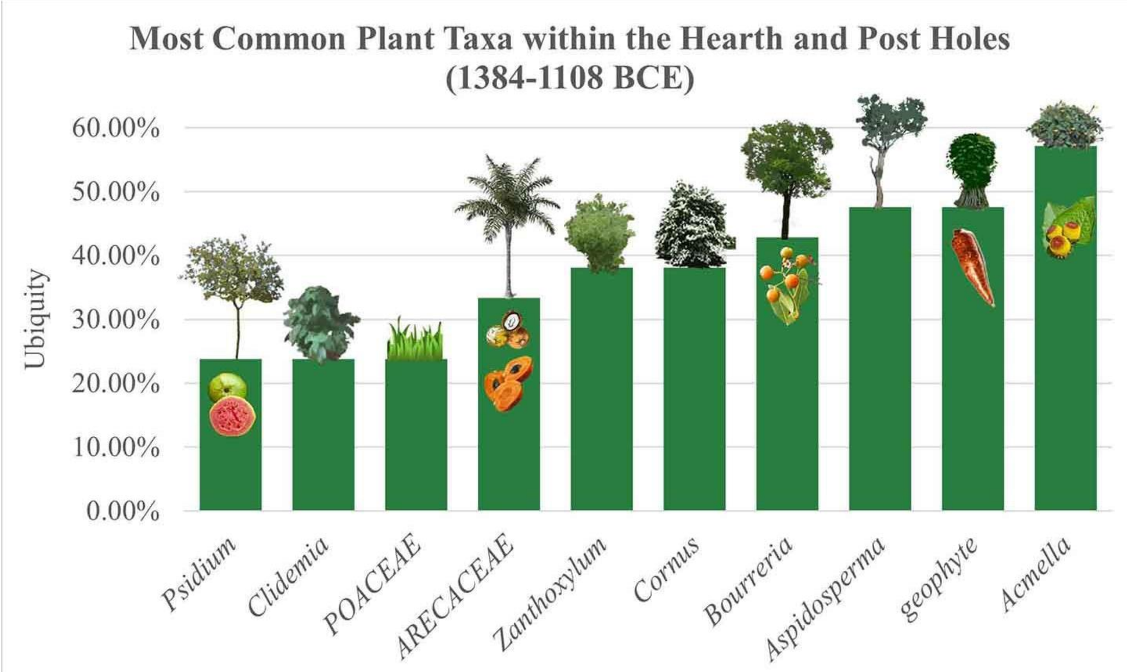


Figure 7-15: *Most ubiquitous plant taxa recovered from the hearth feature and post holes within Un. 61, grouped together because they collectively date to the same time period, which is a much more recent time period than the rest of that stratum (1384-1108 BCE versus 1616-1442 BCE).*

In terms of plant density, there is a greater concentration of plant remains within the hearth feature found within Un. 61 (Figure 7-13). This is expected as it is the only feature located within the excavation with an assumed association with organic material. In terms of artifacts, the hearth also contained 13 boiling stones ranging in size place throughout the feature in terms of depth, in addition to two percussion flakes (one of quartzite, the other dacite) (Sheets personal communication). With the assumption that all of the arboreal taxa represented by wood charcoal were the primary source of fuel for fires ignited in this space, a total of 66 tree taxa were burned in the La Chiripa hearth (Table 7-8). Clearly, an immense variety of taxa were utilized within this hearth as a source of fuel. Such a large assemblage of taxa indicates that this feature was used repeatedly rather than during a single event. Interestingly, only 53% of those tree taxa within the hearth feature have been documented as particularly appropriate sources of fuel. This suggests that the quality of fuel was not necessarily a concern for the people who tended to this fire pit. In fact, the hearth's botanical assemblage does not reveal any common themes that apply to the majority of plants or obvious relatedness among the taxa. The most common woods when considered by density include *Casearia*, *Aspidosperma*, *Ouratea*, and *Zanthoxylum*, which are all common taxa from the site overall. When the macrobotanical results are coupled with Luis Barba's (personal communication) chemical signature results that show high values of phosphates, carbohydrates and proteins, it is confirmed that this feature was likely used to process food. A total of 39 of the taxa identified within the hearth feature produce edible plant parts. This subset includes many foodstuffs such as the cultivars maize and common beans and wood from many well-known trees that produce edible fruits and seeds such as achiote, cacao, cashew, cherry, guava, hackberry, and mamey (Table 7-8). The contents of this hearth will be discussed in further detail within the discussion of the edibility of the identified taxa, Chapter 9. Perhaps the selection of woody fuel was not intentional, and the intent was more to hold some sort of commemorative celebration or remembrance of this structure and the ancestors who used it for the past hundred or so years.

Table 7-8: *Identified plant taxa from the hearth feature (rasgo 2) of the domestic structure within Un. 61 at La Chiripa, which represents the time period 1384-1108 BCE.*

Un. 61 Hearth (1384-1108 BCE)			
Herbs	**Fruit Trees**	**Other Trees**	**Other Trees (continued)**
Acmella sp.	*Anacardium excelsum*	*Acacia* sp.	*Margaritaria nobilis*
Asteraceae	Annonaceae	*Alchornea* sp.	*Maytenus* sp.
Poaceae	*Bourreria* sp.	*Aspidosperma* cf. *megalocarpon*	cf. *Myroxylon balsamum*
	Campnosperma panamense	*Astronium graveolens*	*Nectandra/Ocotea*
Cultivars	*Casearia* sp.	*Buchenavia* sp.	*Peltogyne* sp.
Manihot sp.	*Cheiloclinium cognatum*	*Calycophyllum candidissimum*	*Platymiscium* sp.
Phaseolus sp.	*Coccoloba* sp.	*Cedrela* sp.	*Schefflera* sp.
Zea mays	*Crateva* sp.	*Cornus* cf. *peruviana*	*Sloanea* sp.
unidentified geophytes	*Eugenia* sp.	*Coussarea* sp.	.*Swietenia humilis*
	Naucleopsis sp.	*Coutarea/Exostema*	*Swietenia macrophylla*
Palms	*Ouratea* sp.	*Croton* sp.	*Trema* sp.
Arecaceae	*Parmentiera* sp.	*Dalbergia* sp.	*Trichilia* cf. *pleeana*
	Quararibea sp.	*Dendropanax* sp.	*Virola* sp.
Fruit Shrubs	*Pouteria* sp.	*Enterolobium schomburgkii*	*Zanthoxylum* sp.
Ardisia sp.	*Prunus* sp.	*Faramea* sp.	
cf. *Byrsonima* sp.	*Psidium* sp.	*Hasseltia* sp.	**Other Shrubs**
Celtis sp.	*Tabernaemontana* sp.	*Hirtella* sp.	*Bixa cf. orellana*
Gaultheria sp.	*Terminalia* sp.	*Jacaranda* cf. *caucana*	*Calliandra* sp.
Miconia sp.	*Theobroma* sp.	*Magnolia* sp.	*Capparis sp.*
Morella sp.		*Maquira costaricana*	cf. *Neea* sp.
Muntingia calabura			*Sebastiania* sp

Table 7-9: *Identified plant taxa from the post holes of the domestic structure within Un. 61 at La Chiripa, which represents the time period in which the structure was abandoned (1384-1108 BCE).*

Post Holes of the Un. 61 Structure (1384-1108 BCE)			
Herbs	**Fruit Trees**	**Other Trees**	**Other Trees (continued)**
Acmella sp.	Annonaceae	*Acacia* sp.	*Faramea* sp.
Asteraceae	*Bourreria* sp.	*Alchornea* sp.	*Handroanthus* sp.
Poaceae	*Campnosperma panamense*	*Allophylus* sp.	*Jacaranda* sp.
	Casearia sp.	*Apeiba* sp.	*Mabea* sp.
Cultivars	*Cecropia* cf. *peltata*	*Aspidosperma* sp.	*Magnolia* sp.
Zea mays	*Inga* sp.	*Bellucia sp.*	*Nectandra/Ocotea*
unidentified geophytes	*Naucleopsis* sp.	*Calycophyllum candidissimum*	*Sapindus saponaria*
	Parkinsonia aculeata	*Clethra* sp.	*Swietenia humilis*
Palms	*Parmentiera* sp.	*Cornus* cf. *peruviana*	*Swietenia macrophylla*
Arecaceae	*Poulsenia armata*	*Coussarea* sp.	*Terminalia* cf. *oblonga*
	Pourouma sp.	*Coutarea/Exostema*	*Trema* sp.
Fruit Shrubs	*Pouteria* sp.	*Croton* sp.	*Trichilia* sp.
Hamelia sp.	*Psidium* sp.	*Dendropanax* sp.	*Vochysia* sp.
Morella sp.	*Psychotria* sp.	*Enterolobium* sp.	*Weinmannia* sp.
	Simarouba glauca	*Erythrochiton* sp.	*Zanthoxylum* sp.
Other Shrubs	*Spondias* cf. *mombin*	*Escallonia sp.*	
Gliricidia sepium	*Tetragastris panamensis*		
Palicourea sp.			
Schinus cf. *terebinthifolius*			
Sebastiania sp.			

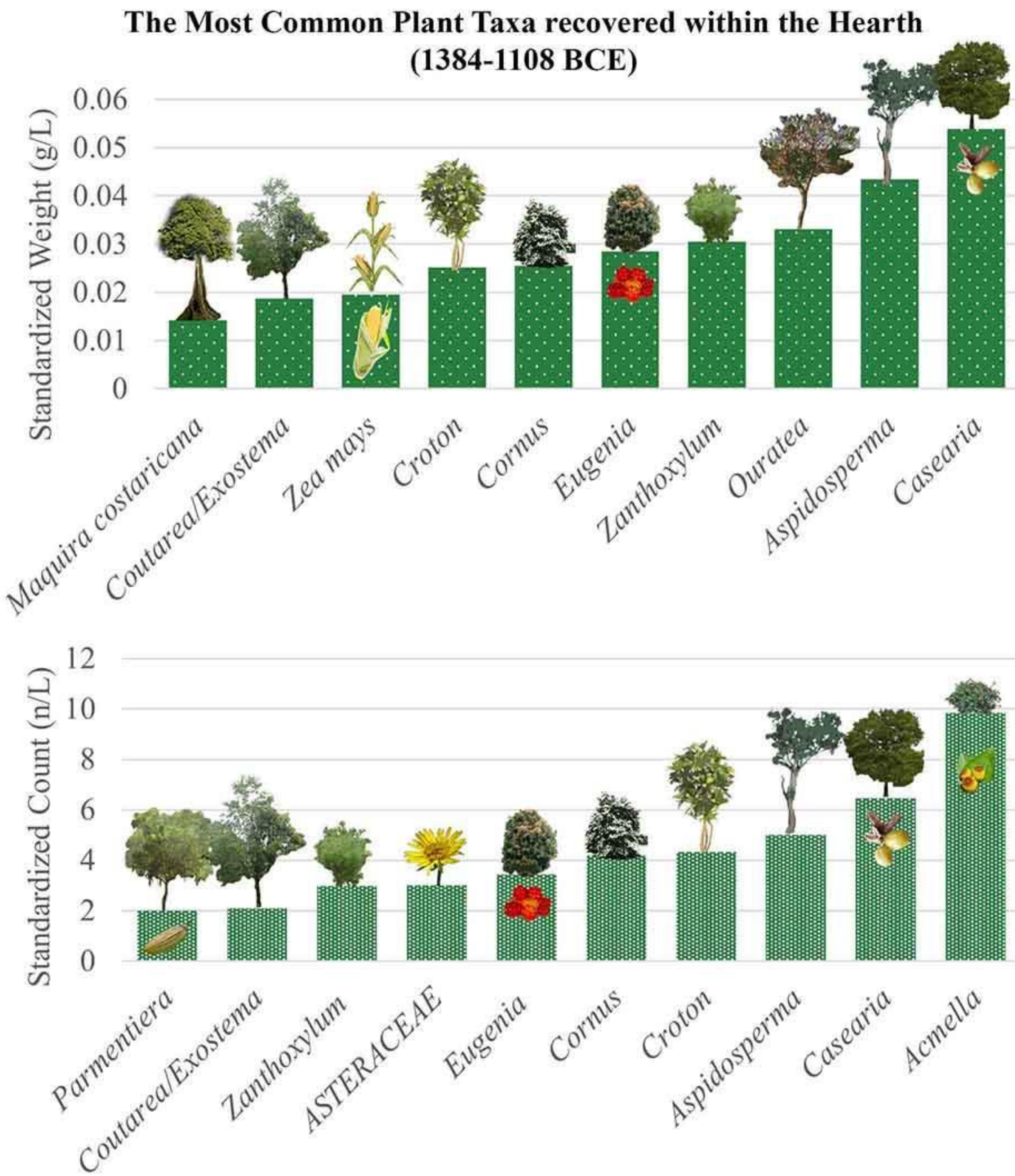


Figure 7-16: *Most common plant taxa recovered from the hearth feature within Un. 61 in terms of weight and count (69.5 L sampled). If the plant produces an edible part it is pictured within its bar.*

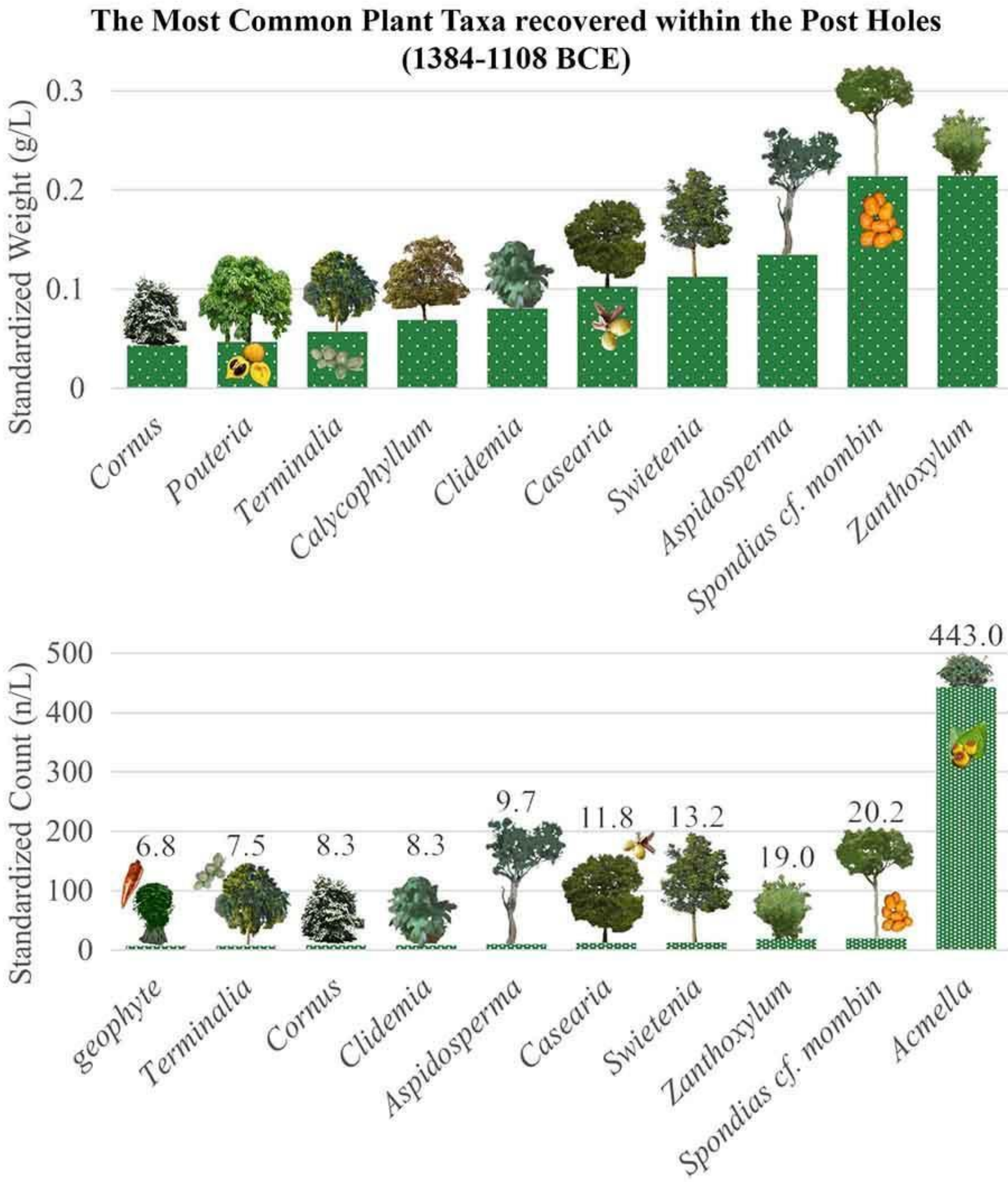


Figure 7-17: *Most common plant taxa recovered from the post hole features within Un. 61 in terms of weight and count. If the plant produces an edible part it is pictured within its bar.*

7.4 Identified Plants From G-164 Sitio Bolívar (430-540 CE)

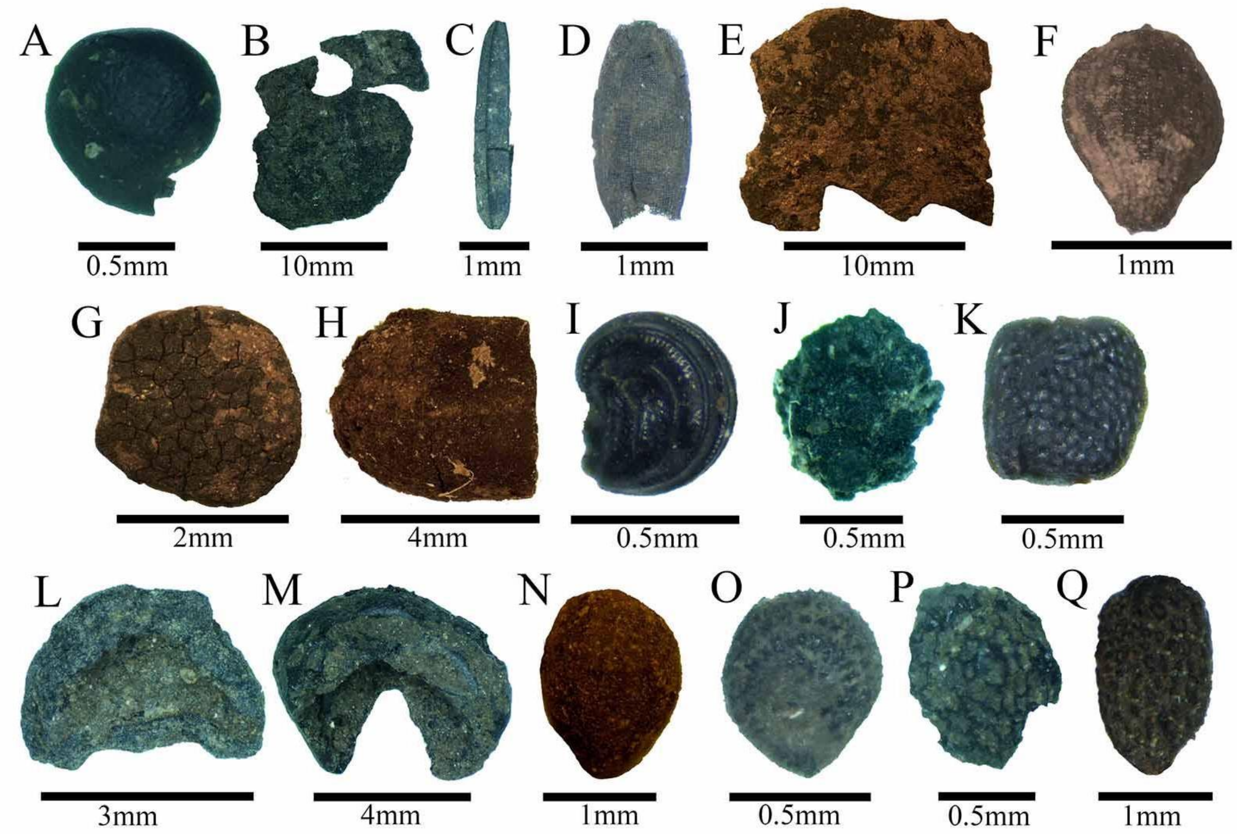


Figure 7-18: Photographs of identified seeds, achenes, and fruits recovered from G-164 Sitio Bolívar including **A** *Chenopodium* sp. (quinoa) seed, **B** *Acrocomia aculeata* (coyol) endocarp **C** Asteraceae (sunflower family) achene, **D** *Acmella* sp. (paracress) achene, **E** Cucurbitaceae (squash) rind, **F** cf. *Fimbristylis* sp. (fimbry) achene, **G** Fabaceae (legume) cotyledon **H** *Phaseolus* sp. (common bean) cotyledon fragment, **I** *Mollugo verticillata* (carpetweed) seed, **J** *Passiflora* sp. (passion flower) seed fragment, **K** *Piper* sp. (hinojo) seed, **L** *Zea mays* (maize) cupule, **M** *Z. mays* kernel, **N** Poaceae (grass) seed, **O** *Portulaca* cf. *oleracea* (purslane) seed, **P** *Nicotiana* sp. (tobacco) seed, **Q** *Cecropia* sp. (trumpet tree) seed.

From all of the sampled stratigraphic levels at Sitio Bolívar a grand total of 113 distinct plants were identified from the macrobotanical remains, representing 53 botanical families and 104 genera. Appendix C contains the complete dataset and table of identified plant material within each sample at Sitio Bolívar. Scanning Electron Micrographs and context maps for each identified woody taxon at La Chiripa are presented within Appendix H. Images of the seeds, achenes, and fruits and their respective context maps are presented both within Figure 7-18 and Appendix I. A general breakdown of the macrobotanical data for each stratigraphic level follows and a summary of general counts is presented within Table 7-10. All stratigraphic levels at Sitio Bolívar date to the same time period 430-540 CE (see Appendix J), so each stratum represents the accumulation of material as this space was inhabited, lived upon, and materials associated with these past people’s daily lives amassed within this 110 year period. Even though they date to the same time period, 3 different cultural levels were detected and will be assessed both separately to look at the site diachronically and together to assess the site as a whole. A complete table of the ubiquity measures for each identified taxa within each stratigraphic level at Sitio Bolívar and their economic uses is presented within Appendix N.

Table 7-10: *A summary of the macrobotanical remains recovered from each stratigraphic level at Sitio Bolívar. All levels date to the same time period (430-540 CE).*

Stratigraphic Level	Samples	Families	Genera	Trees	Shrubs	Cultivars	Herbs	Palms
Nv. 3	n=11 (36.5 L)	13	14	7	2	2	3	1
Nv. 4	n=15 (84.0 L)	32	39	29	8	1	2	1
Nv. 5	n=109 (514.5 L)	49	95	71	15	5	7	3

7.4.1 Nv. 3 (Un. 53, 430-540 CE)

Although all of the stratigraphic levels at Sitio Bolívar ultimately dated to the same time period, several distinct strata were encountered during the horizontal excavations. The first level that was sampled for paleoethnobotanical remains was Nv. 3, located roughly 0.5m below the present day surface. This level had the least amount of artifacts recovered compared to the other levels, with 154 ceramic sherds and 8 lithic fragments, the details of which were discussed in the previous chapter. While this level does not represent the floor of the structure, plant material recovered from this level could represent material built up over time as people lived in this space. A total of 15 distinct taxa were found from this stratum, representing 13 botanical families and 14 genera (Table 7-11). Wood charcoal from the *Handroanthus* (poui) tree was the only taxon unique to Nv. 3, whereas the rest of the taxa have a similar presence in this level compared to all others. Asteraceae and *Piper* (hinojo) were slightly more abundant in this upper level, both of which are herbaceous plants. Cultivars such as maize and unidentified geophytes were present, suggesting that this upper level does represent a lived surface rather than an accumulation of materials after the structure was abandoned and collapsed. The distribution of plant remains within Nv. 3 is similar to the other sampled levels at this site, but with a higher concentration towards the western edge of the excavation (Figure 7-19). This space with a sudden increase in plant density had wood charcoal from the black olive tree (*Terminalia* cf. *buceras*), cacao (*Theobroma*), cashew (*Anacardium occidentale*), and guava (*Psidium*).

Table 7-11: *Identified plant taxa from the Nv. 3 at Sitio Bolívar, resulting from 11 sediment samples amounting a total of 36.5 liters.*

G164 Sitio Bolívar Nv. 3 (CE 430-540)					
Herbs	**Fruit Trees**	**Other Trees**	**Shrubs**	**Cultivars**	**Palms**
Acmella sp.	*Casearia* sp.	*Handroanthus* sp.	*Siparuna* sp.	*Zea mays*	*Acrocomia aculeata*
Asteraceae	*Cecropia* sp.	*Terminalia* cf. *buceras*	*Piper* sp.	unidentified geophytes	
cf. *Passiflora* sp.	*Persea* sp.	*Trichilia* sp.			
	Pouteria sp.				

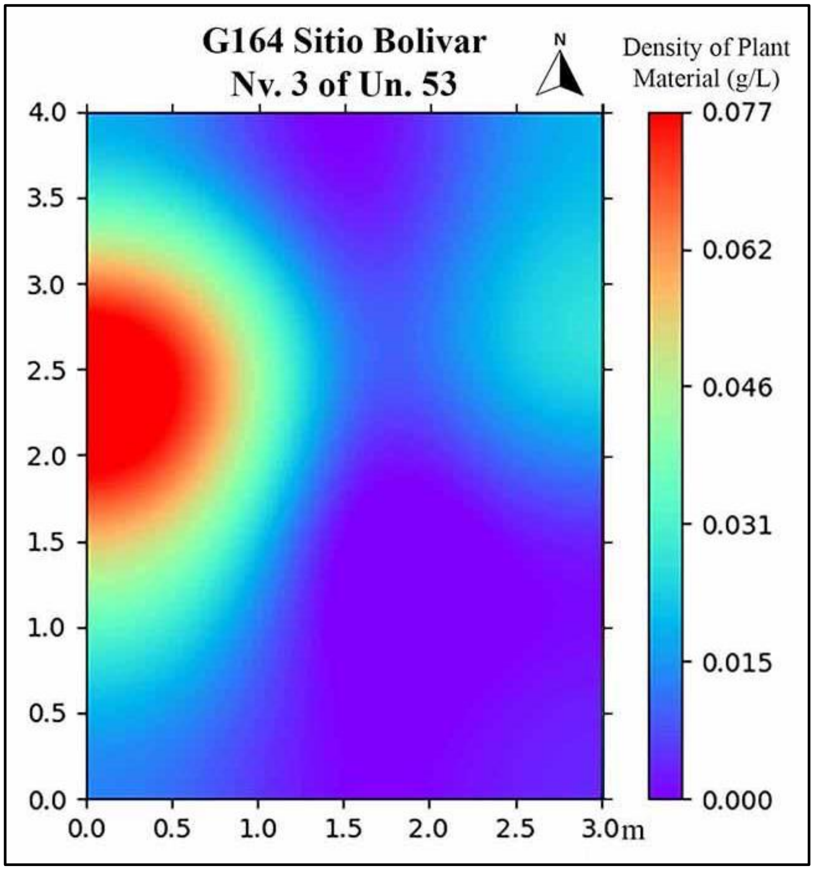


Figure 7-19: *Distribution of plant material recovered from Nv. 3 of Un. 53 at Sitio Bolívar represented through plant densities (grams per liter).*

7.4.2 Nv. 4 (Un. 53, 430-540 CE)

The next level that was sampled for paleoethnobotanical remains at Sitio Bolívar was Nv. 4. Just as with the previous stratum, this level also does not represent the floor of the structure but plant remains recovered from this level could represent material built up over time as people lived in this space. A total of 42 distinct taxa were found from this stratum, representing 32 botanical families and 39 genera (Table 7-12), which is a significant increase compared to the previous stratum. This dramatic increase in taxa demonstrates the higher level of human engagement with this space compared to the previous stratum. The quantity of artifacts recovered from this level also increased significantly, with 756 ceramic sherds and 60 lithic fragments.

Much like every single level sampled within this study, the plant assemblage found within Nv. 4 was dominated by arboreal taxa and supplemented with some herbaceous plants, palms, and cultivars like maize (Figure 7-20 and Table 7-12). Several taxa recovered from Nv. 4 were unique to that level, including quinoa (*Chenopodium*), calabazo (*Crescentia cujete*), acacia (*Acacia*), guachapalí (*Samanea saman* [Jacq.] Merr.), chilamate (*Poulsenia armata*), ouratea (*Ouratea*), tabaquillo (*Cosmibuena*), and canillo (*Clidemia*). The large canopy tree called chilamate is very common within the immediate vicinity of the site today, towering over the other trees and making its presence quite noticeable with its sizable buttresses. It is difficult to determine if this set of plants unique to this stratum depict a different lifestyle than practiced during earlier occupations of the village because the species richness in the region is so incredibly high that it is possible that the sampling regime just didn't capture a complete picture of the plant-human interactions for this stratum. As was discussed with Figure 7-4, the potential species richness at Sitio Bolívar was not ever attained through these paleoethnobotanical samples. Additionally, it should be noted that all of the plant taxa unique to Nv. 4 were the least ubiquitous within that stratum. The most ubiquitous taxa found in Nv. 4 are for the most part consistent with the other stratigraphic levels, thus depicting a continuity of this community's engagement with certain plants.

Table 7-12: *Identified plant taxa from the Nv. 4 at Sitio Bolívar resulting from 15 flotation samples amounting to a total of 84 liters.*

G164 Sitio Bolívar Nv. 4 (CE 430-540)				
Herbs	**Shrubs**	**Fruit Trees**	**Fruit Trees (cont.)**	**Other Trees**
Acmella sp.	*Ardisia* sp.	*Anacardium occidentale*	*Persea* sp.	*Acacia* sp.
Asteraceae	*Bixa* cf. *orellana*	Annonaceae	cf. *Poulsenia armata*	*Aspidosperma* sp.
Chenopodium sp.	cf. *Buddleja* sp.	*Casearia* sp.	*Pouteria* sp.	*Astronium graveolens*
	Capparis sp.	*Cecropia* sp.	*Psidium* sp.	Celestraceae
Cultivars	*Clidemia* sp.	*Crescentia cujete*	*Samanea saman*	*Cornus* cf. *florida*
Zea mays	cf. *Cosmibuena* sp.	*Garcinia* sp.	Simaroubaceae	*Handroanthus* sp.
	Palicourea sp.	*Hedyosmum* sp.	*Spondias* sp.	*Jacaranda* sp.
Palms	*Piper* sp.	*Inga* sp.	*Theobroma* sp.	*Nectandra/Ocotea*
Acrocomia aculeata		*Ouratea* sp.		*Sapindus saponaria*
				Swietenia sp.
				Terminalia cf. *buceras*
				Trichilia sp.

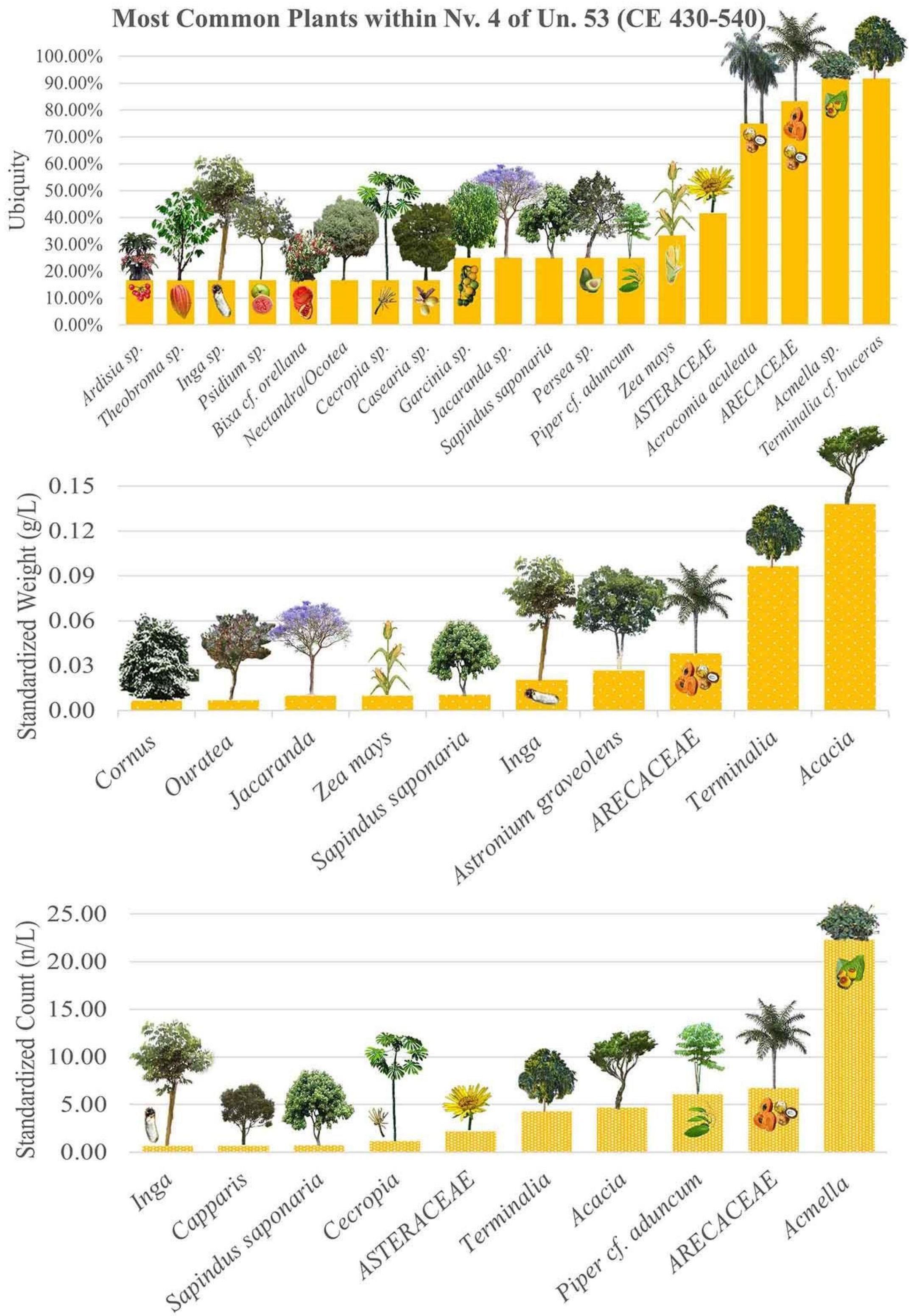


Figure 7-20: *The most common plants recovered from Nv. 4 of Un. 53 at Sitio Bolívar in terms of ubiquity, weight, and count. If the plant produces an edible part it is pictured within its bar.*

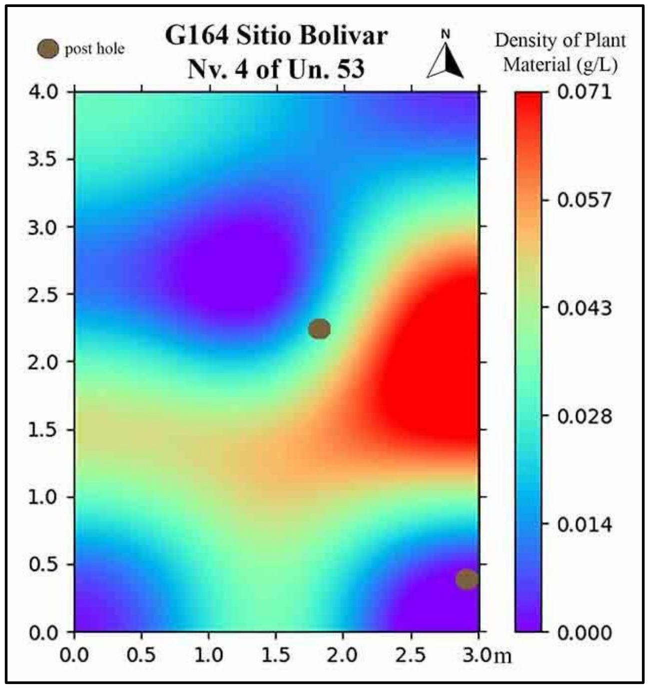


Figure 7-21: *Distribution of plant material recovered from Nv. 4 of Un. 53 at Sitio Bolívar represented through plant densities (grams per liter). The two post holes present within this stratum are marked.*

Two post holes were encountered within this stratum that do not align with any of the other post holes discovered within the stratum below (Nv. 5), thus marking the presence of more than one structure built upon this space. Unfortunately, with only two post holes, it is not possible to determine the orientation of the structure or any estimation of an interior versus exterior designation. The density of plant material recovered from Nv. 4 do not exactly align with the two post holes in any manner that suggests if these post holes were related and formed a structure (Figure 7-21). In fact, the region of this stratum with the highest density of plant remains cuts right in between the two post holes. Additionally, excavations did not encounter any noticeable compacted surface that would have signified a floor of earth compressed from the repeated footsteps of inhabitants. However, the area to the east of the post holes has the highest density of plant material within this stratum, which would signify a similar orientation of this structure to the one found in Nv 5 just below.

The existence of multiple structures stratigraphically within this exact space could have occurred for a variety of reasons. Thatch-roofed structures are short-lived in the tropics, lasting perhaps 2 to 6 years before needing to be replaced (Steger 2023). However, this lifespan can vary greatly depending on climatic conditions, the species used in construction, the skill of those who built the structure, and the degree of repair the homeowner dedicates towards regular maintenance. If cared for appropriately, wattle-and-daub and thatched roofed structures around the world have been recorded to remain functional for over 100 years (Shaffer 2021, Steger 2023). It is possible that this later structure was built when the earlier one was far too damaged or decayed to be repaired. Another explanation could be that the Sitio Bolívar community was temporarily displaced due to an eruption from Arenal Volcano and then returned back to their village once the landscape had sufficiently recovered to make the setting livable again. Studies of Arenal Volcano have identified a catastrophic subplinian eruption (AT-17) that occurred in the middle of what the Sitio Bolívar settlement dates to, circa CE 472, which would have temporarily impacted human activity throughout the Arenal region (Egan 2019). This was a two-phase eruption that sent tephra multiple directions and would have impacted nearly all of the settlements in the Arenal region, as has been modeled within Figure 7-22 which was modified based on Egan (2019:168).

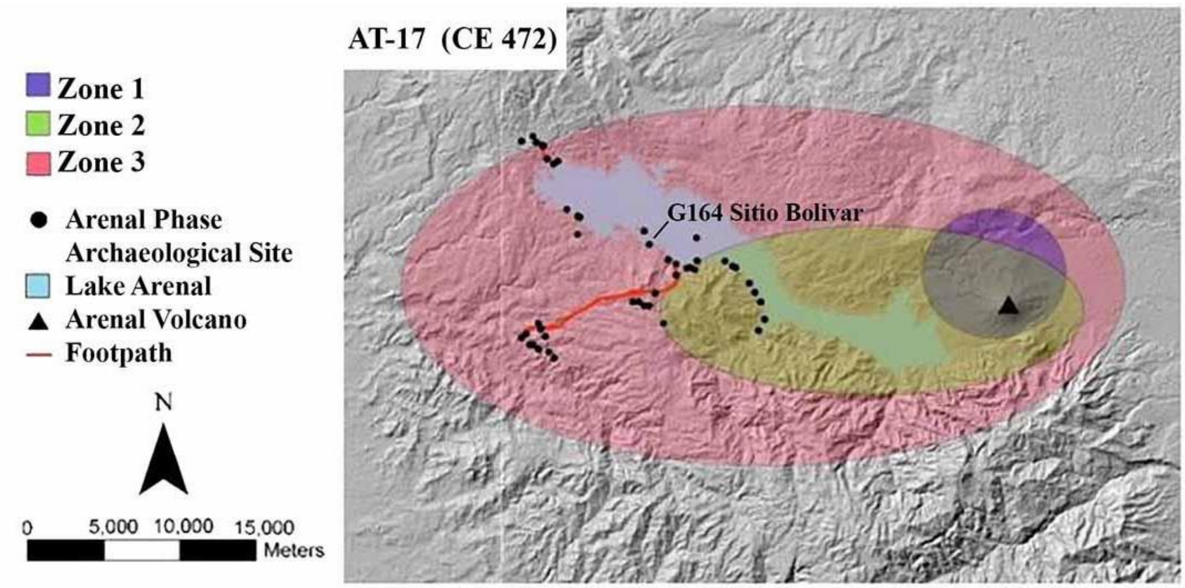


Figure 7-22: Hazard map for the documented AT-17 eruption of Arenal Volcano circa CE 472 that depicts which areas would have been impacted and the severity of damage to that region (modified from Figure 4-18 of Egan 2019:168).

Each zone within this hazard map reconstruction depicts the level of impact, recovery, and human response in the wake of a volcanic event (Egan 2019:163). Zone 1 is the area closest to the volcano and thus would have experienced the greatest impact from an eruption. This zone would have been buried by over 300mm of tephra, nearly complete destruction of plant life, and recovery would have been quite slow, likely taking more than a century and thus forcing people to abandon the region entirely if they were living within this zone. Zone 2 is intermediate in that somewhere between 100 and 300mm of tephra would have been deposited and plant life would have been moderately damaged. Most trees could have survived within this zone, but all low-lying vegetation would have been killed. Aquatic life within the lake and rivers would not be able to withstand these conditions. Additionally, any structures present within this zone would likely have collapsed. Ecological recovery within Zone 2 would have been gradual, taking several decades, which would subsequently force people living within this zone to relocate. Zone 3 is the zone in which Sitio Bolívar was situated and less than 100mm of tephra would have blanketed this area, causing minor damage to structures, plants, and contamination of water sources such as lakes or rivers. Low lying vegetation would have been especially vulnerable in this zone and foliage stripped from trees, but trees could have survived such conditions. Recovery within zone 3 was short term, taking months to perhaps years, and requiring people to relocate but just temporarily. With these criteria in mind, the presence of multiple structures located stratigraphically on top of each other at Sitio Bolívar could potentially signify the temporary abandonment of this space due to the AT-17 eruption in 472 CE, and a subsequent reconstruction of the house structure once people returned back to their home and the village. Therefore, the plant remains identified from Nv. 4 of the excavations represent a later occupation of the site. Unfortunately, the AMS radiocarbon dates obtained from the site did not result in a narrow enough of a time period to separate such a series of occupations and there was not a culturally sterile layer of volcanic ash during excavations.

7.4.3 Nv. 5 (Un. 53, 430-540 CE) - The Main House Structure(s)

The final sampled level at Sitio Bolívar is Nv. 5 and represents the floor of the main structure encountered during excavations. The surface of this stratum was noticeably compacted to the excavators compared to any previous strata and 8 large post holes in addition to 12 smaller post holes were identified, signifying the presence of multiple structures or walls. A single large structure is assumed to take up the eastern portion of the excavation due to the aligned arc of post holes. A series of smaller postholes found within this structure signify a possible wall or partition, which would have created separate spaces or rooms within the structure. A scattering of other post holes of various diameters are distributed throughout the western portion of the excavation, without any obvious alignments or relationships to signify whether or not they form a windbreak, a fence, or an additional structure. The smaller post holes within the western side of the unit vaguely run parallel to the arc of the larger post holes which form a structure on the eastern half, and therefore could potentially mark a small fence that was built outside of the entrance of the house, but the artifact and plant distribution (Figure 7-23) do not confirm such distinct boundaries within this space. Along with the post holes, the artifacts recovered from Nv. 5 made it quite clear to the excavators that this was a lived space with 2,845 ceramic sherds and 238 lithic fragments.

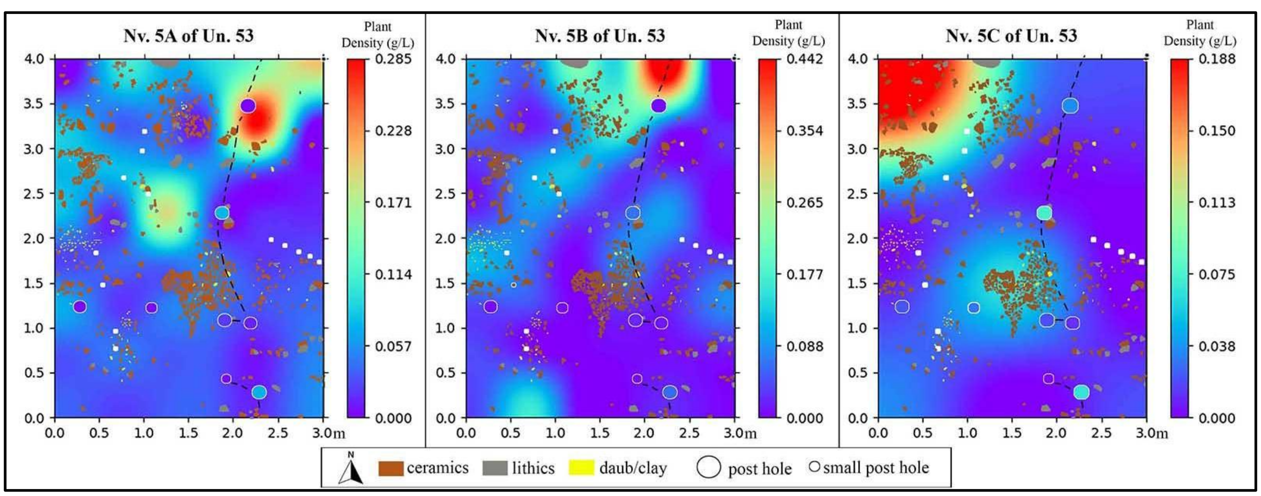


Figure 7-23: *Distribution of plant material recovered from Nv. 5 of Un. 53 at Sitio Bolívar represented through plant densities (grams per liter). This level had a depth of up to 40cm in some locations, so the sampling was split into arbitrary levels of 10cm. Nv. 5A represents the top 10cm of depth, Nv. 5B represents the second 10cm of depth, and Nv. 5C represents the remaining depth of this level (which varied in depth throughout the horizontal excavation).*

Table 7-13: *Identified plant taxa from the Nv. 5 at Sitio Bolívar, resulting from 109 sediment samples amounting to a total of 514.5 L). Samples were split into artificial segments/levels because of the great depth of the level. 5A = the first 10cm of depth excavated, 5B = the next 10cm of depth excavated, and 5C = the remaining depth of the stratigraphic level.*

G164 Sitio Bolívar Nv. 5 (CE 430-540)			
Herbs	**Cultivars**	**Fruit Shrubs**	**Other Shrubs**
Acmella sp.[ABC]	Cucurbitaceae [ABC]	*Ardisia* sp. [B]	cf. *Amphipterygium* sp. [B]
Asteraceae [ABC]	Fabaceae [B]	*Hamelia* sp. [A]	*Bixa* cf. *orellana* [ABC]
cf. *Fimbristylis* sp. [A]	*Phaseolus* sp. [AB]	*Psychotria* sp. [B]	*Buddleja* sp. [AB]
Mollugo verticillata [AC]	*Zea mays* [ABC]		*Calliandra* sp. [B]
Nicotiana sp. [BC]	unidentified geophytes [A]	**Palms**	*Capparis* sp. [AC]
Poaceae [C]		*Acrocomia aculeata* [ABC]	*Clidemia* sp. [C]
Portulaca cf. *oleracea* [AB]		Arecaceae [ABC]	*Diphysa* sp. [AB]
		Attalea sp. [A]	*Palicourea* sp. [A]
		Bactris sp. [B]	*Piper* sp. [ABC]
			Ryania speciosa [B]
			Sebastiania sp. [B]
Fruit Trees	**Fruit Trees (continued)**	**Other Trees**	**Other Trees (continued)**
Anacardium sp. [AB]	*Lacmellea* sp. [A]	*Aspidosperma* cf. *megalocarpon* [ABC]	*Peltogyne* sp. [B]
Annona sp. [AB]	*Manilkara* sp. [ABC]	*Astronium graveolens* [ABC]	*Prioria copaifera* [BC]
Bellucia sp. [AB]	*Parkinsonia aculeata* [B]	*Beilschmiedia* sp. [B]	cf. *Protium* sp. [B]
Bourreria sp. [AB]	*Persea* sp. [ABC]	*Cabralea* sp. [B]	*Sapindus saponaria* [ABC]
Brosimum sp. [B]	*Pourouma* sp. [B]	*Cinnamomum* sp. [AB]	cf. *Schefflera* sp. [A]
Bunchosia sp. [B]	*Pouteria* sp. [ABC]	*Cornus* sp. [AB]	cf. *Swartzia* sp. [A]
Campnosperma panamense [BC]	*Psidium* sp. [ABC]	*Couratari* cf. *scottmorii* [C]	*Swietenia* sp. [ABC]
Casearia sp. [AB]	*Sideroxylon* sp. [A]	*Coutarea/Exostema* [AB]	*Tabebuia* sp. [AB]
Cassia sp. [B]	*Simaba* cf. *cedron* [B]	*Croton* sp. [C]	*Terminalia* cf. *amazonia* [C]
Cecropia sp. [ABC]	*Simarouba amara* [AB]	*Faramea* sp. [AB]	*Terminalia* cf. *buceras* [ABC]
Coccoloba sp. [A]	*Spondias* cf. *mombin* [A]	*Heliocarpus* sp. [A]	*Terminalia* cf. *oblonga* [AC]
Eugenia sp. [A]	cf. *Symphonia globulifera* [A]	*Hura crepitans* [C]	*Tibouchina* sp. [AC]
Ficus sp. [C]	*Tabernaemontana* sp. [B]	*Jacaranda* cf. *caucana* [ABC]	*Trema* sp. [AB]
Garcinia sp. [AB]	*Tetragastris panamensis* [AB]	*Lacistema aggregatum* [B]	*Trichilia* sp. [ABC]

Genipa americana [ABC]	*Theobroma* sp. [A]	*Maytenus* sp. [C]	*Viburnum* sp. [B]
Hedyosmum sp. [A]	*Trophis* sp. [BC]	*Meliosma* sp. [A]	*Vochysia* sp. [B]
Hymenaea sp. [A]		cf. *Mosquitoxylum jamaicense* [A]	*Wimmeria* sp. [A]
Inga sp. [ABC]		*Nectandra/Ocotea* [ABC]	*Zanthoxylum* sp. [ABC]
		cf. *Otoba* sp. [B]	

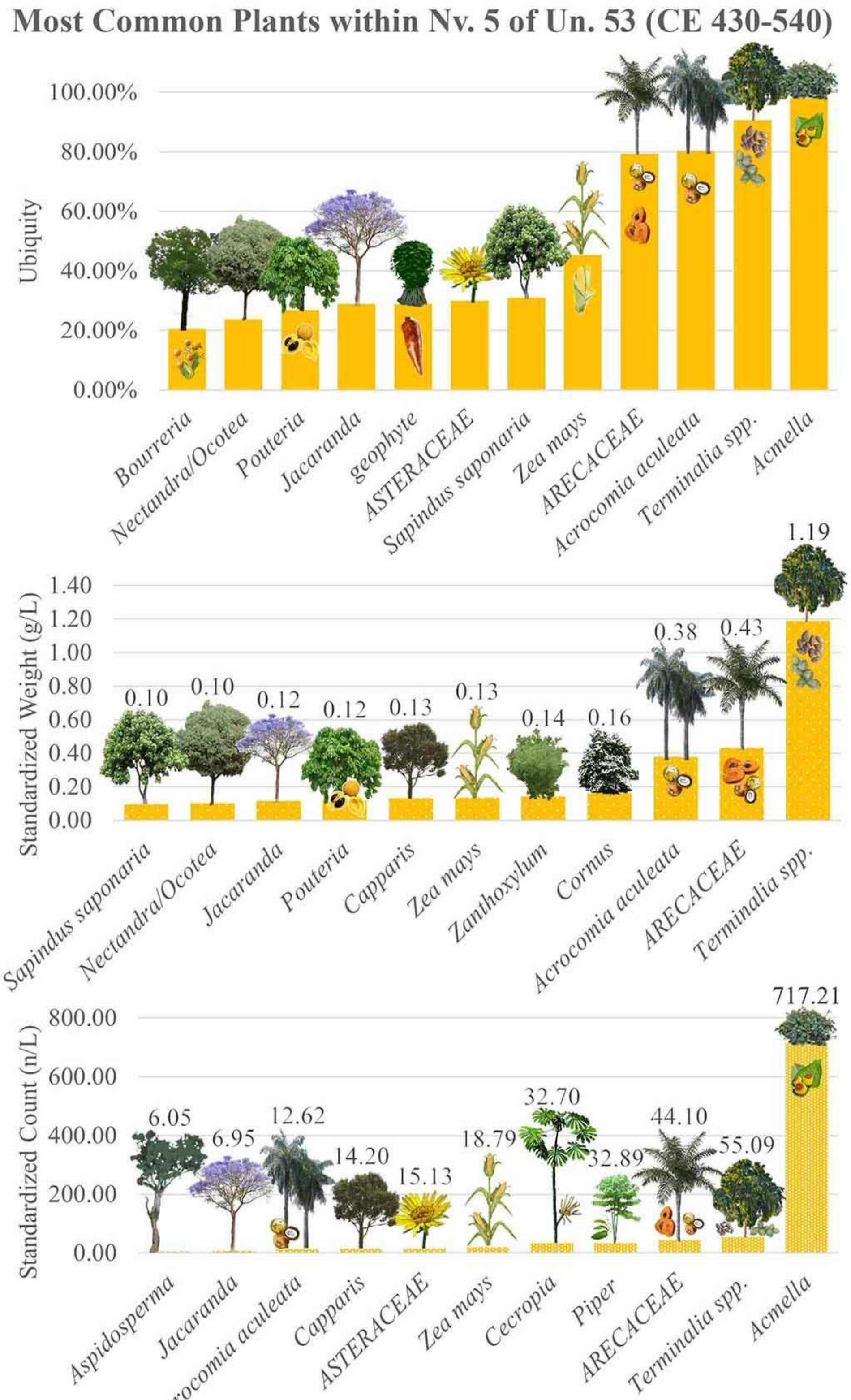


Figure 7-24: *The most ubiquitous plant taxa recovered from Nv. 5 of Un. 53 at Sitio Bolívar. If the plant produces an edible part it is pictured within its bar.*

The excavations and sampling of this stratum were broken up into three arbitrary levels of 10cm each. The distribution of the density of the plant remains within Nv. 5 shows that botanical material was present throughout the excavation and did vary between each of these arbitrary levels, showing a change in the use of this space through time. Curiously, the plant densities generally do not align with the concentrations of artifacts. Each of these substrata reveal more abundant plant remains along the northern side and there was consistently less plant material within the southeast portion of the excavation. These observations are intriguing because the post holes within Nv. 5 align in a slight arc running from the north to the south with an entryway in the southern portion of the excavation marked by two post holes that create an awning just like the La Chiripa structure, suggesting that the interior of the structure opened towards the east. The lower amount of botanical material within this interior section corroborates the interpretation of this space as the interior of the structure because it would have been a common practice to sweep the floor of the structure and clear it from any debris regularly. Another interesting link between the Sitio Bolívar and La Chiripa structures is that an abundance of plant material was deposited immediately outside of the house, just to the right side of the entrance from the perspective of someone exiting the structure.

The paleoethnobotanical identifications from Nv. 5 produce the largest group of taxa at Sitio Bolívar, with 103 distinct botanical taxa coming from 49 families and 95 genera (Table 7-13 and Figure 7-24). The greatest amount of herbaceous plants (*Acmella*, *Fimbristylis*, *Mollugo verticillata*, *Portulaca oleracea* L., and *Nicotiana*) and cultigens (*Cucurbitaceae*, *Phaseolus*, *Zea mays*, and unidentifiable geophytes) are found within this stratum, all of which point to a greater presence of people performing daily activities within this space such as food preparation and consumption. Just as with the other strata, the assemblage is dominated by arboreal taxa identified through the wood charcoal with 71 trees and 15 shrubs, 37 of which produce edible plant parts such as fruit, seeds, leaves, and roots. The food practices and edibility of these taxa will be discussed in greater detail within Chapter 9. The forest composition that can be extrapolated from the arboreal taxa that these late Arenal inhabitants chose to use as a source of fuel will be discussed further within chapter 8.

7.5 A Broad Comparison of the two Archaeological Sites

Table 7-14 is a very broad summary of the paleoethnobotanical results from the stratigraphic levels at each site that were associated with a domestic structure. Providing details of all 187 distinct botanical genera that are found from the two sites is not relevant to the goals of this dissertation, which is to address the long term practices found within this region which could have led these peoples to maintain a resilient lifestyle. Thus, how these taxa relate to forest engagement (Chapter 8) and foodways (Chapter 9) will receive greater attention. The taxa that would have provided useful material and resources for the villagers of the Arenal region will be discussed in further detail in the following chapters, which admittedly is still a large number of taxa.

What stands out the most at both sites is that very few of the botanical identifications come from preserved seeds, achenes, or fruits, which is what is most commonly identified in macrobotanical studies. At both the Tronadora phase structure at La Chiripa and the late Arenal phase structure(s) at Sitio Bolívar, the vast majority of botanical identifications actually come from wood charcoal and represent trees or shrubs that were ultimately burned likely as a source of combustible products. Even though these tree’s demise was ultimately as a source of fuel, their presence within the archaeological plant assemblage can still provide information about the resources that would have been available to the past villagers in the form of food, medicine, tools, construction material, and ritual materials.

Table 7-14. *Total amount of plant material and identifications to the genus level recovered from just the stratigraphic levels containing domestic structures at La Chiripa and Sitio Bolívar.*

	La Chiripa (1616-1108 BCE)		**Sitio Bolívar** (430-540 CE)	
Wood	2271 fragments (43.22g)	144 taxa	3003 fragments (37.25g)	100 taxa
Seeds, Achenes, and Fruits	3399 seeds (1.48g)	12 taxa	4547 seeds (3.73g)	12 taxa
Geophytes	30 fragments (0.46g)	1 taxon	67 fragments (1.29g)	1 taxon
	157 Total Taxa		113 Total Taxa	

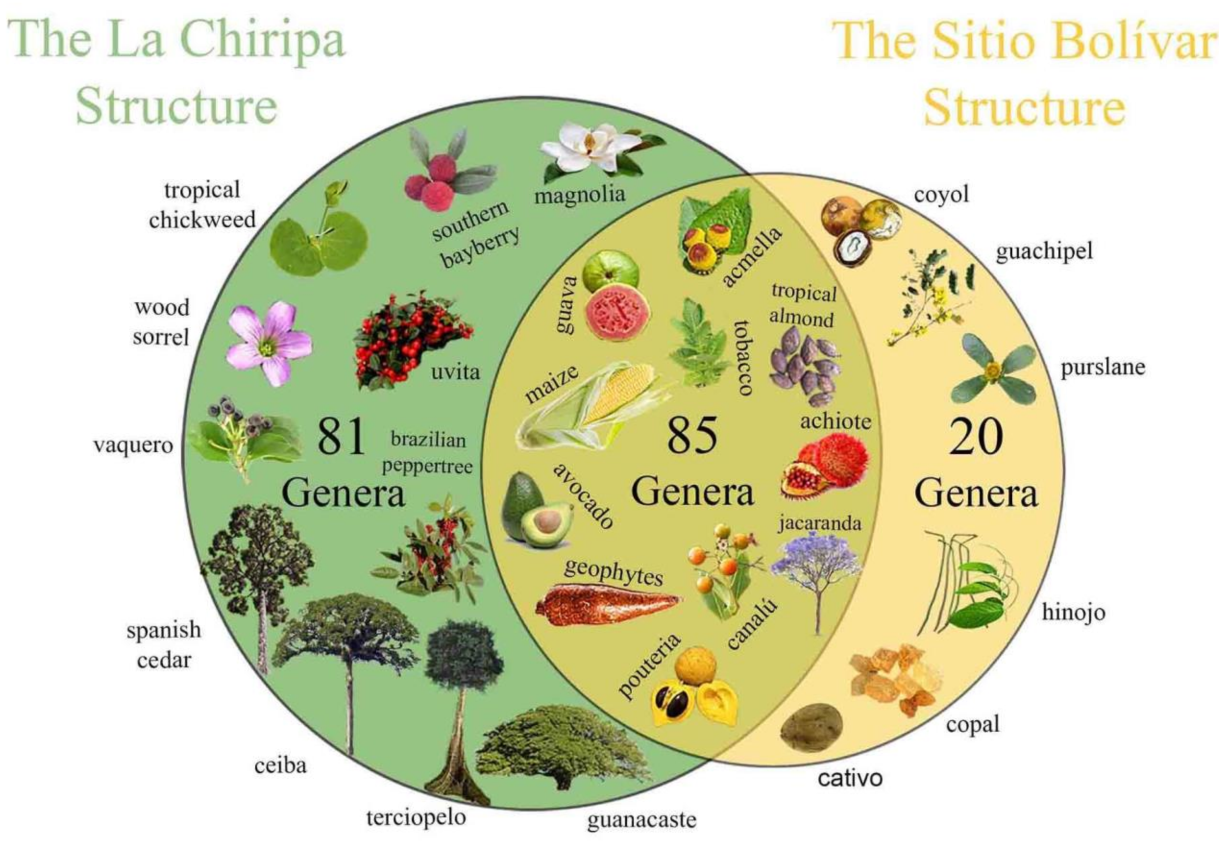


Figure 7-25: *Venn diagram comparison of the botanical genera identified from the stratigraphic levels containing a domestic structure at La Chiripa and Sitio Bolívar with example plants within each category displayed.*

The paleoethnobotanical assemblages at the two sites do overlap a considerable amount, with a total of 85 genera that were recovered from both domestic structures (Figure 7-25 and Table 7-15). For the most part, the two sites share the same set of herbaceous plants and a focus on the cultivars such as *Acmella*, maize, beans, and squash. Curiously, both sites had tobacco (*Nicotiana*) recovered from the structure's floor, which indicates that these spaces were not just used for more mundane food consumption, but also for ritual activities. There are 39 trees or shrubs which produce edible fruits that were found at both sites, including cashew, guanabana, avocado, guava, passionfruit, cacao, sapodilla, fig, and ramon - to name just a few of the more commonly known taxa. These results demonstrate that arboreal plants formed a high proportion of the subsistence regime throughout time in Arenal, from the Tronadora phase through the Late Arenal phase, as will be discussed in more detail within Chapter 9.

Table 7-15: *Plant taxa recovered from both La Chiripa and Sitio Bolívar.*

Cultivar	**Fruit Trees or Shrubs**	**Fruit Trees or Shrubs (cont.)**	**Other Trees**	**Other Shrubs**
Phaseolus sp.	*Anacardium* spp.	*Manilkara* sp.	*Acacia* sp.	*Amphipterygium* sp.
Zea mays	*Annona* sp.	*Ouratea* sp.	*Aspidosperma* spp.	*Bixa* cf. *orellana*
unidentified geophytes	*Ardisia* sp.	*Parkinsonia aculeata*	*Astronium graveolens*	*Calliandra* sp.
	Bellucia sp.	*Persea* sp.	*Buddleja* sp.	*Capparis* sp.
Herb	*Bourreria* sp.	*Poulsenia armata*	*Cornus* spp.	*Clidemia* sp.
Acmella sp.	*Brosimum* sp.	*Pourouma* sp.	*Coutarea/Exostema*	*Cosmibuena* sp.
Asteraceae	*Bunchosia* sp.	*Pouteria* sp.	*Croton* sp.	*Palicourea* sp.
cf. *Fimbristylis* sp.	*Campnosperma panamense*	*Psidium* sp.	*Faramea* sp.	*Ryania speciosa*
Chenopodium sp.	*Casearia* sp.	*Psychotria* sp.	*Handroanthus* sp.	*Sebastiania* sp.
Mollugo veriticillata	*Cassia* sp.	*Sideroxylon* sp.	*Heliocarpus* sp.	*Siparuna* sp.
Nicotiana sp.	*Cecropia* sp.	*Simaba cf. cedron*	*Hura crepitans*	*Viburnum* sp.
Passiflora sp.	*Coccoloba* sp.	*Simarouba* spp.	*Jacaranda* sp.	*Wimmeria* sp.
	Crescentia spp.	*Spondias* spp.	*Maytenus* sp.	
Palm	*Eugenia* sp.	*Symphonia globulifera*	*Meliosma* sp.	
Arecaceae	*Ficus sp.*	*Tabernaemontana* sp.	*Nectandra/Ocotea*	
	Garcinia sp.	*Terminalia* spp.	*Peltogyne* sp.	
	Genipa americana	*Tetragastris panamensis*	*Sapindus saponaria*	
	Hamelia sp.	*Theobroma* sp.	*Schefflera* sp.	
	Hedyosmum sp.	*Trophis* sp.	*Swietenia* spp.	
	Inga sp.		*Tabebuia* sp.	
			Trema sp.	
			Trichilia sp.	
			Vochysia sp.	
			Zanthoxylum sp.	

What differentiates the two sites, and time periods, is also interesting to explore. The two sites differ mostly in the types and quantities of arboreal taxa recovered. La Chiripa, the older of the two sites, has a lot of large well known canopy trees that were not found at Sitio Bolívar. This includes well known trees such as *Ceiba*, *Sloanea* (terciopelo), *Cedrela* (cedar), *Myroxylon balsamum* (bálsamo), *Quararibea* (molenillo), and *Apeiba* (peinecillo), which can all grow to be at least 30m in height or greater (Dünisch et al. 2003, Gribel et al. 1999, Humphries 1978, Santamaría-Aguilar and Fernández 2015, Vozzo 2002). Whether or not this indicates a trend of deforestation through time will be examined further with Chapter 8, which will discuss various aspects of the forest composition of Arenal that can be extrapolated based on the wood species utilized by the inhabitants within this study.

The plant taxa that are unique to the Sitio Bolívar structure include herbs such as *Portulaca* (purslane) and *Piper* sp. (hinojo), which could indicate a greater emphasis on flavorings within this community, but could admittedly just be related to preservation conditions or sampling procedures. Wood charcoal from the copal tree (*Protium*) and guapinol (*Hymenaea*) were only recovered at Sitio Bolívar. Both of these trees produce a hard resin that can be extracted from living trees through tapping their stem tissue for the intercellular resin canals, which is thought of as a controlled wounding of a tree (Neels 2000:9). *Tetragastris panamensis* (kerosin), another plant in the same botanical family as *Protium*, also produces a resin and was recovered from both La Chiripa and Sitio Bolívar. The resin found in these various trees has been burned as a ceremonial incense by indigenous peoples of the Americas for millennia and have been documented as having been valued by the Maya (Gomez-Pompa and Kaus 1990, Lundell 1937, Schwartz 1990, Standley and Steyermark 1946). Lundell (1937) recorded that *P. copal* trees are associated with forests dominated by the chicozapote tree (*Manilkara zapota*). The chicozapote tree was also identified at both of these house structures, but much more heavily at Sitio Bolívar according to its overall ubiquity measures (0.9% at La Chiripa and 14.3% at Sitio Bolívar). This suggests that the presence of *Protium* only at Sitio Bolívar could be linked to the site's stronger presence and use of the *Manilkara* trees, which means that these Late Arenal villagers were frequenting forested spaces that contained *Protium* more often than the Tronadora phase residents at La Chiripa.

Based on these raw numbers presented in Table 7-14, one immediate interpretation is that the plant assemblage became less diverse through time with 47 less botanical genera present at Sitio Bolívar compared to La Chiripa, but both sites have over 100 plant taxa identified from each domestic structure so they clearly both had an abundance of plants available to them. It is important to remember that the taxon accumulation curves for both of these sites (Figure 7-4) did not reach a stable level (especially at Sitio Bolívar), meaning that even more taxa are presumed to have been utilized at each site than the evidence that the paleoethnobotanical results provide. Additionally, the recovery rate of the flotation tank utilized at Sitio Bolívar was lower than that of La Chiripa, suggesting that more plant remains could potentially have been recovered and identified.

An additional way to compare the assortment of plants identified from these two house structures from these two sites beyond the taxon accumulation curves is to look at how diverse the recovered plant assemblages were for each site. One way to determine the richness of a dataset is the Shannon-Weaver index, which incorporates the total count of taxa in an assemblage and the relative abundance of each taxon (Ludwig and Reynolds 1988, Pearsall 2015, Popper 1988). The overall diversity index (H) is calculated using the following equation:

$$H = -\Sigma p_i * ln(p_i)$$

In this calculation, p_i refers to the proportion of the dataset made up of a particular species and *ln* calls for a natural logarithm. The higher the value of *H* is, the higher species diversity is in terms of richness. Whereas an *H* value of zero would indicate that an assemblage only has a single species.

The Shannon Equitability Index measures the evenness of species within a dataset (*V*), where 'evenness' refers to how similar the abundances of different species are in the community. The equitability is calculated using the following equation:

$$V = H / ln(S)$$

This equitability calculation uses the Shannon Diversity Index (*H*) and the total number of unique taxa (*S*). This value ranges from 0 to 1, and a value of 1 would indicate complete evenness of distribution within a dataset. Lower values represent a less even distribution that is more significantly skewed.

Calculations of the *H* (diversity) and *V* (equitability) index values of the plant assemblages from stratigraphic levels associated with the domestic structures at La Chiripa and Sitio Bolívar are presented in Figure 7-26. The results reveal that the La Chiripa structure had a higher species diversity in terms of richness compared to that of Sitio Bolívar, in addition to a more equitable plant assemblage. The Shannon-Weaver Index only provides broad trends, and thus could be useful for "looking for generalized (diverse) versus specialized (not diverse) plant assemblages" (Popper 1988:68). Thus, Sitio Bolívar could be viewed as having a community that is more specialized in its procurement of plant resources compared to La Chiripa, whose community must have practiced a more generalized procurement of plant resources. These results suggest that temporally, the early Tronadora phase communities in the Arenal region incorporated a greater diversity of taxa into their daily lives without a strong preference for any certain taxon. As time went on, the late Arenal phase communities still made use of a great variety of plants but began to prioritize certain taxa, as seen in Figure 7-27.

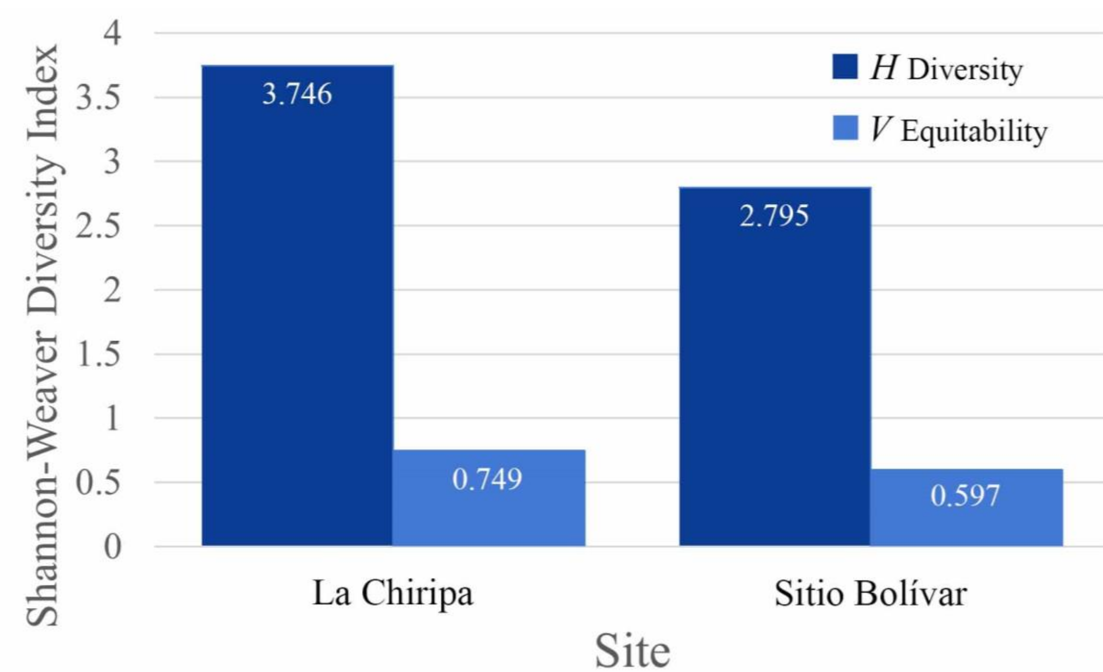


Figure 7-26: *Shannon-Weaver diversity index plot of the plant remains from only the stratigraphic levels associated with the domestic structures at La Chiripa and Sitio Bolívar.*

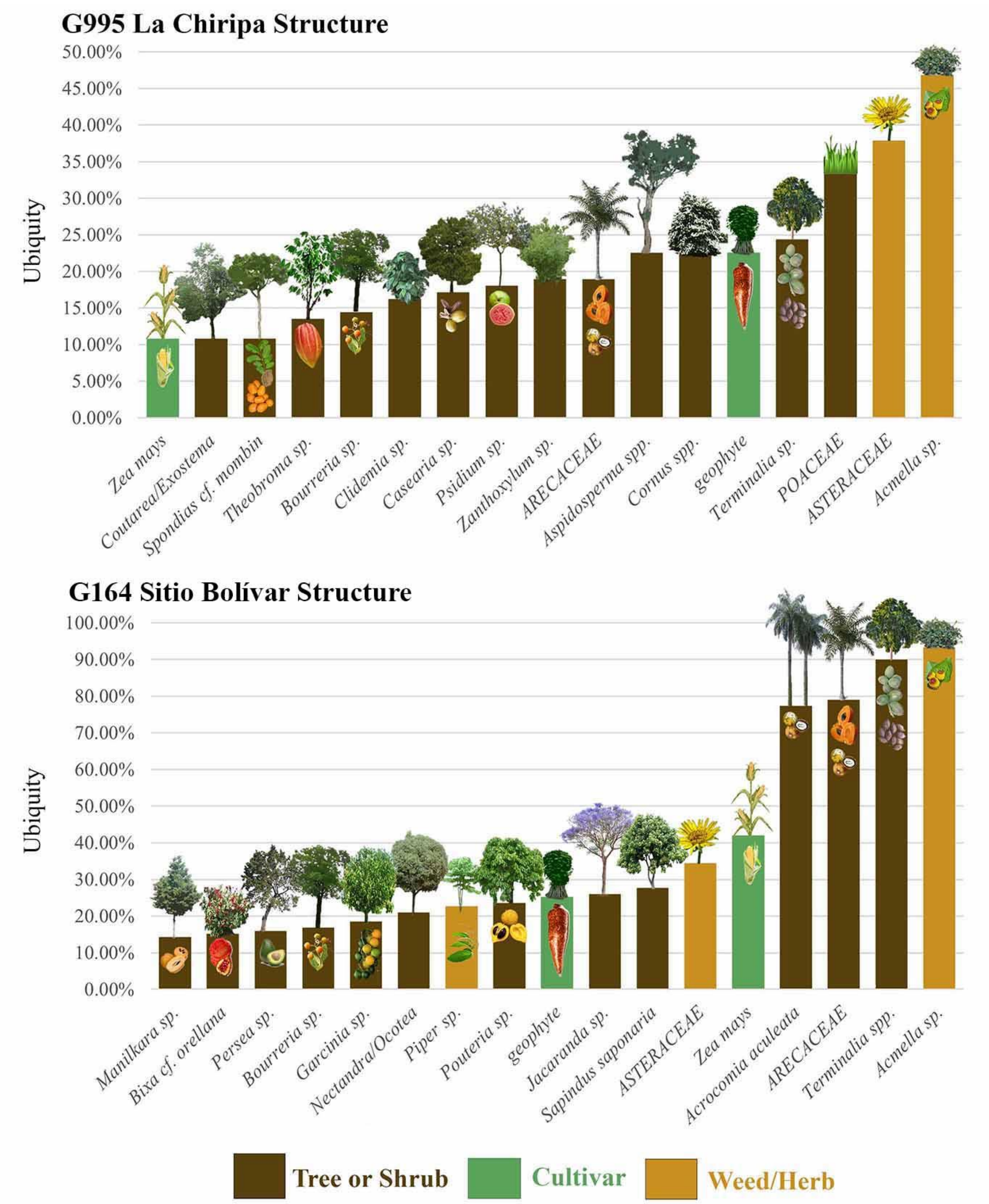


Figure 7-27: *The most ubiquitous plant taxa recovered from only the stratigraphic levels associated with the domestic structures at La Chiripa and Sitio Bolívar. If the plant produces edible parts they are pictured within its bar.*

This intentional selection of certain taxa is more obvious when the elevation of these two sites are compared to present day data of species richness, diversity, and distribution in Costa Rica. Lieberman and colleagues (1996) found that species diversity within the tropical forests in southern Costa Rica was greatest at 300masl with 149 species per hectare and that both species richness and diversity decreased both above and below this altitude. La Chiripa is situated at roughly 950 masl and Sitio Bolívar at 550 masl, which would suggest that La Chiripa, the settlement at a higher elevation, should have a lower species richness and diversity compared to Sitio Bolívar if the assemblages followed extant flora composition. Since the opposite composition is depicted within these dataset, it is clear that the villagers' selection of taxa was not consistent with the natural forest composition. The forests of Monteverde, which is adjacent to the Arenal region but situated at higher elevations of 1480m asl, exhibits a species richness of 111 species per hectare (Nadkarni et al. 2000: 318). The Monteverde data in combination with Lieberman (et al. 1996) suggests that the species richness found at both La Chiripa and Sitio Bolívar are in the expected ranges for the country and neotropical setting overall.

This phenomenon can also be observed when comparing the most ubiquitous plant taxa from each site and structure (Figure 7-27), which provides a more detailed view of the taxa beyond just diversity indices. Ubiquity measures for taxa at La Chiripa never amount to a great enough percentage to suggest that any particular plant was present within the majority of sampled contexts (over 50%), whereas this level of ubiquity did occur for a few taxa at Sitio Bolívar. Paracress achenes (*Acmella*, 93.3%), wood charcoal from the black olive tree (*Terminalia* cf. *buceras* (L.) C. Wright, 89.9%), and palms such as coyol (*Acrocomia aculeata* [Jacq.] Lodd. ex Mart., 77.3%) absolutely dominate the botanical assemblage at Sitio Bolívar with high ubiquity measures. The ubiquity measures for these three plants are so high that they could indicate direct use of these taxa within the domestic structures encountered during the excavations. Paracress may have been an herb growing along the structure's perimeter; its growth may have been encouraged for easy access to its flavorful leaves. Its achenes are plentiful and lightweight, meaning a strong wind could easily distribute them across a space, which could explain their wide distribution and nearly constant presence at the site. Wood from both *T. buceras* and *A. aculeata* have been described as heavy, strong, tough, and durable; both have been documented as being used for construction purposes as beams, posts, poles and other materials (Chudnoff 1984, Little and Wadsworth 1964, Lorenzi 2002). Perhaps the walls of the Sitio Bolívar structures incorporated the coyol and black olive trees. Another taxa that was quite prevalent along the structural floor level (Nv. 5) at Sitio Bolívar was *Cecropia* (guarumo), which has been documented as rot-resistant wood favored to be incorporated as poles in the construction of circular houses nearby Arenal in Nicoya (Hazlett 1985: 342, Koshear 1995: 44). It is also possible that these two trees were highly sought after as a source of firewood and fuel, as they have also been noted as excellent sources of charcoal (Berni et al. 1979, Chudnoff 1984).

The most ubiquitous woody taxa at both sites is *Terminalia*. Multiple species within this genera were recorded at each of these domestic settings including *T. amazonia*, *T. buceras*, and *T. oblonga* (Ruiz & Pav.) Steud. (none of which produce edible fruits). Not all species of the genus produce edible fruits or seeds and not all specimens were able to be identified to the species level, so it is not certain if the edible species were present or necessarily dominant at these sites. The wood from this genera was clearly preferred for fuel purposes though, as evidenced by its dominance in terms of both ubiquity and density (see Figures 7-10, 7-24, 7-27). Kernels of ripe fruit of *T. catappa* L. are eaten fresh or roasted and found in Costa Rica today, but this particular species is not native to the region (Lim 2011). Wood charcoal from *Terminalia* was also recovered from Cerén in El Salvador, where the tree was growing within a preserved milpa agricultural field (Slotten and Lentz 2021). Today the genera is mostly valued for its durable wood and so it is used for construction purposes (Barwick 2004), as it may have been at Sito Bolívar as well.

7.6 In Conclusion

This chapter has initiated the discussion of the paleoethnobotanical data recovered from La Chiripa and Sitio Bolívar through a basic presentation of the taxa by ubiquity and standard densities in regards to the stratigraphic levels and contexts in which they were found. Based on these data, Chapter 8 will look at a more detailed view of the Arenal region's forests and Chapter 9 will discuss the dietary practices within this region through time.

CHAPTER 8

THE PAST FORESTS OF THE ARENAL REGION

A total of 121 tree genera and 39 shrub genera have been identified from the macrobotanical remains collected from the archaeological sites in the Arenal region of Costa Rica, La Chiripa and Sitio Bolívar. While this assemblage of arboreal species cannot accurately depict the true composition of forested spaces in the Arenal region in the past, it can indicate what forest types these inhabitants interacted with and valued in order to obtain their desired resources. This is because all of the plant remains recovered from these archaeological sites interacted with people in some form, so any analysis of the taxa would not include plants that existed within the Arenal landscape but were not transported back to the domestic structures which were sampled. Neither of these sites were directly buried by ash from a volcanic eruption, thus all recovered carbonized material from cultural levels would have been burned by the residents occupying these spaces. With the rare exceptions of the *Terminalia* fruits at La Chiripa and the *Piper* seeds at Sitio Bolívar, these trees and shrubs were identified from carbonized wood remains and thus were ultimately used as a fuel by the villagers of the Arenal region.

Information gathered about all 160 of these arboreal taxa provides insight into the types of forests in which people valued and spent time within in order to gather their botanical resources in the past. This could be on a broad level, for example if the wood assemblage indicates dry versus moist tropical forest spaces or well-developed primary growth stands compared to younger secondary growth forests. These arboreal taxa are linked to specific types of ecological settings such as riparian zones along a lake, river, or stream, open grassland savannas without a heavy tree cover, coastal forests along the Pacific or Atlantic shores, or disturbed settings that have been heavily altered by either human activity such as agricultural fields or settlements. Each of these trees have known growth habits which determine at what elevations they can successfully grow, what type of organisms may be required to aid in pollination and seed dispersal, their preference of soil in order to thrive, and what temperatures and precipitation levels they can accommodate. Certain taxa are more or less tolerant of growing conditions such as extreme circumstances involving drought or fires, or simply the ability to grow when covered by the shade of another tree. This assemblage can elucidate what portion of the forests the Arenal villagers obtained their woody resources from, whether that was the tallest trees towering above others in the canopy or the easier to access plants from the forest understory. The degree of exploitation of these forested spaces can also be explored through analysis of these anthracological remains. Using these topics, this chapter will delve deep into the woods of the Arenal region in the past and examine the ways in which these villagers engaged with their forested surroundings throughout several millennia.

8.1 The Quality and Nature of Fuel Resources

Analysis of the anatomical features of wood charcoal from Arenal can reveal the village resident's practices regarding which resources to burn as fuel. One aspect of fuel use that can be examined is if these domestic spaces prioritized seasoned wood rather than green wood. This aspect is visible in anatomical views of the charcoal fragments because wood cells that are full of moisture will more often rupture and combust once burned. This breakage is most common along the rays (Marguerie 1992, Prior and Alvin 1983), which run transversally (horizontally) through the wood to transport material radially from the cambium to the pith. Radial cracks present in charcoal occur as a result of the shrinkage of wood that is amplified during the carbonization process (Théry-Parisot and Henry 2012: 382). Zicherman (1981) argues that radial cracks appear between 200 and 270°C and are due to the shrinkage resulting from the evaporation of moisture and the plastic flow of thermal stress. Recently, as experimental studies of charcoal anatomy have increased, some scholars (Théry-Parisot 2001, Théry-Parisot and Henry 2012, Zicherman 1981) have argued that the occurrence of radial cracks is not directly correlated with the initial moisture content of wood prior to charring. This is because even seasoned wood, meaning wood that has been dried to a low moisture content, contains moisture bound in the internal structure of wood that when dried during combustion generates stresses leading to radial cracks. Therefore, the mere presence of radial cracks in charcoal does not directly equate to the moisture content of wood prior to carbonization. Other experimental studies have demonstrated that the presence of radial cracks can also be influenced by factors such as the size of the rays (Prior and Alvin 1983), thickness of fiber walls (Prior and Gasson 1993), proximity to the pith (Marguerie and Hunot 2007, Théry-Parisot 2001), the method of charring (Théry-Parisot and Henry 2012), and even the species (Théry-Parisot 2001), all have a great effect on the behavior of wood when charred. Théry-Parisot and Henry (2012) argue that a higher frequency of radial cracks occur in green wood (which has a higher moisture content) compared to seasoned wood, which has fewer but more developed radial cracks. Théry-Parisot and Henry's (2012) experimental study on pine wood demonstrated that 2 to 3 radial cracks per cm^2 occurred on seasoned wood and 8 to 34 radial cracks per cm^2 on green wood. With these studies in mind, anthracological analysis of the charcoal from La Chiripa and Sitio Bolívar included the recording of radial cracks and their frequency. Due to the small size of charcoal fragments in this present study (most often between 2 and 4mm in diameter), if more than one radial crack was observed it was marked as likely being green wood.

From my analysis, the majority of the wood charcoal recovered from both sites were seasoned or well-dried when they were charred, rather than being green wood (Figure 8-1). La Chiripa's wood assemblage contained roughly 27% green wood compared to Sitio Bolívar with about 32%. These data indicate that the people of the Arenal region were generally knowledgeable about the quality and burning capacity of wood they were using as fuel and made an effort to prioritize seasoned and dried branches or logs rather than 'green wood' when burning fuel. Seasoning wood is a process which can take several months to accomplish, likely more in a tropical forest setting like Arenal which experiences heavy rainfall for a large portion of the year. Wood that has been dried significantly prior to burning will result in less smoke and ultimately will be more efficient. The use of moist wood in a fire could indicate that these residents were potentially in desperate need of fuel resources or were not knowledgeable about the best practices for fuel resources. However, the small percentage of wood within this study that did exhibit excessive radial cracks could simply be attributed to the tropical environment which experiences heavy rainfall for a large portion of the year, thus making it more difficult to season wood. The fact that both archaeological sites exhibit a similar proportion of green wood to seasoned wood indicates that management of fuel resources was probably consistent through time, with such practices and knowledge being passed down from one generation to the next over millennia.

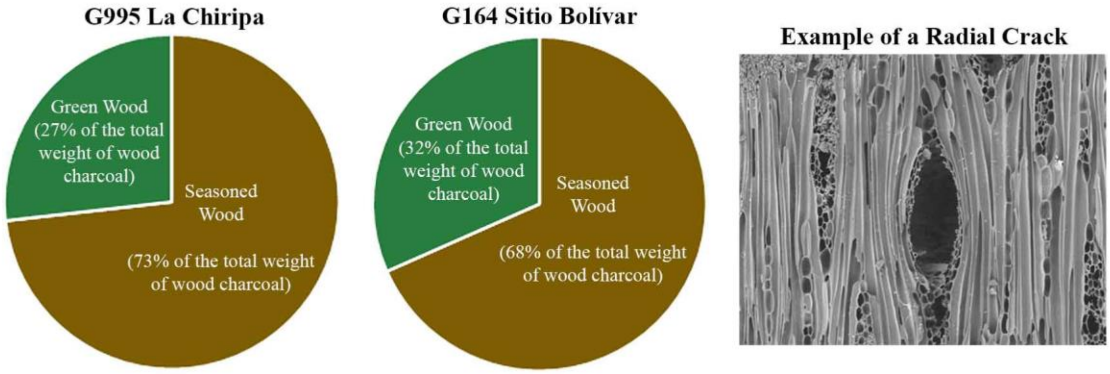


Figure 8-1: *Proportion of charcoal fragments at each archaeological site that exhibited a high frequency of radial cracks, indicating the use of green wood as a fuel. An example of this anatomical characteristic is also pictured.*

All of the woody taxa identified at La Chiripa and Sitio Bolívar were recovered in the form of wood charcoal, yet only 68 of the taxa have been documented as ideal sources of fuel or charcoal production (see Appendix N) (Barwick 2004, Condit et al. 2011, Fern 2022, Longwood 1962, Standley 1884-1963, Standley and Steyermark 1946, Zuchowski 2007). Surprisingly, although all of the wood was recovered in a carbonized form, the majority are not ideal sources of fuel. It is possible that their presence at the sites is not necessarily due to their intentional use in fire pits. If just the species recovered from within the hearth feature at Sitio Bolívar are considered, the percentage of woody taxa known to be suitable as fuel resources is still not overwhelming, only amounting to exactly half of the taxa and 55% of the total standardized density of the wood charcoal (g/L) (Figure 8-1). Perhaps, the quality of the fuel source was not a concern for the people of Arenal or much of the charcoal assemblage originated as deadwood, collected opportunistically. All of the trees and shrubs identified at the sites however have economic or ecological applications. Therefore, the abundance of various useful tree's in the environment could increase over time as people protected certain trees for the various resources they provide. Over time, the deadwood of these useful trees would naturally increase and could subsequently be collected as firewood (Dussol et al. 2017:30). Thus, the usefulness of the wood taxa recovered through wood charcoal analysis as fuel is not necessarily a reflection of the inhabitants' firewood preferences. Rather it could depict a broad spectrum of people's engagement with wood resources in the past.

8.2 Human Impact on the Tropical Woodlands

The charcoal specimens analyzed from Arenal were small in size, generally about 2 to 6mm in diameter. Such fragments are too small to determine a precise age using growth rings with classical methods of dendrochronology (Dufraisse 2006). Growth rings are scarcely visible in these tropical woods. However, the evaluation of ring curvature and the angle of the rays enables an approximation to which part of the tree was used (Marguerie and Hunot 2007:5-6). A flat or smooth curve with relatively parallel rays corresponds to the tree trunk or more mature wood. Whereas a stronger, marked curve and converging rays correspond to the branches or younger wood growth. Analyzed charcoal specimens were grouped into two broad categories of A) strongly curved rings with rays converging at an angle of 20° or more, and B) weakly curved rings with parallel rays (Marguerie and Hunot 2007). This examination was not a measurement of the diameter of the wood, but merely a characterization of if the wood came from small branches or large trunks/branches (Figure 8-2). The presence of bark or pith was extremely rare in this assemblage, so it was not possible to estimate the complete radius of any charcoal specimen.

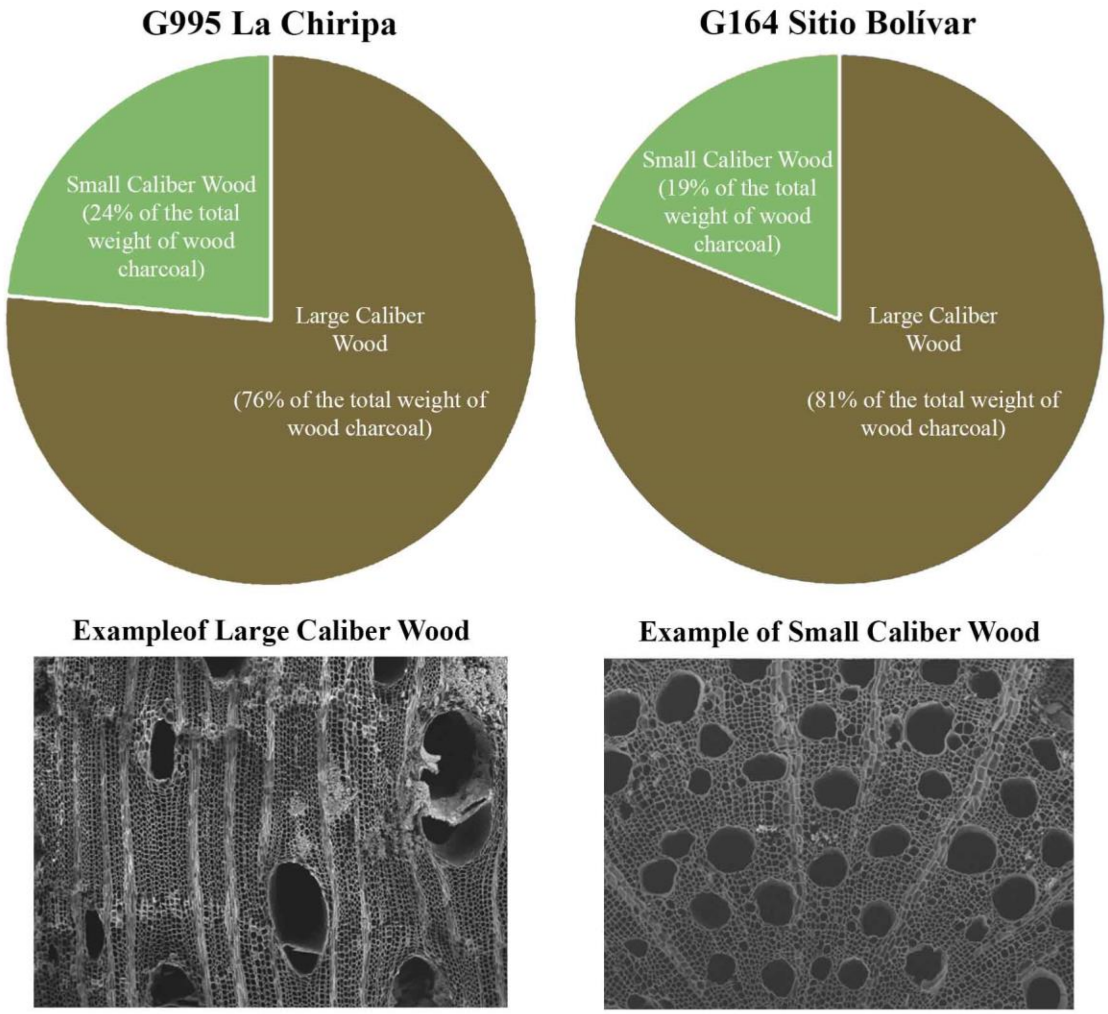
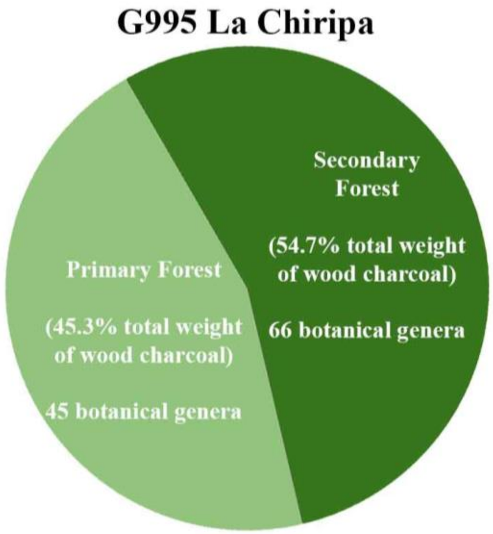


Figure 8-2: *The proportion of wood charcoal at each archaeological site that represented a large caliber of wood (tree trunks or large branches) compared to a small caliber of wood (immature trunks or small branches). This aspect was measured based on the angle of rays in the transversal view, with an angle of rays converging at greater than 20 degrees indicating a smaller caliber of wood.*

While a high species richness and wide range of taxa used as fuel (as seen in this study) could indicate opportunistic use of woody vegetation (Out 2022), analysis of the relative age and caliber of the wood fragments does not suggest opportunistic selection here, because the vast majority of the charcoal in the paleoethnobotanical assemblage was of high caliber, large wood specimens rather than young woody branches, collected for use by the villagers. When the total sum of young wood or branches versus mature wood from the trunk or large branches of a tree was calculated at both domestic structures, large caliber wood from either the trunk or larger branches of trees strongly dominates these fuel assemblages (76% at La Chiripa and 81% at Sitio Bolívar, see Figure 8-2). This indicates that fewer branches or young, immature trees were used for fuel by the past inhabitants of the Arenal region. Shrubs could potentially appear in this category of a smaller caliber of wood due to their trunks and branches generally having smaller diameters. Yet, when the taxa identification is considered, shrubs do not comprise a large proportion of the smaller caliber of wood categories (only 7% at La Chiripa and 3% at Sitio Bolívar). However, although both of these domestic sites exhibit a high diversity of taxa, they do not necessarily demonstrate an even distribution of species (Figure 7-23), which would indicate a non-selective process (Asouti 2019). The paleoethnobotanical results from Sitio Bolívar show a less equitable distribution compared to La Chiripa, and many of the taxa at Sitio Bolívar had much higher ubiquities as well, suggesting an intentional and selective process of obtaining woody fuel resources during the later time period.

This finding that the majority of the wood being older or of a larger caliber is unexpected. Typically, a sustainable forest management strategy would not use mature, large caliber wood for fuel purposes because it could rapidly deplete a forest (Asouti and Austin 2005). The collection of dead and fallen branches, which due to their smaller diameter would appear as a small caliber wood based on this criterion, would be a more sustainable practice because entire trees are not being felled and removed from the landscape, eventually leading to the destruction of the forest. In contrast, opportunistic collection of available dead wood would allow the forest to continue to thrive and to be available for future generations and descendent populations. Therefore, the Arenal wood dataset indicates that these people did not practice a wood collection strategy that promoted a long-term continuation of the forest composition.

This aspect of forest engagement can be examined not just through the anatomical characteristics of the wood charcoal, but also through an analysis of the taxa these villagers selected for firewood. One avenue in which this can be explored is through the composition of primary versus secondary forest taxa (Figure 8-3 and Appendix O). A primary forest (also referred to as an old-growth forest) is commonly perceived to be the climax forest type of an environment and secondary growth forests are successional forests that develop after the original forest has been cleared and/or substantial human and natural disturbances (Chokkalingam and de Jong 2001:19, Helms 1998). Old growth forests in the study area of Costa Rica have been defined by indicators of the absence of stumps, the occurrence of emergent trees, and the presence of large lianas and slow-growing understory of palm species (Chazdon 1992, Guarigata et al. 1997). Secondary forests notably are providers of environmental services such as protection from erosion, atmospheric carbon fixation, refugia of plant biodiversity in otherwise fragmented landscapes, and providers of useful plants (Chazdon and Coe 1999, Fearnside and Guimares 1996, Guariguata and Ostertag 2001, Lamb et al. 1997, Toledo et al. 1995, Voeks 1996). Examination of forest compositions in modern day northeastern Costa Rica demonstrate that species richness is consistently lower in secondary forest stands compared to old-growth stands (Guariguata et al. 1997:111).



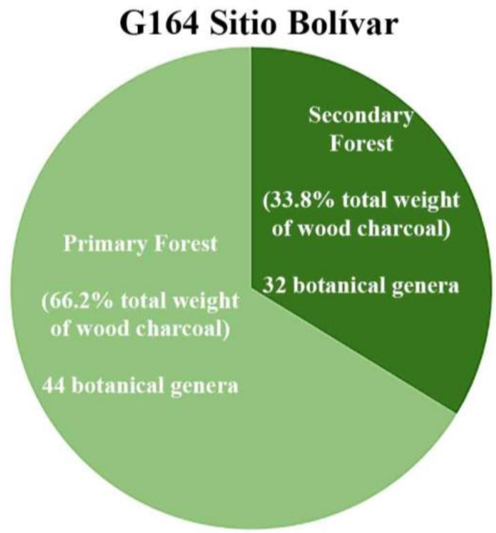


Figure 8-3: *The proportion of recovered and identified wood charcoal that represents taxa known to grow within primary forests versus secondary forests at each archaeological site.*

At La Chiripa, there is a relatively even distribution of tree taxa from primary forests (45.3%) compared to secondary forests (54.7%) in terms of weight of the charcoal. It is relevant to think about the timing of this site's main occupation relative to Arenal Volcano's activity during the Tronadora phase. Using Egan's (2019) refinement of this region's time periods and volcanic events, we know that the La Chiripa structure was first inhabited between 1637 and 1534 BCE and that the most recent cataclysmic eruption of Arenal prior to this time period was AT-8's subplinian eruption circa 1692 BCE. AT-8 had a Volcanic Explosivity Index (VEI) of 4 and thus a far-reaching pyroclastic flow and tephra-fall deposits. This means that the landscape surrounding La Chiripa had been heavily impacted and altered less than a century before the residents moved into this space, thus increasing the likelihood that forests surrounding La Chiripa were secondary in nature rather than primary. Burial by tephra can impart a significant influence on vegetation (Ayris and Delmelle 2012), but unfortunately AT-8 was an early eruption of Arenal Volcano that was poorly recorded and therefore the extent and impact of this eruption was not able to be modeled by Egan (2019). Nevertheless, the chronological proximity of AT-8 to that of the La Chiripa structure's occupation suggests that a mixed use of secondary and primary forest vegetation could be more a reflection of the ecological setting at that time rather than a preference by the past inhabitants.

The majority of the wood charcoal recovered from the Late Arenal phase village at Sitio Bolívar, when measured by weight (g) per liter sampled (66.2%), comes from trees that would have occupied a primary forest with old growth stands of trees. This is a greater presence than seen at La Chiripa during the earlier Tronadora phase. When the volcanic activity during the Arenal phase is considered, especially in respect to Sitio Bolívar's main occupation, it is possible that this distinction in taxa is more reflective of the forest's actual composition rather than the residents' selection of fuel resources. The forests of Arenal had multiple centuries to become well developed at the time that the Late Arenal phase occupation of the Sitio Bolívar village existed (CE 430-540). The most recent eruption of the Arenal Volcano was several hundred years prior with AT-16 circa CE 101, a violent strombolian eruption with a VEI of 4 that would have buried the area of Sitio Bolívar with roughly 60mm or more of tephra (Egan 2019:131-144).

The fact that there are so many old growth trees represented at Sitio Bolívar could suggest that these villagers and people in the region overall were not depleting their forests. Since it had been many centuries since the landscape had to recover from a volcanic eruption, it is expected that the forests were well developed at this time. Mazón and colleagues (et al. 2020:5) found that forests at low elevations in Costa Rica have a limited recovery with slower tree growth after disturbances compared to other elevations, which suggests that the forests surrounding Sitio Bolívar would have taken even longer to recover compared to those closer to La Chiripa. This makes it even more impressive that taxa common to primary forests dominate the charcoal assemblage at Sitio Bolívar. Furthermore, if the results were the opposite, showing more secondary forest tree species, this demonstrates that the people of Arenal were over-exploiting their forests and few primary growth stands were available. Therefore, because so many old growth trees that occupied the canopy layer of a forest were present in both assemblages, these results indicate that the forests were thriving, healthy, and well-managed. An additional perspective is that old growth forests were certainly much more common during the past than they are today (Chazdon 2014, Gómez- Pompa et al. 1972). Today, much of the Arenal region has been cleared of forests and is used for cow pasture or large urban settlements.

It must be noted however, that there is not a clear, concise distinction between these two forest types. The differences in development and growth between the two categories should be viewed as more of a gradient where a secondary growth forest eventually over time recovers from the disturbance that disrupted its previous form and transitions to being considered an old growth forest. The timing and composition of this distinction varies greatly around the world and is not necessarily agreed upon by scholars, since understanding how forests recover after a clearance is still a current research topic (Guariguata and Ostertag 2001). Much of the emphasis of research that has been conducted focuses on which species dominate the various stages of succession (e.g. Finegan 1996, Guariguata et al. 1997, Gomez-Pompa and Vazquez-Yanes 1976, Peña-Claros 2003), which can be addressed for example with an examination of the pioneer species present within this paleoethnobotanical assemblage.

Many of the trees identified from strata associated with the structures at La Chiripa (n=49, Figure 8-4 and 8-5) and Sitio Bolívar (n=38, Figure 8-6) are considered to be pioneer species (see Appendix O), meaning they are fast-growing trees that would be the first plants to fill a landscape that is recovering from a disruption. Pioneer species are considered to be light-demanding, short-lived, with early maturation, fast growth, high reproduction rates, and often established in open areas (Martínez-Ramos et al 2021: 3573). Many of these trees are valued for their ability to prevent soil erosion, including *Anacardium* (cashew), *Swietenia* (mahogany), *Calliandra* (gallito), *Simarouba* (aceituno), *Capparis* (caper bush), and *Parkinsonia aculeata* L. (palo verde); all of which were identified from both sites in this study. *Trema* and *Cecropia* trees, are among the most abundant pioneers of neotropical forests (Alvarez-Buylla and Garay 1994, Hartshorn 1978, Martínez-Ramos et al. 2021). It is expected that such trees would be common in a region that experiences frequent environmental disasters and disruptions to the landscape, so their presence in the anthracological assemblage documents the remnants of a recovering ecosystem.

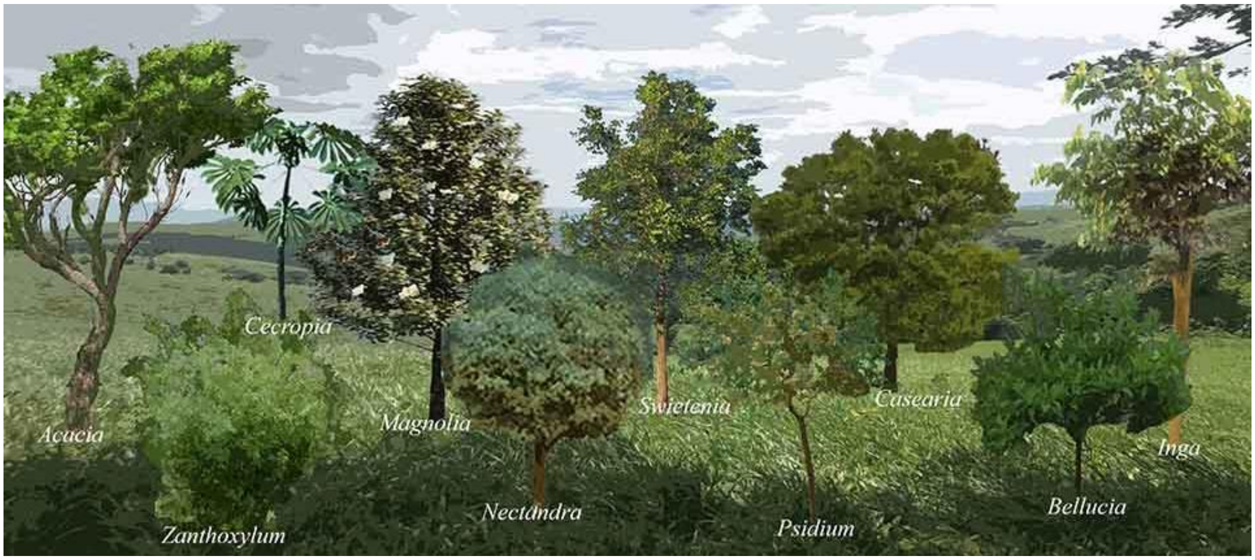


Figure 8-4: *Artistic reconstruction of the landscape surrounding La Chiripa using the most ubiquitous pioneer taxa identified at the site, which is situated at roughly 950 masl along the continental divide in the Premontane Transition zone of the Tropical Moist Forest. Taxa included are Acacia, Bellucia, Casearia, Cecropia, Inga, Magnolia, Nectandra, Psidium, Swietenia, and Zanthoxylum.*

Succession of plant communities in secondary growth forests is complex and not necessarily a predictable process (Martínez-Ramos et al 2021, Norden et al. 2015), so it is difficult to determine precisely which stage of succession each of the pioneer taxa identified within this study occupied. Yet it is interesting that there was a strong presence of pioneer taxa among both assemblages that could have been early inhabitants of the Arenal forests after volcanic episodes. Even though La Chiripa contained wood charcoal from a greater variety of pioneer taxa, the ubiquity rates of such taxa at Sitio Bolívar was far greater (Figures 8-5 and 8-6). Trees such as *Zanthoxylum*, *Garcinia*, *Nectandra/Ocotea*, *Sapindus saponaria* L., and *Terminalia* all have ubiquity measures at Sitio Bolívar that are greater than any pioneer taxa present at La Chiripa. *Terminalia*, in particular, absolutely dominates the dataset with multiple species identified within this genus at both sites (*T. amazonia*, *T. buceras*, *T. catappa*, and *T. oblonga*), but more so from the Late Arenal phase structure at Sitio Bolívar (ubiquity of 89.9% at Sitio Bolívar, 24.32% at La Chiripa). *T. amazonia* and *T. oblonga* were found to be among the most productive species in terms of growth in young secondary forests and open pastures in the Talamanca region of Costa Rica (Piotto 2007), along with *Rollinia*, *Cordia*, *Virola*, *Abarema*, *Inga* (of which, the latter 3 were also identified from these archaeological sites). The *Terminalia* genera varies in growth rate, but is generally moderate compared to many other pioneer taxa (Finegan et al. 1998). Other trees found at these two sites such as *Cavanillesia*, *Croton*, *Inga*, *Jacaranda*, *Ocotea*, *Protium*, *Sapium*, *Simarouba*, *Trema*, *Virola*, *Vochysia*, and *Zanthoxylum* grow at very fast rates of greater than 1 cm per year or greater in terms of DBH (Condit et al. 1993, Finegan et al. 1998), suggesting that they may have been among the earliest of pioneer species in the Arenal landscape. Yet most of these taxa are only mildly ubiquitous at either of these sites, with the exception of *Jacaranda* which was the eighth most common taxa at Sitio Bolívar in terms of ubiquity. Of the 23 genera documented by Condit and colleagues (1993) to be the fastest growing trees under optimum light at Barro Colorado Island in Panama, only 9 were not identified within this archaeological investigation into the Arenal region. Among these, *Vochysia*, *Jacaranda*, and *Simarouba* are widely-distributed species which may be present within old-growth forests, but are much more common in heavily disturbed landscapes due to their fast growing nature (Condit et al. 1993, Finegan et al. 1998). Many of these pioneer taxa are valued today for their ability to recoup degraded soils and aid in the regeneration of forest cover (Condit et al. 1993).

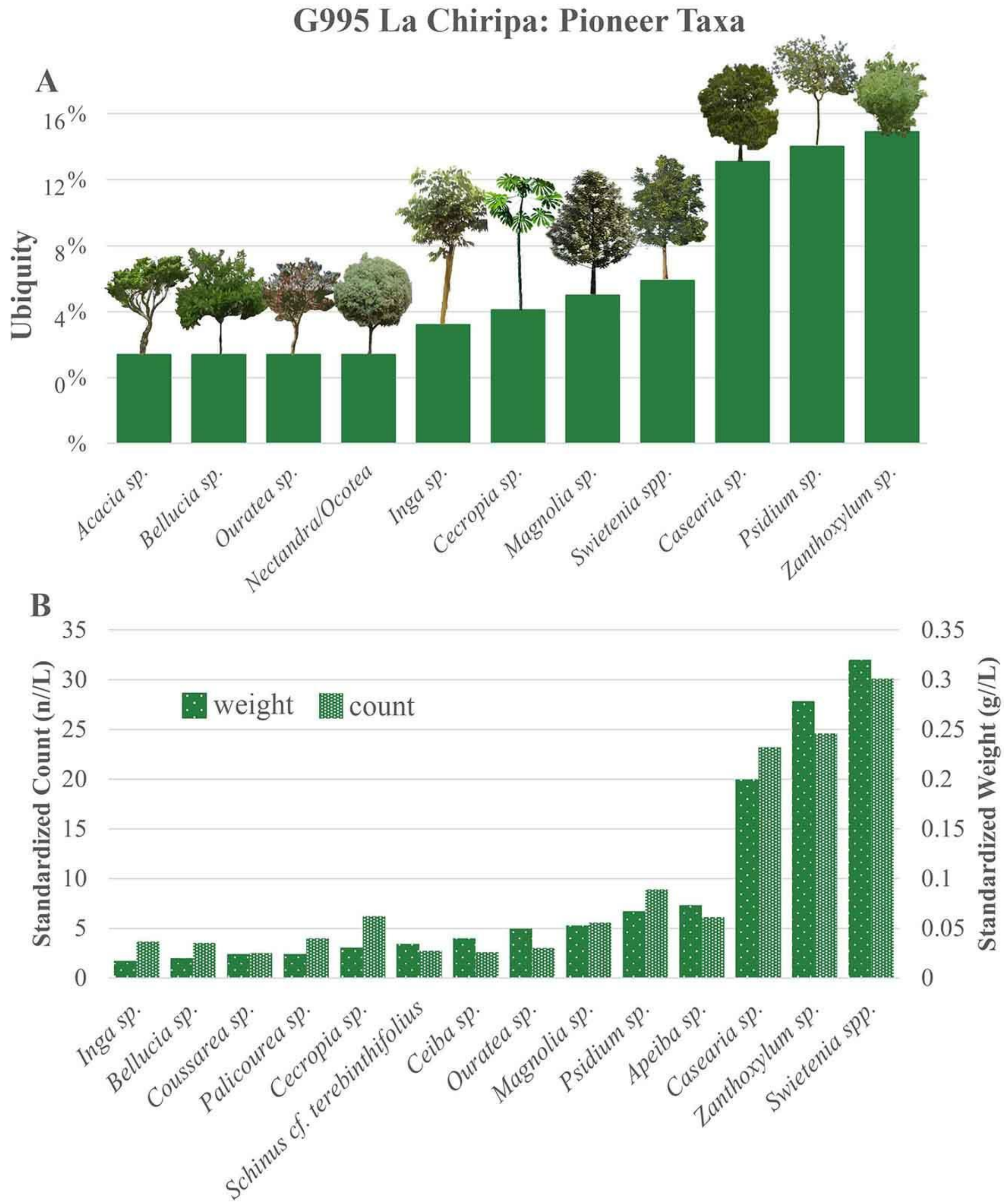


Figure 8-5: *Pioneer trees recovered from the stratigraphic levels associated with the structure at La Chiripa. Graph A displays the most ubiquitous pioneer taxa and Graph B displays the pioneer taxa with the highest standardized densities.*

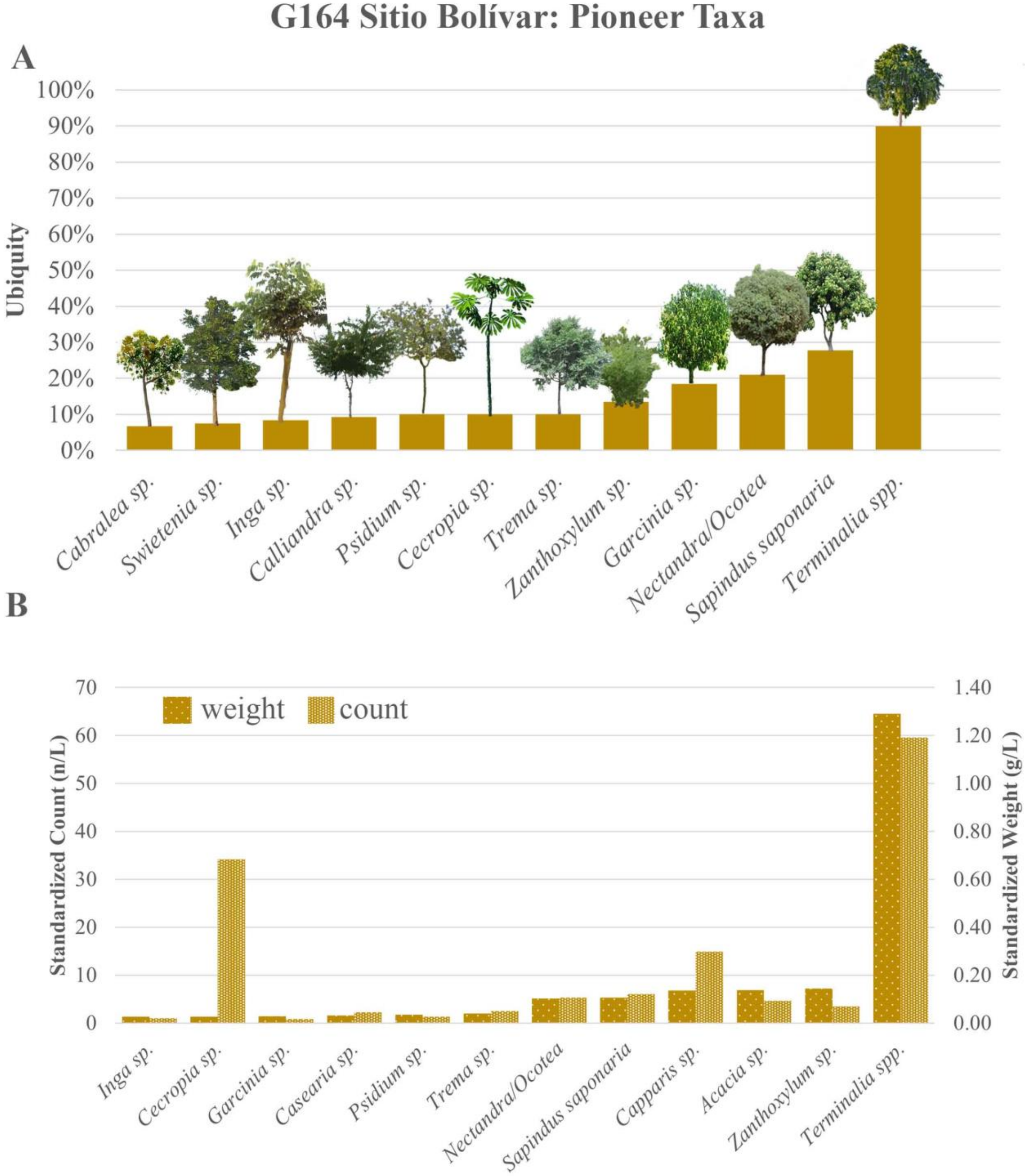


Figure 8-6: *Pioneer trees recovered from the stratigraphic levels associated with the structure at Sitio Bolívar. Graph A displays the most ubiquitous pioneer taxa and Graph B displays the pioneer taxa with the highest standardized densities.*

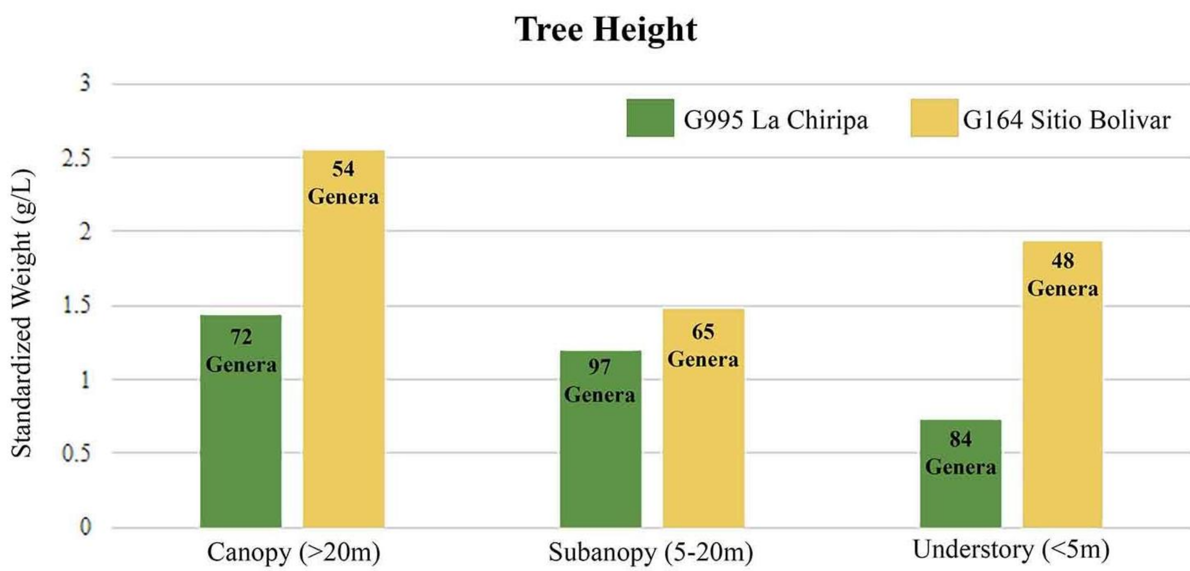


Figure 8-7: *Height of the tree taxa identified from both archaeological sites as compared by the sum of the standardized densities (g/L). Arbitrary limits were defined in order to distinguish the arboreal taxa and place them into groups (based on Finegan et al. 1998, Nadkarni and Wheelwright 2000): canopy trees include any taxa that can grow to heights greater than 20m, subcanopy trees include those taxa that can grow to heights between 5 and 20m, and understory trees include tree taxa that grow to a maximum height of less than 5m.*

When the height of the different identified arboreal taxa at La Chiripa and Sitio Bolívar is compared, a diverse forest composition is evident. While such a measurement is normally estimated in a way that involves the diameter at breast height (DBH) measurement, this type of calculation was not possible with the charcoal fragments. Instead, this height was determined by botanical descriptions of these identified taxa's potential using a variety of resources (e.g. Condit et al. 2011, Fern 2022, Zuchowski 2007). Trees that would have occupied the canopy, subcanopy, and understory of a forest are all present at both of the sites in the wood charcoal (Figure 8-7). The canopy is the uppermost layer of vegetation, generally associated with tall, woody plants, and is considered to be a structurally complex and ecologically important subsystem of a forest (Nadkarni et al. 2004, Parker 1995, Richards 1954). The understory, just as it sounds, is composed of the underlying layer of vegetation of a forest, most often including the small trees and shrubs growing closer to the forest floor. While both secondary and primary forests technically contain a canopy, only primary or old-growth forests would contain the very large trees that were included within this criterion and calculation (Guariguata and Ostertag 2001).

Based on the overall weight of charcoal in the analyzed samples, canopy trees are the most abundant at both settlements despite a greater number of taxa identified representing the sub canopy or understory of the forest (Figure 8-7). This suggests that the villagers of the Arenal region were not selecting their wood resources from just the smaller, shorter trees in a forest that would have been easier to access, and perhaps younger in growth development. They were frequently interacting with, and perhaps felling, canopy trees and collecting their wood for their use whether that was for fuel, construction, or other purposes. It is certainly possible that some of the canopy wood they acquired for use as a fuel were naturally knocked down and opportunistically collected, but the higher proportion of these taxa within the charcoal assemblages at both sites suggest some level of intentional engagement and procurement. The La Chiripa charcoal assemblage had a lot of canopy trees growing greater than 30m in height that were not found at Sitio Bolívar, including well known trees such as *Ceiba*, *Sloanea* (terciopelo), *Cedrela* (cedar), *Myroxylon balsamum* L. Harms (bálsamo), *Quararibea* (molenillo), and *Apeiba* (peinecillo) (Dünisch et al. 2003, Gribel et al. 1999, Humphries 1978, Santamaría-Aguilar and Fernández 2015, Vozzo 2004). While archaeological plant assemblages do not accurately represent extant flora composition, as mentioned previously, it is possible that the La Chiripa site was situated closer to or perhaps within a forested space with larger canopy trees because it is located at a higher elevation (roughly 950 masl) compared to Sitio Bolívar which is lower in a valley by Lake Arenal (roughly 540 masl). Modern forests in Costa Rica contain a greater density of larger trees at higher elevations, whether they are a primary or secondary forest (Mazón et al. 2020).

The large trees that would occupy the upper canopy of a forest and would have been more likely to survive a less severe volcanic eruption or be more distant from the volcano, allowed people to continue to engage with them as a resource despite such a recent environmental event. Additionally, forests at higher elevations such as La Chiripa would have been less impacted by and less vulnerable to disturbance events (Mazón et al. 2020). Thus, the development of cultural practices that heavily relied upon canopy taxa may have been an adaptation to living in a volcanically active landscape. These results corroborate the same data presented earlier, that primary forest taxa were more commonly engaged with at the site and likely surrounding the settlement since primary forests have a greater presence of large canopy trees. These results also are linked with the anthracological data that indicated that the majority of wood charcoal came from large tree trunks rather than small branches. Considered together, these data depict practices in which the people of both of these past settlements collected their forest resources primarily from large, tall, and mature trees.

Some of the wood charcoal identified at Sitio Bolívar come from trees that are considered vulnerable, critically endangered, or threatened today according to the IUCN Red List of Threatened Species (2009) including *Aspidosperma*, *Avicennia*, *Bourreria*, *Cedrela*, *Couratari*, *Dalbergia*, *Erythrochiton*, *Hedyosmum*, *Manilkara*, *Perrottetia*, *Platymiscium*, *Protium*, *Swietenia*, and *Zanthoxylum*. Most of these are not present in high quantities at the site (Figure 8-8), but their presence does show us how the forest's composition today has changed from the past when many of these trees may have not been as scarce within Costa Rican forests. Other than *Aspidosperma*, *Bourreria*, and *Zanthoxylum*, the majority of these trees were found in low ubiquities in these samples and therefore were not heavily exploited by the residents of the Arenal region. *Aspidosperma* (aracanga), *Manilkara* (sapodilla), and *Swietenia* (mahogany) are all dominant hardwoods today in the Central Maya lowlands (Ford 2008). Many of these trees however, are valued as a source of timber and are strongly desired today in logging and harvesting activities (such as *Cedrela*, *Couratari*, *Manilkara*, and *Swietenia*), and this value may have led to their overexploitation and low presence in modern forests. It is unclear if the villagers at La Chiripa or Sitio Bolívar valued these trees for their strong potential in construction since they were recovered as a source of fuel as wood charcoal, not as beams incorporated into structures.

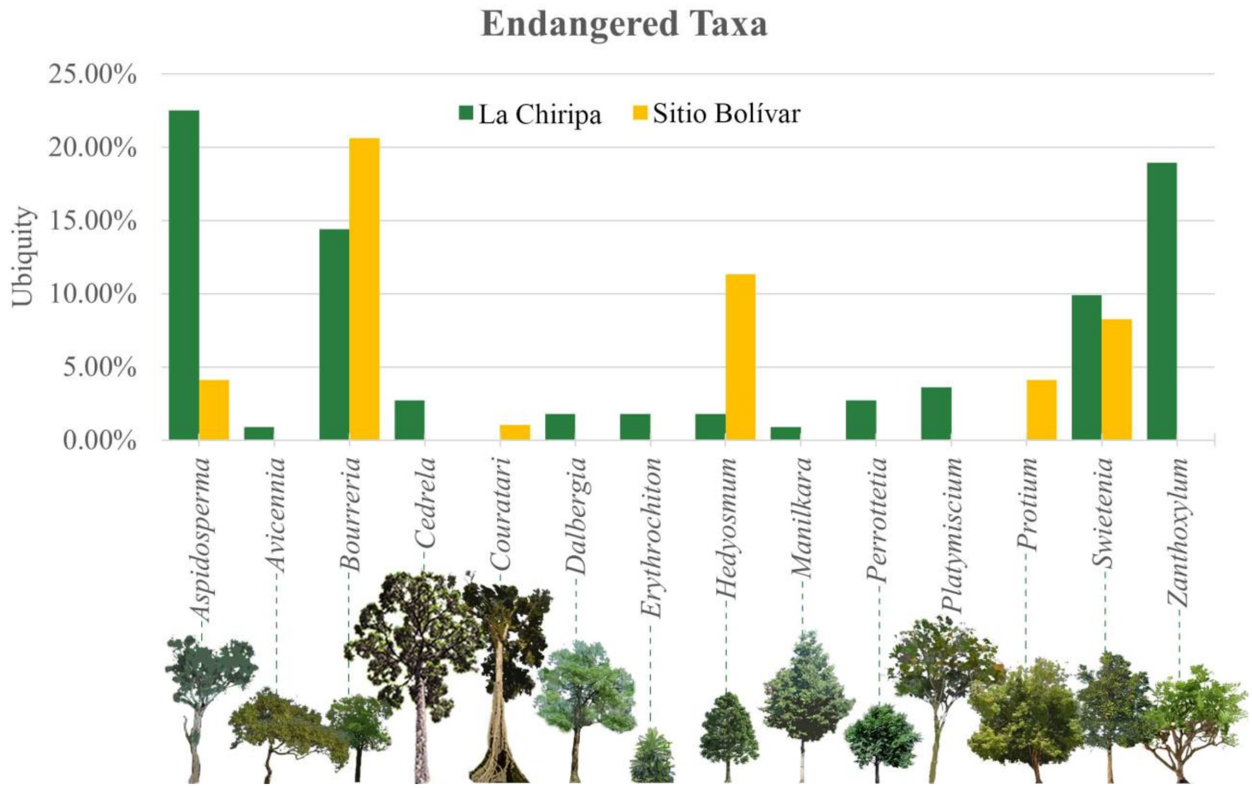


Figure 8-8: *Identified taxa from the paleoethnobotanical assemblage that today are vulnerable, critically endangered, or threatened according to the IUCN Red List of Threatened Species (2009).*

The *Bourreria* (canalú) tree was of ritual significance to the ancient Maya and has been identified from multiple archaeological sites in the region (Ancona et al. 2019, McNeil 2012). Today, *Bourreria* is incredibly rare with only a few known trees growing in Central America; each of them having lived for hundreds of years (McNeil 2021:140). Pollen from the fragrant white flowers of *Bourreria* (canalú) were recovered from multiple temples and tombs at Copan in Honduras as offerings or sacred trees. It is thought that the trees would have been planted surrounding temples (McNeil 2012, 2021). The flowers are so intensely fragrant that "only a handful of blossoms will fill a room with their scent in the evening, when the flowers smell the strongest (McNeil 2021:139). The Mexica of highland Mexico also associated *Bourreria* flowers with ceremonies; they used them as offerings in temples, in gardens, incorporated them into cacao beverages, and even waged a war against the Mixtec over the procurement of these trees (Sahagún 1950-1982). Both the Aztec and Maya used *Bourreria* to heal wounds and incorporated their flowers into funerary rites (Atran et al. 2004:96, Kremer and Flores 1996, Sahagún 1950-1982). Since wood charcoal from *Bourreria* was among the most ubiquitous plant remains at both La Chiripa and Sitio Bolívar, it is likely that the villagers of Arenal also placed a sacred emphasis on its flowers in their own daily lives.

Today, the greater emphasis on exploitation of large trees occupying the canopy of a forest would not be considered a sustainable practice. Whereas, the diverse assemblage and high species richness in the paleoethnobotanical results (see Chapter 7) show that the Arenal residents had an abundance of plant resources that they utilized. Thus, it is possible that these villagers were not concerned about depleting their forest resources because their environment was so incredibly rich in plants and taxa. [Perhaps the consideration to preserve the forest resources for the future may not have been a major concern in the lives of these people.] The relatively small Arenal population lived in a flourishing tropical forest that provided plentiful resources. Population densities in the Arenal area were low during all cultural phases investigated, with just a few households per square kilometer according to Sheets (2011:428). It is likely that these peoples were aware that their landscape would change dramatically every few centuries, due to volcanic episodes occurring at a regular rate of every few centuries. Thus, their own impact on the forests may have been viewed as minimal compared to that of Arenal Volcano's regular disruptions to the entire region. Many native populations of the Americas viewed their engagement with all living things as harmonious, rather than as oppositional or destructive (Kimmerer 2013, Niigaaniin and MacNeil 2022, Taube 2003). Hanks notes that "the forest belongs to the Maya and they to it" (Hanks 1990:389). Instead of the Arenal residents viewing their resource procurement practices as exploitative, it could be that these people simply chose to rely more on arboreal resources for their daily needs because the trees were reliable. In addition, large canopy trees were more likely to survive minor volcanic episodes and the impacts of more catastrophic eruptions at their distance from Arenal Volcano compared to more susceptible shrubs and understory growth.

8.3 Forest Types and Life Zones of Arenal

Today, Central America is a mosaic of different ecological settings including forests, savannas, agricultural fields, and pastures that have all been impacted by human engagement (Ranere and Cooke 2003). Spanish chroniclers described Central America in the same manner in the sixteenth century (Cooke and Ranere 1992, Sauer 1966). Anthracological data from Arenal cannot accurately reconstruct the past environment because the data reflects trees and shrubs that were intentionally selected by people rather than a true reflection of the natural flora. However, depictions of the ecological systems in which these trees were growing, and therefore regions where the structure's inhabitants likely traveled to or traded with can be determined. When situated within the established environmental life zones (Holdridge et al. 1971), arboreal taxon recovered from La Chiripa and Sitio Bolívar represent every ecological zone in the area today (Figure 8-9 and 8-11, Table 8-2), not just the Premontane Wet Forest or Tropical Moist Forest in which the structures are situated. This suggests that people were certainly traveling to all of the different life zones in the Arenal region to collect their resources. Open forests, mixed forests, and savannas are not as common among the tree assemblage at either site or time period. This is not surprising since the region is characterized as a Tropical Wet Forest (Haber 2000). These results suggest that such settings were not as abundant surrounding the settlements or that people did not focus on the plants in those ecological zones.

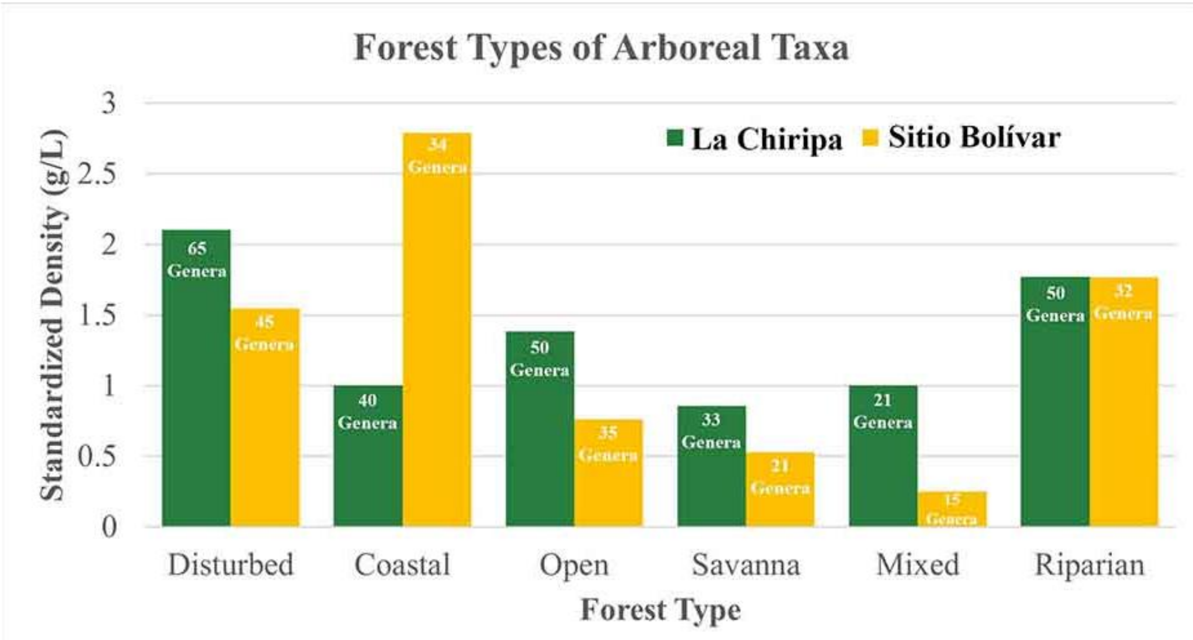


Figure 8-9: *Forest types represented by the anthracological specimen recovered from each archaeological site, indicating which ecological settings these villagers may have visited and engaged with in order to obtain their daily resources.*

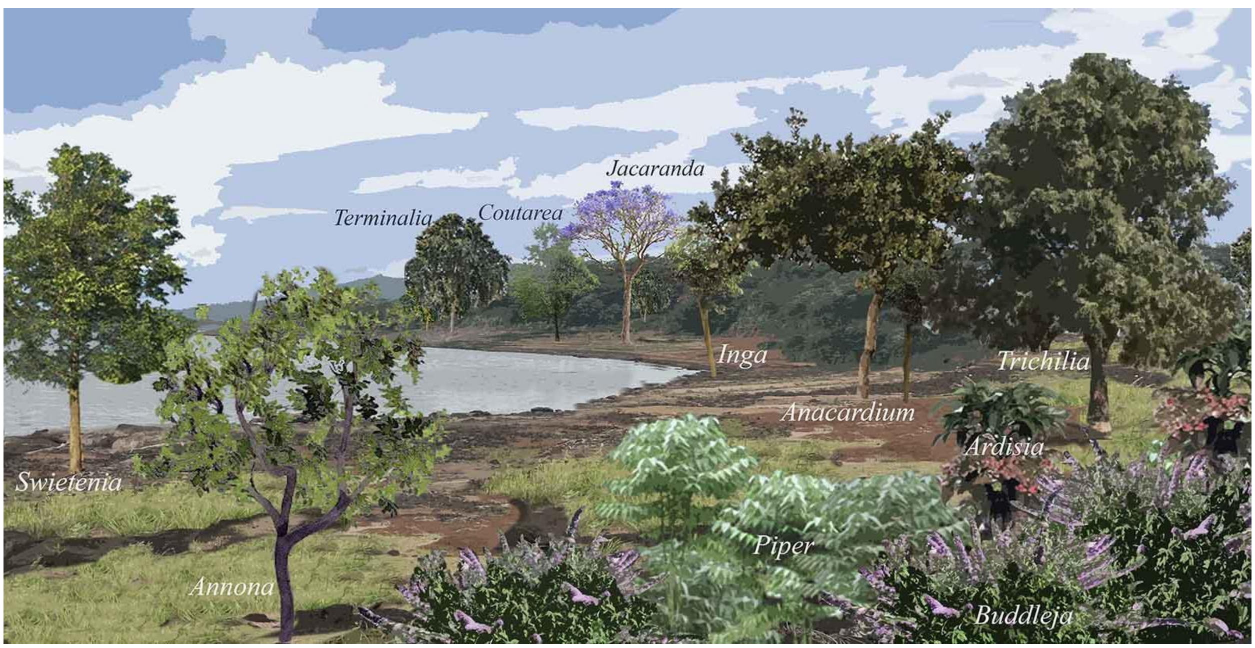


Figure 8-10: *Artistic reconstruction of the most ubiquitous riparian taxa identified from Sitio Bolívar including Terminalia, Jacaranda, Piper, Annona, Inga, Trichilia, Swietenia, Buddleja, Coutarea, Anacardium, and Ardisia.*

Both archaeological sites are mostly represented by plant taxa from riparian and disturbed environments, in terms of the quantity of taxa and standardized densities (Figure 8-9). Riparian trees are those that are common along water sources such as streams, rivers, and lakes. Riparian forests are ecologically important because they are a haven for plants and wildlife, with higher species richness measures compared to non-riparian forests, and they protect the water quality of rivers and lakes by serving as buffer zones from anthropogenic practices which may lead to erosion, deforestation, and pollutants (Brumberg et al. 2021, Luke et al. 2018). Riparian zones within tropical forests harbor even more biodiversity than their temperate counterparts (Bradshaw et al. 2009), which could be a partial explanation for the high species richness found in the Arenal region. The Sitio Bolívar village site is currently located directly along the shore of Lake Arenal and would have been in a similar position in relation to the lake in the past even though its levels have been altered dramatically over the past millennia (see Figure 5-8). Therefore, such a strong presence of riparian taxa is to be expected from these past settlements, especially Sitio Bolívar. These riparian taxa allow for a depiction of this village along the lake shore in the past (Figure 8-10), as it is today.

Ruderal taxa that depict disturbed habitats were expected within both site assemblages simply because habitation sites are disturbed habitats themselves, along with any land or ecosystem in which the biomass has been altered, whether natural or anthropogenic (Pickett and White 1985). Disturbances could include natural events such as volcanic eruptions, earthquakes, or floods. They could be anthropogenic disturbances such as human settlements, transportation corridors or pathways, or cultivated habitats which incorporate intentionally introduced plants. Various agricultural products such as maize, beans, squash, and geophytes were found within the samples at both settlements, so there definitely were cultivated agricultural spaces present nearby each of these homes in addition to managed forest spaces of fruit trees and shrubs. The taxa that are considered ruderal are quite abundant at both La Chiripa (65 genera) and Sitio Bolívar (45 genera) overlapping significantly with pioneer taxa, discussed above.

8.4 Ecological Life Zones, Trade, and Travel

It is interesting that based on overall weight, the type of forest that is most represented at Sitio Bolívar are trees that are typically thought to occupy a coastal environment (Figure 8-9). These data indicate that the people of Arenal were frequently visiting either the Atlantic (roughly 150 km) or Pacific (roughly 45 km) coasts of Costa Rica, and would bring back wood resources on their voyages and other valued coastal resources. However, with the exception of *Avicennia* (black mangrove), the majority of the tree taxa that are known to grow in coastal settings are also common within inland tropical moist forests. Only a single fragment of wood charcoal was identified at la Chiripa from a coastal tree that is exclusively found in a coastal environment, *Avicennia*. Its presence indicates these people's engagement with coastal settings. The Gulf of Nicoya would have been only 40 to 50 km in distance, meaning mangrove resources were available. It was already established that the past residents of Arenal interacted with their surrounding regions due to stylistic similarities with other regional residents seen in ceramic artifacts. Pottery forms from both the Greater Nicoya and Caribbean Lowlands regions were identified at Sitio Bolívar previously (Hoopes 1994a:188), as was discussed in Chapter 5.

In addition to mangroves, several other arboreal taxa identified with Arenal's assemblage would have required some level of travel or trade to obtain. According to the Museo Nacional de Costa Rica's Herbarium collection, *Peltogyne*, *Buchenavia*, *Cavanillesia*, and *Erythrochiton* all grow exclusively at much lower elevations than the La Chiripa settlement (under 500m) and are not present within any of the modern day provinces of Arenal, either Guanacaste or Alajuela. These residents would have had to travel to Puntarenas to find these plants if their growing habits were the same in the past as they are today within Costa Rica. None of these four trees produce edible plant parts, but most of them are known to provide valuable timber (Longwood 1962, Lorenzi 2002). *Peltogyne* (amaranto) may have been a desired commodity because its wood becomes a violet purple when cut through an oxidation process and then slowly darkens to a deep brown (Longwood 1962). *Buchenavia* (amarillo) is a moderately durable wood that can withstand exposure to weather, making it used for external surfaces in construction (Lorenzi 2002). *Cavanillesia* (pijio) is a soft, light-weight, and spongy wood valued more for its use in rafts (Lorenzi 2002).

At Sitio Bolívar, taxa identified within the wood charcoal assemblage that likely would not have been local to the village include *Amphipterygium*, *Cabralea*, *Chenopodium*, *Couratari* cf. *scottmorii* Prance, *Prioria copaifera* Griseb., and *Peltogyne*. Again, most of these taxa exist today within the Puntarenas province, so while they are not in the immediate vicinity of Arenal, they are available along the Pacific coast. Interestingly, *Chenopodium* (goosefoot) has not been recorded within any provinces adjacent to Arenal today but can be found farther south in Cartago and San Jose. Although this herbaceous food crop doesn't grow in the region today, it could have in the past since it is tolerant of a broad range of climates (Jellen at al. 2011). *Cabralea*, *Couatari*, and *Peltogyne* are all strong, durable woods and so may have been transported for their timber (Condit et al. 2011).

Table 8-1: *Arboreal taxa that today are only found in the Alajuela province, rather than Guanacaste, thus demonstrating that the villagers obtained resources both from the north and south of Lake Arenal.*

G995 La Chiripa	**G164 Sitio Bolívar**
Bellucia sp.	*Bellucia* sp.
Campnosperma panamense	*Campnosperma panamense*
Carapa sp.	*Lacmellea* sp.
Cheiloclinium cognatum	cf. *Poulsenia armata*
Copaifera sp.	*Tetragastris panamensis*
Escallonia sp.	
Macrocnemum roseum	
Poulsenia armata	
Tetragastris panamensis	

A number of arboreal taxa identified from these domestic structures come from trees, while still considered local, do not grow on the southern side of Lake Arenal today in the Guanacaste province, where both of these sites were located. A total of 11 taxa identified from these sites only grow north of Lake Arenal today in the Alajuela province (Table 8-1), which signify that these Arenal residents likely traveled all around their region, gathering valuable resources.

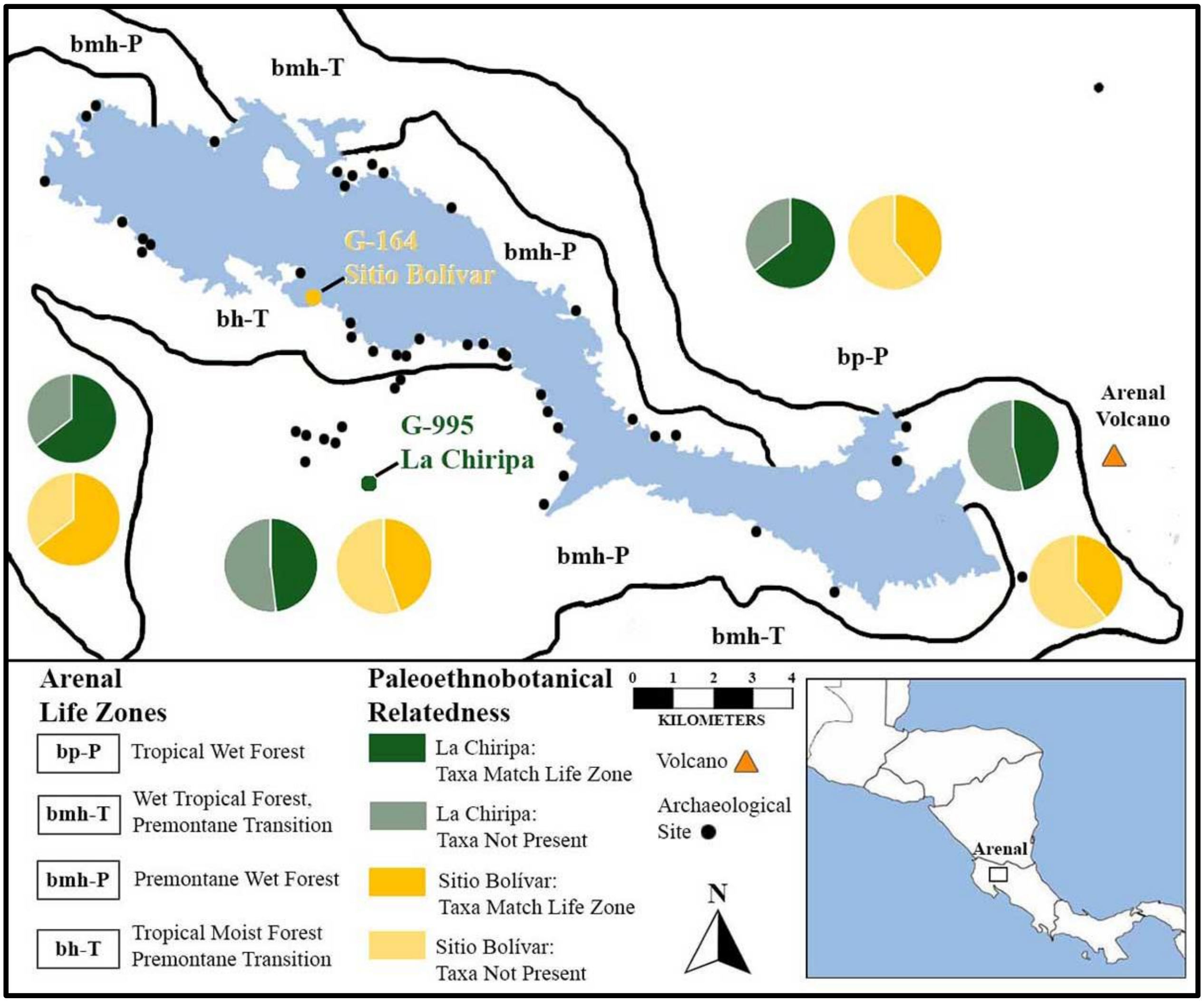


Figure 8-11: *Map showing the relatedness of the paleoethnobotanical dataset from each archaeological site to the four different life zones present within the Arenal area (Haber 2000: 44-45, Holdridge et al. 1971). Each pie chart depicts the ratio of characteristic tree species found within that life zone which are present among the paleoethnobotanical assemblages. Darker tones indicate characteristic arboreal taxa of that zone which are present archaeologically, and lighter tones indicate characteristic arboreal taxa of that zone which are not present archaeologically.*

The extent to which the residents of La Chiripa and Sitio Bolívar traveled around the Arenal region can be determined using a comparison of the paleoethnobotanical data to the Holdridge life zones that depict the ecology surrounding the lake, as was discussed within Chapter 4 (see Figure 4-3 and Table 4-1). Trees characteristic of all of these life zones are found within the paleoethnobotanical assemblages (Figure 8-11 and Table 8-2), albeit not at high ratios for the most part. This discrepancy is a reminder that paleoethnobotanical assemblages are not a true reflection of the surrounding vegetation composition, instead they reveal which flora people were engaging with in their daily life and selecting for their various needs.

Table 8-2: *Characteristic tree taxa of each Life Zone (Haber 2000: 44-45) recovered within the paleoethnobotanical assemblages from the domestic structures in Arenal.* 🟢 = taxa found at G995 La Chiripa, 🟡 = taxa found at G164 Sitio Bolívar.

Tropical Moist Forest (bh-T)	**Premontane Wet Forest (bmh-P)**	**Premontane Rainforest (bp-P)**	**Tropical Wet Forest - Transition (bmh-T)**
Anacardium excelsum 🟢🟡	*Beilschmiedia* 🟡	*Allophylus* 🟢	*Acacia* 🟢🟡
Ardisia 🟢🟡	*Cecropia* 🟢🟡	*Bourreria* 🟢🟡	*Alchornea* 🟢
Astronium graveolens 🟢🟡	*Cedrela* 🟢	*Capparis* 🟢🟡	*Croton* 🟢🟡
Beilschmiedia 🟡	*Cinnamomum* 🟡	*Cecropia* 🟢🟡	*Ficus* 🟡
Brosimum 🟢🟡	*Croton* 🟢🟡	*Cedrela* 🟢	*Hedyosmum* 🟢🟡
Croton 🟢🟡	*Dendropanax* 🟢	*Cupania* 🟢	*Inga* 🟢🟡
Capparis 🟢🟡	*Eugenia* 🟢🟡	*Inga* 🟢🟡	*Nectandra/Ocotea* 🟢🟡
Cecropia 🟢🟡	*Ficus* 🟡	*Meliosma* 🟢🟡	*Otoba* 🟡
Cedrela 🟢	*Inga* 🟢🟡	*Naucleopsis* 🟢	*Platymiscium* 🟢
Ceiba 🟢	*Meliosma* 🟢🟡	*Nectandra/Ocotea* 🟢🟡	*Pouteria* 🟢🟡
Cupania 🟢	*Nectandra/Ocotea* 🟢🟡	*Pouteria* 🟢🟡	*Sapium* 🟢
Eugenia 🟢🟡	*Pouteria* 🟢🟡	*Psychotria* 🟢🟡	*Sloanea* 🟢
Ficus 🟡	*Randia* 🟢	*Pterocarpus* 🟢	*Terminalia bucidoides* 🟢🟡
Hura crepitans 🟢🟡	*Sapium* 🟢	*Quararibea* 🟢	*Theobroma* 🟢🟡
Lonchocarpus 🟢	*Sideroxylon* 🟢🟡	*Sapium* 🟢	*Vochysia* 🟢🟡
Nectandra/Ocotea 🟢🟡		*Trichilia* 🟢🟡	
Sideroxylon 🟢🟡		*Trophis* 🟢🟡	
Terminalia oblonga 🟢🟡			
Trichilia 🟢🟡			

It is interesting that while Sitio Bolívar's plant assemblage is most characteristic of the life zone in which it is situated (the tropical moist forest), the assemblage from La Chiripa shows stronger similarities to life zones in which it is not currently situated, including the Premontane rainforest and the tropical moist forest rather than the Premontane wet forest that it resides in (Figure 8-11). This could simply indicate that the ecological zones of this region today are not the same as they were in the past [consistent with the time frame that people lived at La Chiripa, roughly 3,000 years ago]. In fact, the arboreal taxa identified from the house structure at La Chiripa have a slightly greater ratio of relatedness to each of these different life zones compared to Sitio Bolívar, perhaps signifying that these Tronadora phase residents were more mobile and moved around the landscape more regularly for their plant resources compared to the Late

Arenal phase residents. It is possible that this links to the degree of sedentism of these two populations. While archaeological data indicate that people were sedentary during both of these time periods, larger sedentary villages were identified from the Arenal phase (Sheets and McKee 1994). The greater relatedness of the La Chiripa assemblage to each of these life zones is undoubtedly linked to that settlements' higher level of species richness (Figure 7-27), demonstrating their broader engagement with the flora available to them. The residents at the Sitio Bolívar village were certainly more selective of their plant resources and had strong preferences for palms and *Terminalia* trees over other taxa, which could have been abundant locally, thus negating the need to travel extensively.

8.5 Paleoecological History

It is important to keep in mind that the Holdridge climatic life zones (1967) discussed within Chapter 4 represent current conditions and that the climate of the region certainly varied through time. Paleoecological data recovered via microbotanical studies in Costa Rica and Panama can help to depict the climate and vegetation patterns in the past for this region (Figure 8-12), especially with the use of palynology which isn't as directly biased towards just the flora that people interacted with during their lives. Pollen and charcoal analysis from La Selva biological station, which is situated 78 km east of Arenal Volcano, depict a highly diverse rainforest over the past three millennia (Kennedy and Horn 2008), aligning with the macrobotanical data in this dissertation.

Pollen and phytolith records from the Chagres River basin in Panama depict a mature tropical moist forest circa 9,300-7,000 BCE that included such arboreal taxa as palms, *Trichomanes*, *Guatteria*, *Tetragastris*, *Protium*, *Virola*, *Copaifera*, *Swartzia*, *Bursera*, and *Lafoensia* (Bartlett and Barghoorn 1973, Piperno 1985, 1988), most of which were also identified within this macrobotanical study in Arenal suggesting that their presence among the Central American landscape has remained somewhat consistent through time. Other cores from Laguna de la Yeguada (Panama) and the Cordillera de Talamanca (Costa Rica) demonstrate through pollen and phytolith evidence the montane forests circa 9,000 BCE contained genera such as *Alnus*, *Carex*, *Chusquea*, *Ilex*, *Magnolia*, *Podocarpus*, *Quercus*, and *Symplocos* (Bush et al. 1992, Martin 1964, Piperno et al. 1990, 1991a,b). Of these genera, only *Magnolia* was identified from the Arenal assemblage at La Chiripa. There is over 7,000 years of difference between these records, so the lack of similarity between the studies is expected. The microbotanical records from La Yeguada signify an increase in forest burning around 7,000 BCE (Piperno et al. 1991b), at which point populations may have begun to plant preferred taxa in newly burned forest patches to enhance their food supplies as is evidenced by the increase in domesticated plants around this time including lerén (*Calathea allouia* [Aubl.] Lindl.) and squash (*Cucurbita* spp.), and arrowroot (*Maranta arundinacea* L.), and manioc (*Manihot esculenta*) (Piperno and Pearsall 1998, Piperno et al. 2000, Ranere and Cooke 2003:238).

A sediment core taken from Lake Cote that depicts an environmental history of the Arenal region specifically. It shows a drier climate regime in the past circa 2,000 to 600 BCE (Arford 2001). The sediment core from Lake Cote further documents that farming intensified with frequent fires occurring in the Arenal landscape starting around 2000 BCE and that the majority of these fires were likely of human origin (Arford 2001). Shortly afterwards, maize pollen grains in the same core document the presence of agriculture in the region. This is corroborated by a lake-sediment core from Laguna Los Mangos in the Diquis subregion of southern Costa Rica (Johanson et al. 2019), which captures the arrival of maize agriculture circa 1400 BCE. The macrobotanical remains at La Chiripa do confirm that agriculture was present during this time period, but not as a primary component of the diet. As discussed earlier within this chapter, while the residents of Arenal were certainly impacting their forests, their use of arboreal remains was not overexploiting the forests in a detrimental manner, since the same relative proportion of forest taxa was present from the Tronadora phase at La Chiripa (1616-1426 BCE) all the way through to the Late Arenal phase at Sitio Bolívar (430-540 CE).

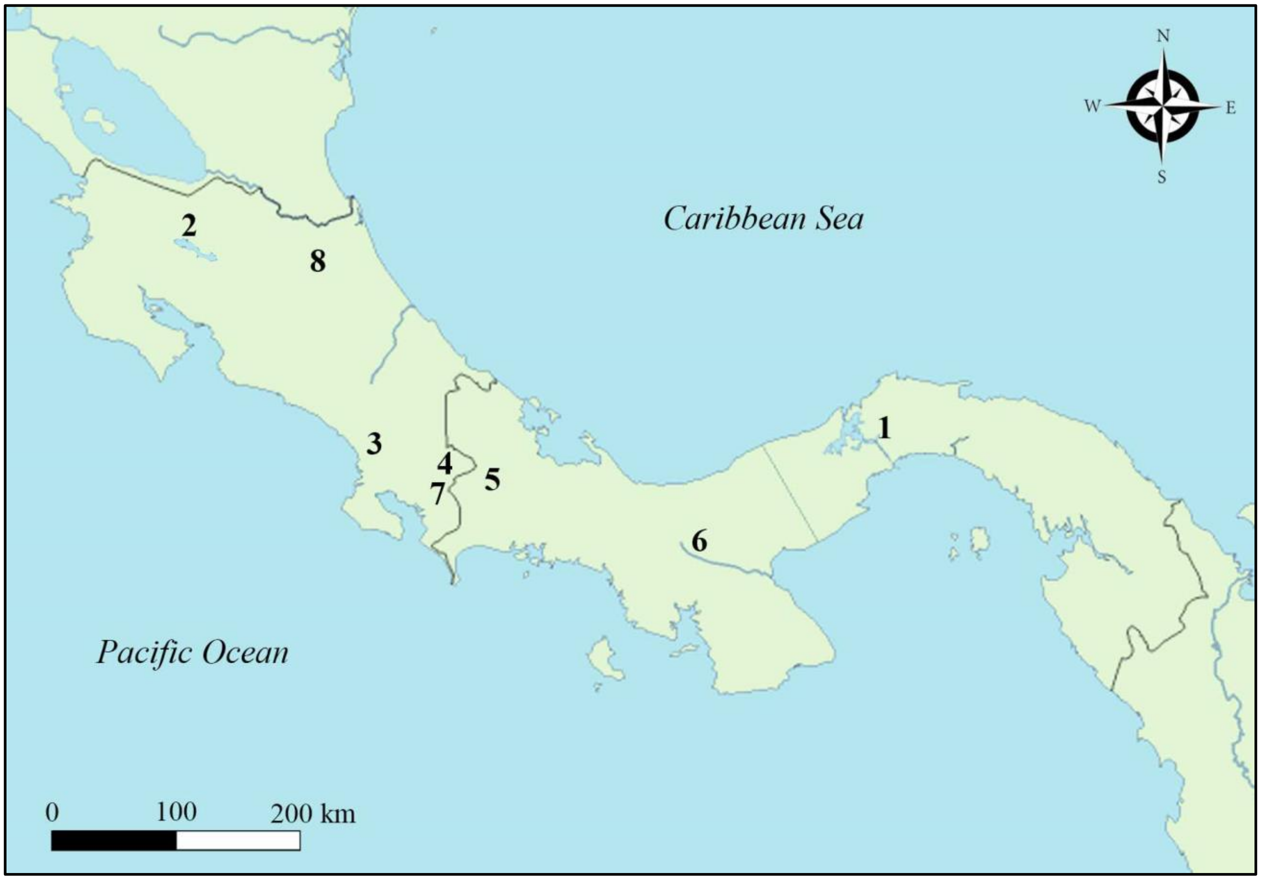


Figure 8-12: *Map of locations mentioned with paleoecological data:* ***1*** *Chagres River,* ***2*** *Lake Cote,* ***3*** *Laguna Los Mangos,* ***4*** *Laguna Santa Elena,* ***5*** *Laguna Volcan,* ***6*** *Laguna de la Yeguada,* ***7*** *Laguna Zoncho, 8 La Selva Biological Station.*

Pollen and charcoal in sediments from southern Costa Rica and northern Panama (from sites including Laguna Volcan, Laguna Santa Elena, and Laguna Zoncho) reveal a nearly continuous record of human alteration of these tropical forests over the past three millennia (Anchukaitis and Horn 2005, Behling 2000, Clement and Horn 2001). Pollen and charcoal records from Laguna Volcan in the Cordillera de Talamanca show strong impacts to the lower montane rain forest starting around 900 BCE (Behling 2000). The Laguna Zoncho core reveals forest clearance and burning by indigenous peoples between 1290 BCE -1490 CE (3240 and 460 cal. yr BP), with fluctuating intensities of past human impact (Clement and Horn 2001). The pollen core at Laguna Santa Elena documents nearly intact premontane forests approximately 200 BCE, although there is evidence of human presence on the landscape in the form of maize pollen and charcoal (Anchukaitis and Horn 2005). The sediment core at Lake Cote, nearby

Arenal, suggests that forest regeneration occurred around this time as well, as evidenced by an increase in lower montane pollen taxa (Arford 2001). Clearing for agriculture around Laguna Santa Elena resulted in the dominance of disturbance taxa by 550 CE, which is long after the La Chiripa site was occupied but right around the time that Sitio Bolívar began to flourish. Sitio Biolivar does have a much stronger presence of agricultural crops, especially maize, so these data sets are generally aligned and the macrobotanical assemblage complements the palynological studies well.

However, palynological data is of limited applicability when considering arboreal populations in tropical forests because the pollen profiles primarily document wind pollinated species. The vast majority of tropical woody species are pollinated by animals or insects (98%), which only disperse pollen over short distances (Ollerton et al. 2011, Bush and Rivera 1998, 2001). Specifically in northern Costa Rica, around 65% of trees are bird dispersed and only 10% are wind dispersed (Lawton et al. 2016: 439). Within this paleoethnobotanical assemblage, only 14 taxa are wind pollinated, or roughly 7.6% of the identified botanical genera. Others are pollinated with the aid of insects such as bees, moths, and beetles, or mammals (both arboreal and terrestrial). Therefore, pollen records in tropical forests overrepresent wind pollinated trees and can only provide a glimpse of the paleoecological record for this region.

8.6 Relatedness to the Monteverde Cloud Forest: A final comparison to the region's tree phytosociology

The Monteverde cloud forest is roughly 18 to 20 km in distance from these archaeological sites and is one of the closest biological preserves today (Figure 8-13). The conservation efforts at Monteverde are based in biodiversity research, and thus an immense amount of data on this modern forested space can be compared to the paleoethnobotanical data collected from the Arenal region to reveal a glimpse of how the forests have changed over the past several millennia. The Monteverde Cloud Forest Preserve is also situated along the continental divide within the Tilarán mountain range, but at an elevation of 1500 m asl (Nadkarni and Wheelwright 2000). More than 3,200 species of plants have been identified in Monteverde, including over 750 species of trees (Haber 2000a: 52). Yet, only 65% of the botanical genera (117 of 179) identified at La Chiripa and Sitio Bolívar have been recorded in Monteverde (Haber 2000b). The composition of the paleoethnobotanical taxa at each of these archaeological sites which is found within the modern forests in Monteverde is the same for both sites, with both containing a ratio of 66 to 67 percent of taxa that are recorded within Monteverde.

When the most prevalent trees by plant families of the Monteverde forest (Lauraceae, Rubiaceae, Fabaceae, Moraceae, Euphorbiaceae, Myrtaceae, Melastomataceae, Solanaceae, Salicaceae, and Asteraceae according to Haber 2000: 53) are compared to the paleoethnobotanical data from these two Arenal domestic settlements, nearly all of the same botanical families are present except for Moraceae (Figure 8-14). However, the Moraceae family was present at both archaeological sites, just not as a dominant family. The prevalence of these families are not exactly aligned with those of the Monteverde forest but they are quite close. For example, Lauraceae are not as strongly represented at either of the sites, which is interesting because the family is known for its oil rich and nutritious fruit such as avocado (*Persea americana*). Rubiaceae, another dominant family of Monteverde, is not as prevalent among the paleoethnobotanical dataset, which could be a reflection of the family not producing as many culturally important foods compared to other families. Again, Figure 8-14 demonstrates the selectiveness residents of Sitio Bolívar had for their arboreal resources with palms (Arecaceae) and *Terminalia* (in the Combretaceae family) surpassing any other family by a significant degree.

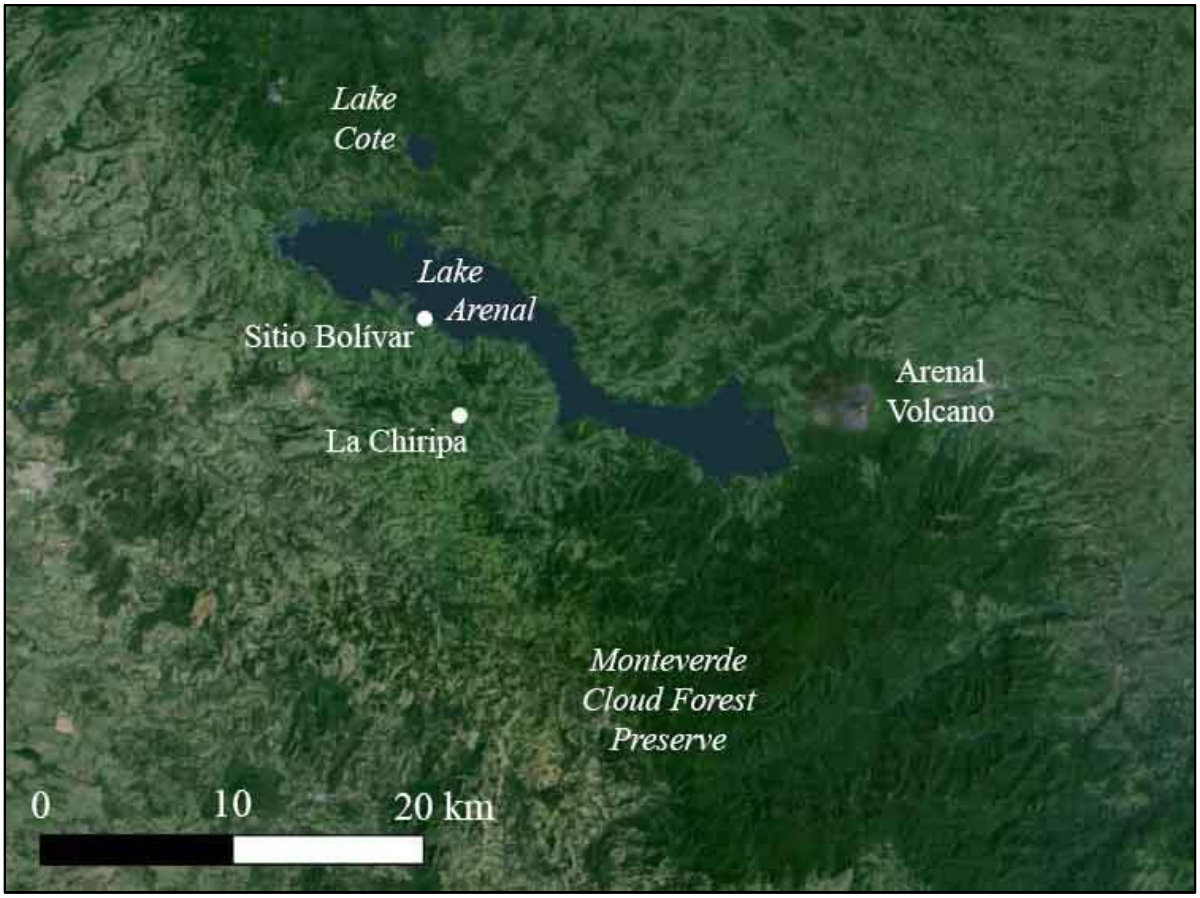


Figure 8-13: *Map showing the spatial relationship between the Monteverde Cloud Forest Preserve and the archaeological sites in this investigation.*

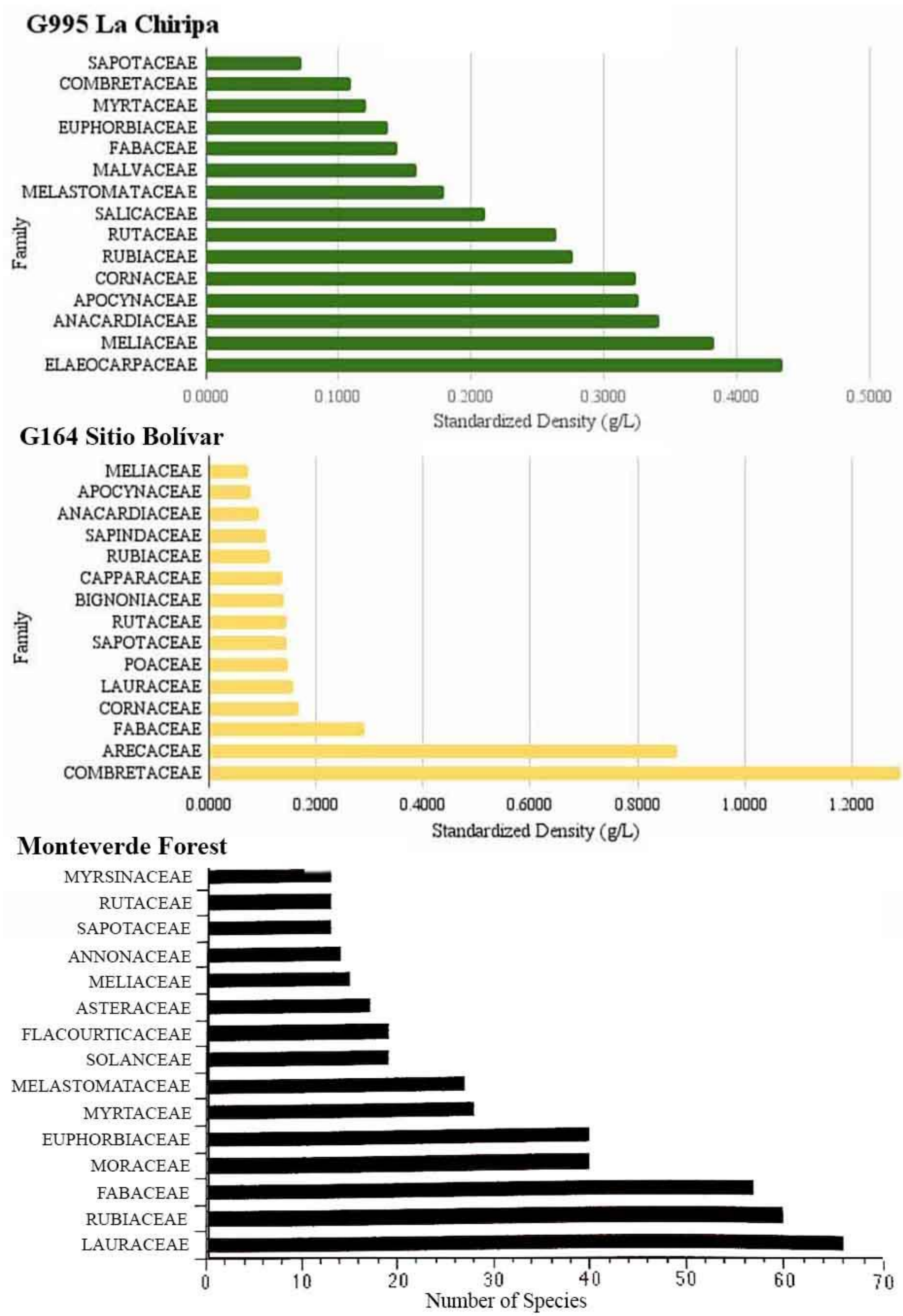


Figure 8-14: *The most prevalent botanical families in terms of standardized density (g/L) at each archaeological site from stratigraphic levels pertaining to the domestic structures. The plot of Monteverde tree families is modified from Haber 2000: Figure 3.8.*

8.7 Conclusions

The discrepancy between the paleoethnobotanical data and the characteristic taxa within each life zone, as well as the Monteverde forest, indicate many different conclusions. First of all, it is inevitable that the forests of Arenal and its adjacent areas have changed over the past 3,000 years. While I do argue that the past residents of Arenal achieved a form of stability in their lifestyles through their selective use of plant resources that could withstand ecological disruptions, it would be foolish to believe that the forests these peoples lived within remained stable since those times and could be found in the area today. Through millennia of human engagement, a multitude of ecological disasters, changing political regimes, and increasing population, the flora of Arenal has certainly been altered since the time that the Tronadora phase occupants of La Chiripa lived and engaged with this setting. Since the Neotropics have an incredible species richness, it is possible that the forests of Monteverde are distant enough and at a higher elevation, securely engulfing the forests in clouds, that the forest composition is demonstrably different than Arenal. Perhaps the conservation efforts in the Monteverde biological preserve do not accurately represent the region's composition of flora when managed by people as an effort to create a "pristine" forested space. Just as has been documented in the Amazon (Denevan 2006, Erickson and Balée 2006), I believe the people of Central America also altered their landscape to be more productive for their own purposes over thousands of years. Paleoecological studies are increasingly demonstrating that indigenous people of the Americas altered and managed their landscapes and had an impact on climate variation through time (Cuthrell et al. 2016, Erickson 2008, Erickson and Balée 2006, Fedick 1996, Harrison 1990, Lightfoot et al. 2013, Turner 1978). People of the Isthmo-Colombian region played an essential role in shaping ecosystems through a range of innovative strategies (Hoopes 2012). This included not just the use of fire and agricultural technologies, but also the management of forested spaces through arboricultural practices.

Every single taxon identified from either of these archaeological sites has a known documented use by people today. All 179 of these genera had uses in these people's lives (Appendix N), a testament to the management and care taken by the past residents of Arenal to live within a productive landscape. These uses could be as food or oil supplying sustenance, nourishment, and a tasty meal or snack (see Chapter 9), or as a source of fuel allowing one to cook a meal properly, or to fire their newly crafted clay vessel, as evidenced by the 68 genera in these two assemblages with such a documented use (although the majority of these identified taxa were recovered as charcoal fuel to begin with). However, there is much more to plant use than simple consumption because plants are woven into everyday life in a wide variety of manners (Morell-Hart 2011: 98). Some of these plants could also serve as a container (*Crescentia*) or basket (*Acalypha*, *Acrocomia aculeata*, *Bactris*, *Heliocarpus*, *Muntingia*) to store or serve foodstuffs (Barwick 2004, Blombery and Rodd 1983, Standley 1884-1963, Woodson and Schery 1949). At least 120 of these plant genera have properties making them valuable in medicinal application to remedy bodily concerns. Further, many of these taxa can be used as a soap or shampoo, perhaps after a long day in working in the fields or forests (e.g. *Acalypha*, *Attalea*, *Cassia*, *Ceiba*, *Sapindus saponaria*) (Barwick 2004, Standley and Steyermark 1946, Uphof 1959). Numerous trees could serve as a sturdy beam supporting a home or as a thatch material to put a roof over one's dwelling (e.g. *Acrocomia, Hirtella*) (Zamora 1989). Less durable wood could be used as a source of amusement and joy in the form of a toy for children (*Tapirira*, *Heliocarpus*) (Berni et al. 1979, Lorenzi 2002). Trees such as *Hura crepitans,* *Hymenaea*, *Hieronyma*, *Peltogyne* are a lightweight wood source to create canoes and rafts to explore waterways (Barwick 2004, Longwood 1962). Trees and shrubs also are a great source for fence posts or hedges used to delineating space (e.g. *Diospyros*, *Diphysa*, *Lonchocarpus*, *Morella*, *Swietenia*) (Lorenzi 2002, Sauer 1979). Plants can provide means to repel and control pests and insects (e.g. *Avicennia*, *Manihot*, *Piper*, *Ryania*) (Bloomquist 1999, Fern 2022, Norrington 2001). Numerous taxa could provide a dye to transform one's clothing, food, or other belongings (e.g. *Bixa orellana*, *Ceiba*, *Croton, Maclura tinctoria*, *Neea, Psidium*) (Bailey 1919, Facciola 1998, Fern 2022, Standley and Steyermark 1946). Some of these taxa produce a tannin to dye leather, fabric, or make ink (e.g. *Bellucia*, *Buchenavia*, *Garcinia, Hamelia*) (Fern 2022, Little and Wadsworth 1964, Lorenzi 2002, Morton 1987). Some of these trees produce a resin to burn as an incense during ritual or ceremonial activities (*Hymenaea*, *Myroxylon balsamum*, *Protium*, *Tetragastris*) (Gomez-Pompa and Kaus 1990, Longwood 1962, Lundell 1937, Schwartz 1990, Standley and Steyermark 1946). Others produce a latex or wax to make candles that provide one with light at night (e.g. *Lacmellea*, *Morella*, *Symphonia globulifera* L. f.) (DeFilipps et al. 2004, Pennington et al. 2004, Standley and Steyermark 1946). A few of these taxa have been used as a hallucinogen to transport one's mind to another realm or state of consciousness (*Virola*, *Otoba*, *Psychotria*, *Tabernaemontana*) (McKenna 2006, Pinkley 1969, Plotkin and Schultes 1990, Schultes 1972). Fiber or pulp from trees like *Bactris*, *Carapa*, *Ficus*, and *Otoba* have been used to make barkcloth or paper (Fern 2022, Koshear 1995, Vosso 2002). Others provide fiber to create rope, cordage, or twine to tie things together (e.g. *Apeiba*, *Cecropia*, *Cedrela*, *Heliocarpus*, *Trema*) (Fern 2022, Kosher 1995, Standley and Steyermark 1946). Many trees also serve as an integral component of a landscape to control and prevent soil erosion (e.g. *Anacardium*, *Erythrochiton, Simarouba*) or restore fertility to a soil depleted of nutrients (e.g. Byrsonima or any nitrogen-fixing legume) (Chudnoff 1984, Fern 2022). Many trees provide a much-needed source of shade on a hot, sunny day (e.g *Enterolobium*, *Gliricidia sepium*, *Hura crepitans, Hymenaea*) (Barwick 2004, Laborde and Corrales-Ferrayola 2012, Longwood 1962). Some of these plants have been valued simply as an ornamental, uplifting one's mood with showy and fragrant flower blossoms (*Jacaranda*, *Melampodium*, *Thevetia*, *Tibouchina*) (Standley 1884-1963, Standley and Steyermark 1946). A complete list of the plants identified from these sites and their known uses are in Appendix N.

This chapter has demonstrated that the people living at La Chiripa and Sitio Bolívar were knowledgeable about their arboreal resources and traveled throughout the region to obtain materials from many woody taxa. These past populations were relatively small in size and did not make a detrimental impact on the landscape, but rather they likely managed their forests in order to maintain the growth of the trees and shrubs they deemed useful. The next chapter of this dissertation will focus on the taxa which produce edible plant parts in order to explore this facet of daily life in Arenal. The archaeological and paleoethnobotanical data will be examined to discuss the ways that these residents procured their food, what agricultural practices they may have employed, how they prepared their food, presented and consumed their meals, and ultimately discarded what was found archaeologically.

CHAPTER 9

FOOD AND DAILY MEALS

Compared to other plant lifeforms, trees provide the greatest range of useful goods for people. They are a font of many things and a variety of cultural uses could have been applied to the abundant forest taxa identified within this investigation by the residents of Arenal including as food, medicine, fuel, construction, dye, resin, oil, and fiber for cordage. The following discussion will primarily consider food-related products in order to explore the culinary setting of Arenal.

9.1 Prior Understandings of Subsistence in the Arenal region

Until now, there has only been a limited knowledge of the subsistence patterns for the past Arenal region. Phytolith, pollen, and macrobotanical remains recovered from the Proyecto Prehistorico Arenal (PPA) during the 1980s demonstrated that maize, jícaro, and a member of the amaranth family were present throughout all major time periods (roughly 2000 BCE to 1400 CE), and that common beans appeared after 600 CE, essentially confirming that the famed 'three sisters' complex was part of the later Arenal people's lifeway. This polycultural style of agriculture is an efficient crop and soil management system that allows all of these plants to thrive because they work together to enhance agroecological services (Altieri 1999). Such services include enhancement of the soil's physical and biochemical environment as well as the minimizing of soil erosion (Romero-Perezgrovas and Cheesman 2014, Staller et al. 2006). Maize supplies a sturdy structure to support the trellising bean, the leguminous beans replenish the soil with nitrogen that has been depleted from maize, and the squash broadly covers the soil surface, provides shade, lessens soil erosion, and helps to preserve moisture (Staller 2010, Staller et al. 2006). This particular combination of plants also provides a complementary set of essential nutrients including proteins, amino acids, vitamins, and minerals (Hart 2008, Kaplan 1965, Robinson and Decker-Walters 1996). The practice of intercropping maize, beans, squash and sometimes sunflowers or amaranth has been observed deep within the history of agriculture in the Americas (Dillehay et al. 2007, Kaplan and Lynch 1999, Kimmerer 2013, Piperno and Flannery 2001, Slotten et al. 2020, Smith 1997, Wilk 1997). Thus, it is not a surprise to find this agricultural system present within the diets of those living in the Arenal region.

The early work of the PPA also provided a glimpse of the fruit trees that could have formed part of the inhabitants' subsistence regimes such as avocado, guanabana, nance, and walnut (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994). These early results demonstrate that the past peoples living in Arenal obtained food from their agricultural fields as well as collecting fruits from trees within their local forests. While the early paleoethnobotanical work in this region did suggest a dietary regime including agricultural crops and tree fruits, this is not especially unique to Arenal and was likely a common practice throughout the Americas. Furthermore, the more intensive paleoethnobotanical investigations within this dissertation demonstrate that the different components of diet within the past in Arenal were not evenly distributed and do not follow the typical inclusion of agricultural products as staple ingredients in the diet. Yes, maize, beans, and squash were a component of the diet, but this systematic macrobotanical data expands our view of available foodstuffs in the Arenal region to include nearly 100 edible plant taxa -- which indicates an incredibly diverse and flexible food regime consisting of much more than agricultural staple crops that continued in the region for several millennia.

9.2 The Diverse Array of Edible Plants in Arenal

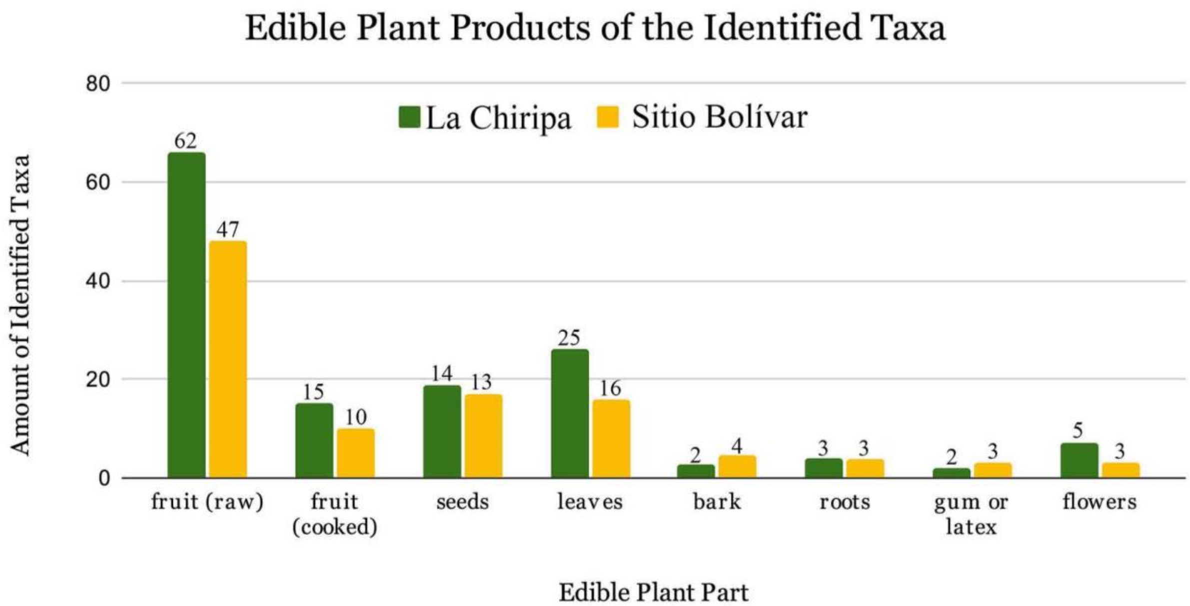


Figure 9-1: *Edible plant products of the identified taxa from the macrobotanical remains recovered at La Chiripa and Sitio Bolívar.*

The systematic collection of macrobotanical remains has greatly expanded our understanding of subsistence practices of the past in the Arenal region, with a collective total of 95 plant taxa that produce edible plant parts. As was presented within Chapter 7, the vast majority of identified macrobotanical remains at both of these archaeological sites is in the form of wood charcoal, meaning that the direct recovery of edible plant parts was uncommon within these assemblages. Therefore, in order to assess the dietary patterns within the Arenal region we must assume that if a tree taxon was present at these sites, the residents also had access to that taxon's fruits, leaves, seeds, and other edible plant parts. The woody parts of these trees and shrubs were more likely to preserve in the long term compared to other parts of a plant because they would have been exposed to fire and placed in a situation which could lead to their carbonization, and thus preservation archaeologically. Among the total 95 botanical taxa identified from the macrobotanical remains at the two sites that produce edible fruits, leaves, roots, or vegetative material, only 15 were recovered in a form other than wood charcoal. A breakdown of the distribution of edible plant parts among these taxa (Figure 9-1) reveals that the most common category of edible plant parts was fruit, which are most commonly eaten raw, not cooked. Fleshy fruits are unlikely to be preserved archaeologically in a tropical setting because they are not commonly exposed to fire and subsequently carbonized. Without the identification of the wood charcoal material within the macrobotanical samples, the presence of such a large assortment of food resources would not have been visible. With such an analysis, it is clear that both settlements' residents were arboriculturalists who collected a variety of foods from their surrounding forests. A total of 82 taxa at La Chiripa produce edible parts compared to the 60 taxa at Sitio Bolívar, which are both considerably sizeable assemblages. A complete list of edible taxa and their respective edible plant parts are included in Appendix N, which is a table of the ubiquity values for all botanical identifications in this dissertation.

9.3 Herbs and Flavorings

The paleoethnobotanical results provide a sense of what potherbs, edible greens, and flavorings were available to these people. Edible greens have been an underappreciated category of plant products in macrobotanical studies (Cagnato 2018). Spices, herbs, and flavorful foods have long been prized ingredients in a meal that can bring value to a food beyond just its nutritional benefits (Hastorf 2017). The choice of herbs added to a recipe may have characterized these household's identities and tastes.

At the Tronadora phase structure at La Chiripa, many herb species were found (see Figure 7-5) such as paracress (*Acmella*) and carpetweed (*Mollugo verticillata*), which could have added some spiciness to a meal. Additionally, the flowers and buds from balo (*Gliricidia sepium*), wood sorrel (*Oxalis*), and guarumo (*Cecropia*) could have been incorporated into meals. *Oxalis* leaves can also be consumed after cooking to give a sour flavor to a dish, due to its oxalic acid (Dunn and Sanchez 2021, Kunkel 1984). The aromatic bayberry (*Morella*) leaves can be used as a flavoring similar to bay leaves. Sorrel (*Rumex*) adds a citric flavoring found at La Chiripa, the leaves of which can be eaten once cooked (Uphof 1959). Additionally, the gum produced from bálsamo (*Myroxylon balsamum*) could also have been incorporated into meals to flavor a dish. Achiote (*Bixa*) seeds could be ground into a paste and add both flavor and a vibrant red coloring to a meal. *Ceiba* seeds can also be roasted, ground into a powder, and then added as an additional flavoring (Facciola 1990).

Within the Arenal phase domestic setting at Sitio Bolívar, many of the same herbs and flavorings found at La Chiripa were also recovered, including *Acmella*, *Bixa*, *Cecropia*, and *M. verticillata*. This settlement also had purslane (*Portulaca oleracea*), hinojo (*Piper* sp.), and *Chenopodium* (see Figure 7-18). Purslane is very nutritious, containing all essential minerals, vitamins, and proteins (Uddin et al. 2014). The herb is drought resilient, adaptable to many soil conditions, and the leaves are commonly added to salads or soups today (Facciola 1990, Standley and Steyermark 1946). Hinojo leaves and fruits could have been cooked and consumed as a spice or potherb, adding a pepper-like flavor to meals (Little and Wadsworth 1964). *Chenopodium* was found within the Arenal phase stratum at La Chiripa, but not from the Tronadora phase house structure contexts, further suggesting that this herb was not a component of diet until this later time.

The herbaceous *Acmella* (paracress) plant was by far the most ubiquitous taxon at both of these archaeological sites. It has showy gold and red inflorescences and is common in disturbed habitats, damp marshes, and dry open fields (Breedlove and Laughlin 2000:248, Lentz and Dickau 2005: 250, Nash and Williams 1976:320). The leaves and flowers of *Acmella* have been valued medicinally for their anesthetic and antibacterial properties, since they contain spilanthol and acmellonate (Rondanelli et al. 2020). When chewed, the flowers and leaves have a strong, pungent taste accompanied by a tingling sensation that can numb the one's lips and tongue, hence one of its common names being the 'toothache plant'. When used in moderation, the plant can be used as a flavoring and green leafy vegetable; the flower is added to vegetables both fresh (raw) and cooked (de Souza 2024, Paulraj et al. 2013, Rondanelli et al. 2020). Within Costa Rica, *Acmella* achenes have also been recovered at the Guayabo de Turrialba site (Torreggiani 2014). *Acmella cf. oleracea* (synonymous with *Spilanthes acmella* [L.] L.) has been recovered through paleoethnobotanical investigations at Late Classic Maya settlements (Cagnato 2018, Slotten et al. 2020, Wendel 2019). At La Corona in Guatemala, the plant was recovered from inside of a *chultun* (an underground storage pit) believed to contain the remains of feasting activities (Cagnato 2018). The achenes were also recovered by the thousands within the preserved milpa fields at both Cerén and Birds of Paradise (Slotten et al. 2020, Wendel 2019). The plant's strong dominance among the macrobotanical remains at Arenal suggests that it may have been incorporated into meals regularly as a flavoring. *Acmella* achenes were recovered from nearly every square meter of excavations at Sitio Bolívar (see Appendix I), with an overall ubiquity value of 93.28%. At La Chiripa the plant was primarily found in spaces exterior to the structure (with an overall ubiquity value of 31.4%, see Appendix G for a map of contexts in which it was recovered), suggesting that the herb was growing along the edges of the structural walls, lining the dwelling with easily accessible flavorings for a dish.

9.4 Agricultural Products

Unsurprisingly, agricultural crops such as maize, beans, and squash were recovered from both archaeological sites in this study. This was expected because of the results from the prior paleoethnobotanical work in Arenal that has been discussed earlier in this chapter (Clary 1994, Piperno 1994, Mahaney, Matthews, and Vargas 1994).

All of the maize identified at La Chiripa was found in the form of carbonized cupules; no kernels or whole cobs were found. The cupules are a more durable plant part compared to the fleshy kernels, making their long-term preservation more likely compared to other parts of the maize plant. Additionally, both the maize and common beans at La Chiripa were recovered entirely from the hearth feature (Rasgo 2), which dated to a time period several hundred years after the house was initially built. This suggests that these agricultural crops were not as common initially during the Tronadora phase, and may have been selected specifically for inclusion in the ceremonial activity that occurred when the structure was closed and abandoned.

Both maize and beans can be considered semi permanent agricultural crops, meaning that they could have been grown near to the La Chiripa dwelling, which was situated in the Premontane Wet Forest lifezone. However, these agricultural crops would not have been as productive within this lifezone as in others (Tosi 1980), as was discussed in Chapter 4. This lifezone experiences a greater amount of precipitation, thus rendering agricultural crops such as maize less productive. More permanent crops thrive better in this lifezone, such as with an agroforestry system that incorporates the maintenance of fruit producing trees and shrubs. Palynological evidence in southern Costa Rica demonstrates that maize was present in the area at least by 3500 BCE (Arford and Horn 2004). Yet stable carbon isotope analysis of skeletal material from multiple individuals from the later Silencio Phase (600-1300 CE) at the El Silencio site in Arenal revealed a range of values from -16.6 to -20.8 $\delta^{13}C$ (Friedman and Gleason 1984, Norr 1991:179) This indicates that a maximum of 12% of the diet was from C-4 photosynthetic pathway plants such as maize (Friedman and Gleason 1984, Norr 1991, Sheets 1994:15). Neither the maize or beans were abundant in the macrobotanical assemblage at La Chiripa and were only found within the hearth: only about 10 maize cupules were recovered in total, thus aligning with this isotopic data from the Silencio phase. At Sitio Bolívar the consumption of agricultural crops, specifically maize, was more prevalent, with kernels, cupules, and cob fragments all recovered (an overall ubiquity value at the site of 42.02%). However, maize still did not prove to be the most abundant edible taxa from this dwelling (see Figure 7-27), *Acmella* (93.28% ubiquity), and coyol palms (77.31% ubiquity) were much more common. This aligns well with the isotopic data in the region. The distribution of these taxa spatially across the sampled contexts will be discussed in further detail in a later section within this chapter, section *9.7*.

Kosher's (1995: 68) ethnographic study of Guaymí farmers in the Nicoya region of Costa Rica found that maize had the highest failure rate from year to year compared to any other crop, often due to weather-related causes. "Even though maize has a broad tolerance for altitude and rainfall conditions, it was the only crop for which negative returns were recorded, that is farmers did not even manage to harvest as much as they had planted" (Koshear 1995: 68). Studies like this demonstrate how maize yields can vary widely for climatic reasons, thus it may have not been as appealing to the residents of Arenal in the past. Although maize and beans are present at La Chiripa, Sitio Bolívar, and other archaeological sites in the Arenal region, these agricultural crops were not a prominent source of food or staples for people in this area, rather their focus was on fruiting trees, as will be discussed in the next section.

9.5 Edible Fruits from Trees and Shrubs

El Gigante rockshelter in western Honduras provides some of the earliest direct evidence for forest engagement in Central America. It has a record of human-environmental interactions spanning the entirety of the Holocene (Kennett et al. 2023). Tree fruit crops such as avocado, hog plum, mamey, and acorn (Fagaceae) were present circa 11,000-10,000 cal BP at El Gigante and persist through the Holocene, in addition to squash and maguey (*Agave*) (Kennett et al. 2023, VanDerWarker 2024). Such research when coupled with the finds from Arenal suggest that a reliance on arboriculture may have been widespread throughout prehispanic Central America, with a focus on culturally valued fruit trees.

Overall, 74 of the identified tree taxa produce edible fruits. Notable fruit trees in the assemblage that are quite common and widely consumed even today include cacao (*Theobroma*), cashew (*Anacardium occidentale*), avocado (*Persea*), cherry or plum (*Prunus*), fig (*Ficus*), guava (*Psidium*), hogplum or jocote (*Spondias mombin*), nance (*Byrsonima*), ramón (*Brosimum*), sapodilla (*Manilkara*), and mamey (*Pouteria*). Admittedly, within this group of edible taxa, some of the fruits are certainly more desirable than others. While they are all technically edible, some may not be commonly consumed or enjoyed. For example, *Salacia* fruits have a pleasant flavor but are not as desirable or popular to eat today because the flesh of the fruit can be difficult to separate from the seeds in some species (Lorenzi et al. 2000). Standley and Steyermark (1946) note that people find rosetillo (*Randia*) repulsive in appearance since it is black when ripened and has an unpleasant flavor. Nevertheless, the sheer quantity of edible taxa available to inhabitants of both La Chiripa and Sitio Bolívar demonstrates that they would have been able to collect from a variety of fruit trees year round for their subsistence needs.

The edible fruits identified at the two sites do overlap considerably; 37 of these trees and shrubs were identified from the macrobotanical remains at both sites (Figure 9-2). Even if some of these fruits were not readily available at a certain time, perhaps due to an ecological disaster, a change in seasons, or even a poor yield in a particular year, there would have been many alternative options for people to choose throughout the year. This may have required some travel to nearby forests or communities, making a wide selection of edible taxa available to these people. The paleoethnobotanical data demonstrate that they did in fact engage with a diverse assemblage of edible plants. Due to an abundance of edible flora identified from the wood charcoal remains, only a selection will be discussed with a focus on the more ubiquitous and culturally significant trees and shrubs.

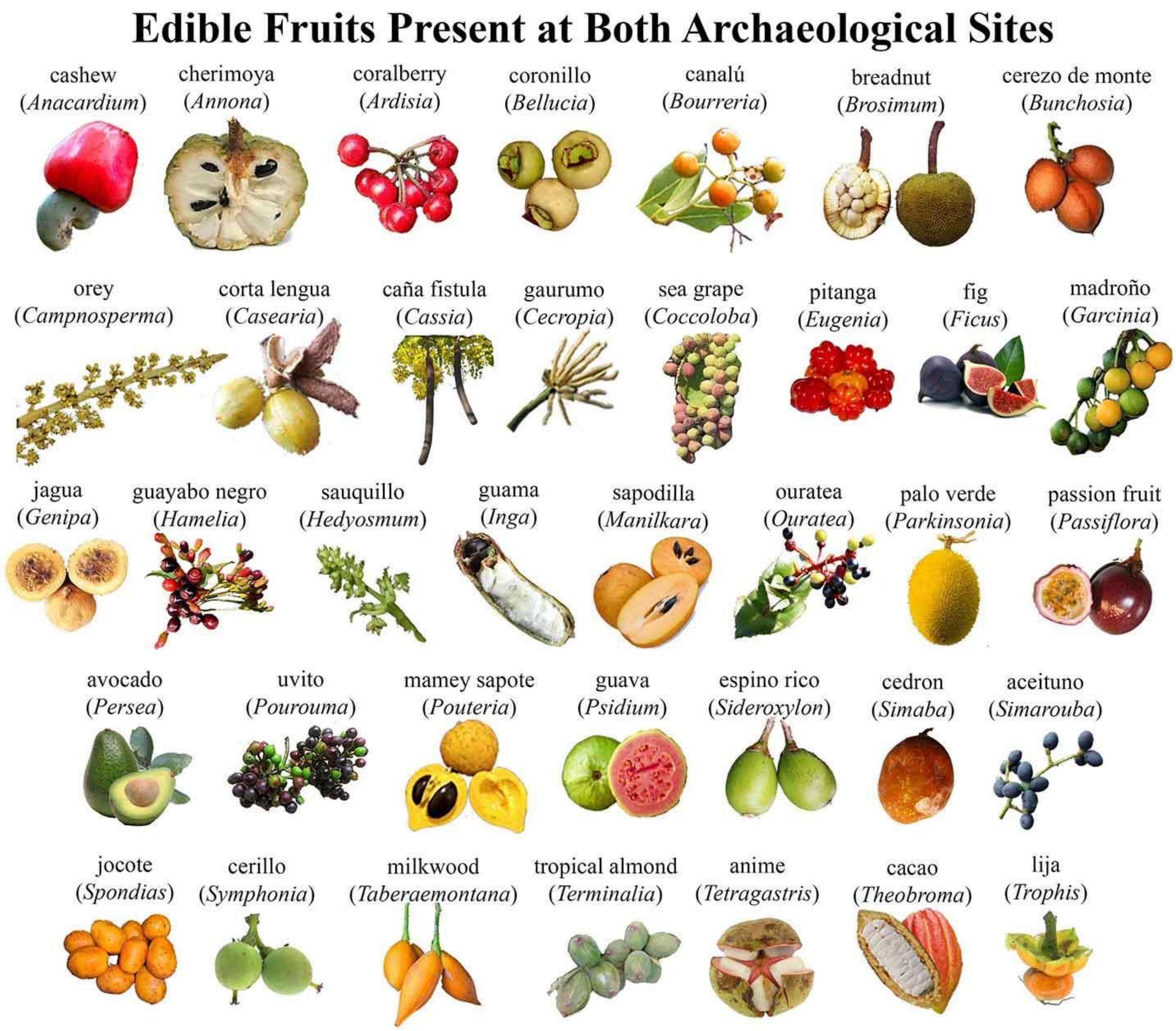


Figure 9-2: *Arboreal taxa that produce edible fruit which were recovered and identified from both archaeological sites in this study (n=37).*

Palms are one of the most ubiquitous arboreal taxa at both of these sites. This is not surprising as the Arecaceae family has also dominated paleoethnobotanical assemblages elsewhere in the Isthmo-Colombian region (Blanco Vargas 2002, Corrales 1990, Corrales and Mora 1990, López-Rojas et al. 2024, McNeil 2006b, Morell-Hart 2011, Morell-Hart, Joyce, and Henderson 2014). The palm wood and endocarps preserved at La Chiripa were not identifiable to the genus level, but wood charcoal and endocarps from coyol (*Acrocomia aculeata*), pejibaye (*Bactris*), and cohune palms (*Attalea*) were identified from Sitio Bolívar.

Coyol (*Acrocomia aculeata*) endocarps were the fourth most common macroremain recovered from Sitio Bolívar (Figure 7-27). The fruit is edible fresh, the endocarps may have been ground for cooking oil and the palm's sap used to produce a fermented beverage (Alcorn 1984:375, McNeil 2012, Roys 1931:288). The fruits are high in calories due to its high fat and protein content in the kernels (Lentz 1990:190), thus they can be a productive inclusion within one's dietary intake. According to Roys (1931:288) in the Relaciones de Yucatán, the coyol pits were used in times of scarcity because the tree produces them in great quantities. Sites like Copan (McNeil 2006b) and Sitio Bolívar both demonstrate that it was a preferred food source since it is one of the most ubiquitous macrobotanical remains recovered from domestic contexts (77.31% ubiquity at Sitio Bolívar). Coyol palm nuts and endocarps were also found at the Aguadulce Shelter and in the Chiriquí region of Panama, from deposits dating back to 5,000 BCE (Ranere and Hansell 1978, Smith 1980), demonstrating its longevity in Central American diets. Coyol was also recovered in significant amounts from domestic areas in the Jacó Valley of the Central region, dating to between 200 BCE and 500 CE (Corrales 1990, Corrales and Mora 1990). Coyol does not do well in riparian conditions and prefers well drained soils (Uhl and Dransfield 1987), so it is curious that it was so popular at Sitio Bolívar despite the settlement's proximity to a marshy lake. This suggests that the residents selectively brought coyol fruits back from microhabitats which were more suitable for the palm's growth.

While only a single charcoal sample was able to be identified to the *Bactris* genus (pejibaye) at Sitio Bolívar, it is quite likely that other specimens were of this taxon as well. Fruits from the pejibaye palm are very nutritious and have been considered a staple food in the moist forests of Central America for as long as the region has been inhabited (Koshear 1995). Pejibaye is particularly well documented paleoethnobotanically in Costa Rica: it was identified from the Greater Chiriquí region at both Sitio Drago and Cerro Brujo (Linares 1976,1977, Linares and White 1980, Martin 2015), as well as at sites like Nuevo Corinto and others in the Central Region (Blanco Vargas 2002, Corrales 1990, Corrales and Mora 1990, López-Rojas et al. 2024). Today, the fruits are cooked by being boiled in salty water, allowing the tough skin to be peeled off, revealing the fibrous orange pulp that has a smooth and buttery taste (Koshear 1995: 60-61). Even the round seed in the center of the fruits is edible and has a sweet white endosperm that tastes similar to coconut. The apical meristem of pejibaye is also eaten today, either raw or fried in oil (Koshear 1995: 88).

The other type of palm that is identified at Sitio Bolívar is the cohune palm (*Attalea*). Carbonized cohune palm seeds were also recovered from Sitio Black Creek in southern Costa Rica (Baldi 2011). Cohune palms are common in modern Mesoamerican milpa fields and ruderal landscapes disturbed by people (Eshelman and Beach 2020, McSweeney 1993), and has been described as one of the most abundant trees in Central America (Balée 2013, Horwich and Lyon 1990, Standley 1932). It is often intentionally left in agricultural fields in order to provide shade and perhaps increase soil fertility (McSweeney 1993). In the past, the cohune palms were likely valued for their oil (McSweeney 1995).

There is a considerable amount of wood from the cacao (*Theobroma*) tree in the assemblage at La Chiripa, it is the sixth most ubiquitous fruit tree from this domestic structure (with a ubiquity measure of 36% from the Un. 60 stratum). It is present as well at Sitio Bolívar, but not as dominant (5% overall ubiquity). Identification of the wood charcoal was only possible to the genus level, but it is likely that these specimens belong to the semi-domesticated tree of *T. cacao*. Cacao are spindly trees that thrive in the understory of a forest, are shade tolerant, and require fertile soils with enough moisture and pools of water to support larval development of their primary pollinator, small flies and midges (Bletter and Daly 2006, Coe and Coe 2013). These characteristics certainly would have existed surrounding both the La Chiripa and Sitio Bolívar settlements, and the high ubiquity of the wood charcoal in the assemblages suggest the trees were in fact growing nearby. Once pollinated, the cauliflorous flowers result in a large pod that contains around 40 seeds that are surrounded by a sweet, white pulp. The seeds cannot survive low temperatures or low humidity and have a short dormancy period (Ogata et al. 2006: 70); these limitations are significant because the seeds are the plant part used to produce chocolate.

People used cacao to produce ritual beverages as early as 3300 BCE during the Early Formative Period in southeastern Ecuador, where it was identified using a variety of methodologies, including starch grain analysis, ancient DNA (aDNA), and chemical residue analysis (Blake and Zarillo 2022, Zarillo et al. 2018). Macrobotanical evidence shows that cacao was grown by 1300 BCE in Gran Coclé, Panama (Dickau 2005). Cacao wood has also been identified in the Maya area at sites such as Tikal (Lentz et al. 2014) and San Bartolo (Santini 2016), but it is more often recovered via residue analysis archaeologically (Hall et al. 1990, Henderson et al. 2007, Joyce and Henderson 2007, 2010). Chemical analyses have revealed theobromine and caffeine compounds (which are both prevalent in cacao and rare in other plants indigenous to the Americas) in ancient pots and other artifacts from the Soconusco region of Mexico (Powis et al 2007) and from northern Honduras (Henderson et al. 2007, Joyce and Henderson 2007). Cacao is a spindly understory tree that is most well-known for the chocolate produced from its seeds. In Mesoamerica, cacao seeds would have been fermented and incorporated into beverages (McNeil 2006a).

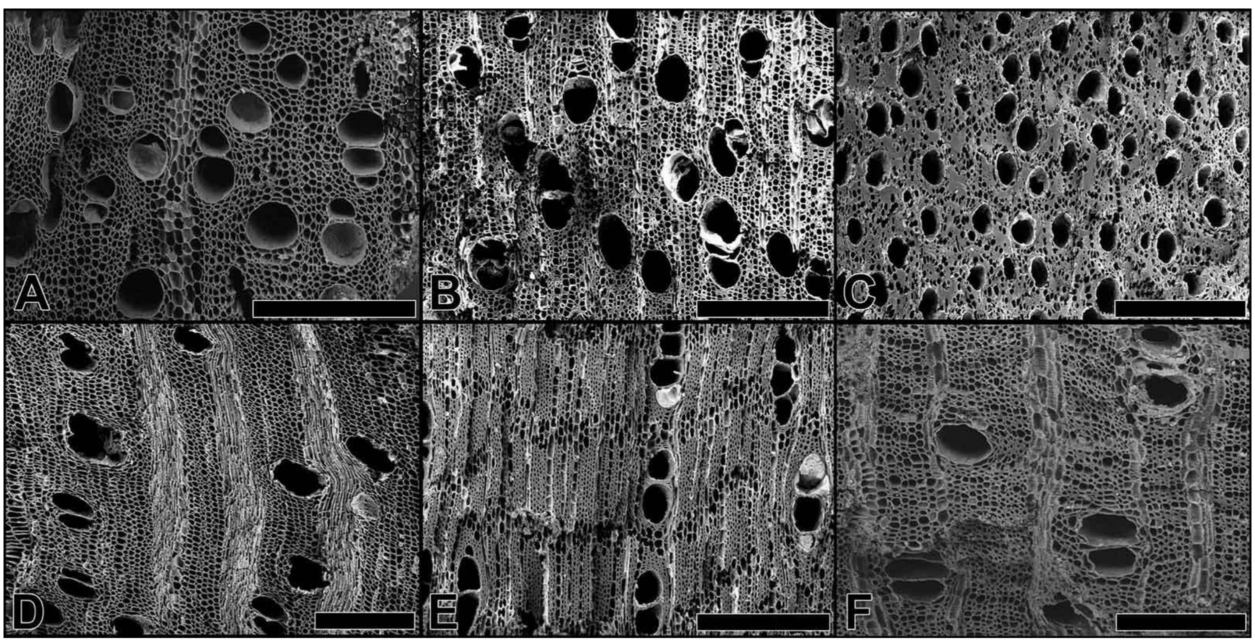


Figure 9-3: *Transverse views of wood charcoal recovered from both La Chiripa and Sitio Bolívar that were identified to taxa relating to cacao consumption, either from the cacao tree itself (A) or ingredients that would have been incorporated as admixtures (B through F):* **A** *Theobroma*, **B** *Bixa*, **C** *Bourreria*, **D** *Curatella americana*, **E** *Pouteria*, and **F** *Quararibea*. *All scale bars are 300 µm in length*. Tangential and radial views can be found within Appendices F and H.

Interestingly, other species are present at La Chiripa that have been documented as being incorporated into cacao beverages throughout Central America (Figure 9-3, de Avila 2024, Dreiss and Greenhill 2008, McGee 1990, McNeil 2012, Sotelo et al. 2012, Standley and Steyermark 1946). Maize may have been combined with cacao to create a beverage, such as *tejate*, as was practiced farther north in Mesoamerica later by both the Maya, the Aztec, and in Oaxaca (Sotelo et al. 2012). Additionally, Zapotec, Aztec, and Maya populations have added aromatic flowers to cacao beverages since pre-columbian times, including the flowers from the "flor de cacao" (*Quararibea*) tree, uvito (*Pourouma*), and the white "popcorn" flower (*Bourreria*) to both strengthen the flavor and add a pleasant fragrance to the drink. Further, the *Bourreria* flowers are used for medicinal purposes to treat fevers and coughs (Dreiss and Greenhill 2008:108, McNeil 2012). Additionally, achiote (*Bixa* sp.) wood is present at both of the Arenal settlements. Spanish chroniclers observed Nicaraguans adding achiote seeds to their cacao beverages in order to color it red and add a spicy flavor (Millon 1955:163). Images of "bleeding cacao" (likely *T. cacao* mixed with *Bixa orellana*) appear in Mixtec codices and Classic Maya ceramics, suggesting that cacao pods with achiote were included as offerings in Aztec and Maya ceremonies (Dreiss and Greenhill 2008, McGee 1990:46). Seeds from *Curatella americana* would also have been used to flavor cacao (Standley and Steyermark 1946). In Oaxaca, other taxa such as *Pouteria* and *Piper* have also been added to cacao beverages to create different flavor profiles (de Avila 2024), both of which were also found at these sites. Due to the strong presence of cacao in the wood charcoal remains in conjunction with other plants known to have been added to the chocolate beverages in pre-hispanic times such as *Bixa*, *Bourreria*, *Piper*, *Pouteria*, and Quararibea, it is quite possible that the villagers at La Chiripa were consuming cacao in a similar manner.

The cashew tree (*Anacardium*) is a tropical evergreen native to Northern Brazil and both the cotyledon (or "nut") and the fleshy accessory fruit are edible (Mitchell and Mori 1987). Both the wild (*A. excelsum*) and cultivated (*A. occidentale*) species are present at La Chiripa, but just the cultivated form is at Sitio Bolívar. This could suggest that the wild form was not as prevalent in more recent time periods, indicating a greater selection or preference for the cultivated *A. occidentale* in the Late Arenal period. Wood charcoal from the cashew tree has also been recovered from a Formative period deposit in Honduras (Lentz et al. 1997). The wood is strong, making it ideal for carved tools or construction purposes. The tree is incredibly useful medicinally as well: the leaves, bark, fruit, sap, roots, and gum all have known medicinal applications (Bown 1995).

Another fruit tree that was quite ubiquitous at both settlements in this investigation is Guava (*Psidium*). Guava had similar overall ubiquitous at both sites (11.63% at La Chiripa and 10.08% a Sitio Bolívar), but was more common compared to the rest of the macrobotanical assemblage at La Chiripa where it is the most ubiquitous arboreal fruit tree. Guava is a small evergreen tree or shrub that produces edible fruits with an aromatic flavor that can range from sweet to acidic, as well as edible leaves and oil from the seeds (Norrington 2001). Guava has been used in traditional medicine throughout Central America to treat inflammation, pain relief, fevers, and in various skin applications (Atran et al. 2004:118).

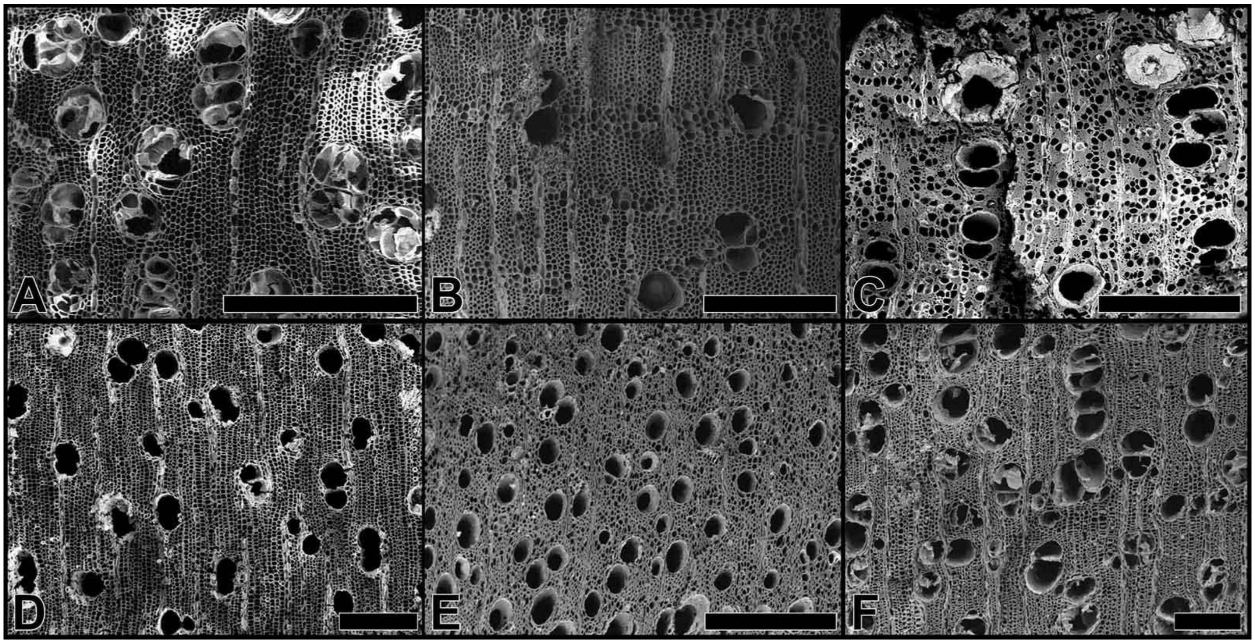


Figure 9-4: *Transverse views of wood charcoal recovered from both La Chiripa and Sitio Bolívar that were identified to taxa of common fruit trees.* **A** *Anacardium (cashew)*, **B** *Brosimum (ramón)*, **C** *Manilkara (sapodilla)*, **D** *Persea (avocado)*, **E** *Psidium (guava)*, and **F** *Spondias (jocote)*. *All scale bars are 300 µm in length*. Tangential and radial views can be found within Appendices F and H.

Spondias is one of the less well-known crops within the Anacardiaceae family (which also includes cashew, mango, and pistachio), but its plum-like fruit is widely consumed throughout the Neotropics today, both fresh or prepared into jams and beverages (Baraona Cockrell 2000, Miller 2011, Miller and Schaal 2005). Today, *S. mombin* L. is widely cultivated in tropical areas for its pleasantly acidic fruit, although the leaves, sap, and seeds can also be consumed (Facciola 1998). Wood charcoal from *Spondias* was identified at both of these sites, although the determination to species level was not always possible. The taxon was found throughout the La Chiripa house structure in all sampled contexts, including the exterior and interior of the structure, the hearth, and from within post holes. The majority of these specimens from La Chiripa are from the hogplum or jobo tree (*Spondias mombin*), but a few fragments were not identifiable to the species level and could possibly be *S. radlkoferi* or *S. purpurea*. *Spondias* charcoal was also found exterior to the Sitio Bolívar structure in an area that could potentially be a midden, due to the density of broken ceramic sherds and lithic debitage. Jocote (*S. purpurea*) wood charcoal and pits have been found in the Greater Nicoya region of Costa Rica and Nicaragua, at both Santa Isabel and El Rayo during the Sapoá period (AD 550-1300) and appears to have served as a major source of food (McCafferty 2021). The fruit tree was mentioned in the sacred Maya book, the Popol Vuh, demonstrating its significance to Mesoamerican cultures.

The economically and ecologically valuable trees ramón (*Brosimum*) and sapodilla (*Manilkara*) are among the abundant charcoal remains at La Chiripa. Both were also found at Sitio Bolívar, but the presence of ramón was not as strong at this site. Ramón had ubiquity values of 2.91% at La Chiripa and 0.84% at Sitio Bolívar. Sapodilla's ubiquity values were 0.58% at La Chiripa and 14.29% at Sitio Bolívar. Both ramón and sapodilla are slow-growing evergreen trees characteristic of old-growth forests in Costa Rica (Koshear 1995: 85) and are thought to have been among the most important trees in Maya agroforestry systems (Dussol et al. 2017). Both trees produce edible fruit, their wood serves as a valuable construction material, they have numerous medicinal applications, and are important sources of firewood (Atran et al. 2004, Lentz et al. 2012, Thompson et al. 2015). Additionally, the milky latex from sapodilla, along with espino rico (*Sideroxylon*) is a staple ingredient in *chicle*, a traditional chewing gum from Central America (Matthews 2009, Monroy-Garcia 2021).

Pouteria (mamey, sapote) produces an edible sweet, creamy fruit in a range of sizes and colors (red, orange, pink). The tree was a common part of forest gardens in southern Central America (Gomez-Pompa et al. 1987, Jones 1982) and is still frequently found in home garden surveys today of indigenous dwellings in the Nicoya area of Costa Rica (Koshear 1995: 86-88). Archaeologically, it has also been identified from Sitio Drago in the Greater Chiriquí region, along with many other tree fruit taxa such as sapodilla, nance, and mamey (Martin 2005). Its presence within the Arenal domestic structures was notable (9.01% ubiquity from the La Chiripa structure and 23.53% ubiquity from the Sitio Bolívar structure). Over a dozen species within the genus are found in Costa Rica today, so identification of the wood charcoal was left at the genus level due to the difficulty in differentiating the various species anatomically. The seeds from the fruits were an important source of oil and fats in Mesoamerica (Lentz 1999) as the tree is considered a staple among the Itzaj Maya of the Peten (Altran and Ucan Ek 1999). Mature trees can produce up to 500 fruits per season in an ideal environment (Balderi et al. 1996), which Pennington (1990) suggests grow in tropical forests between 0 and 800 m asl. This could indicate that the residents of La Chiripa managed this tree in their higher elevation forests, although it may not have yielded as productive of a crop, or they traveled to lower elevations to benefit from this tree's fruit supply.

Avocado (*Persea*) was identified from both archaeological sites, but is much more prevalent at the Late Arenal phase settlement (3.5% overall ubiquity at La Chiripa and 15.97% overall ubiquity at Sitio Bolívar). Avocado remains have been found in both Colombia and Honduras dating to 10,000 BP (Gnecco 2000, Kennett et al. 2023), demonstrating its early importance in diets in Latin America. Farther south, in Peru, the Caral people of the Supe Valley used domesticated avocado at least since 1200 BCE, where archaeologists speculate that avocado was an important staple since there is no evidence of maize or other grains within this cultural complex (Skidmore 2005, Solis et al. 2001). Piperno and Pearsall (1998) hypothesize that the avocado tree was cultivated and ultimately domesticated because of its resilient nature and the high nutritional value of its fruits. Avocados were grown within sacred gardens and home gardens in the Maya region (Landon 2009) and appeared on iconography from both the Maya and Aztec cultures (Galindo-Tovar et al. 2007, Martin 2006). Early chronicles by the Spanish and other Europeans documented avocado growing from Mexico to Peru (Galindo-Tovar et al. 2008, Gama Campillo and Gomez-Pompa 1992, Popenoe 1934). Carbonized pits of avocado were recovered previously in Arenal at the Dos Armadillos site (G154), which dates to the Tilarán phase (1300-1400 CE). Thus it was expected that this fruit tree would be utilized by the residents of both La Chiripa and Sitio Bolívar, and it was.

Not all of the fruit trees identified in this investigation were identified from both domestic settlements. Figure 9-5 shows the edible fruits that were identified from only one of these two sites. Comparing these two images demonstrates the difference in either the local ecological life zones surrounding each settlement and/or a difference in dietary preferences.

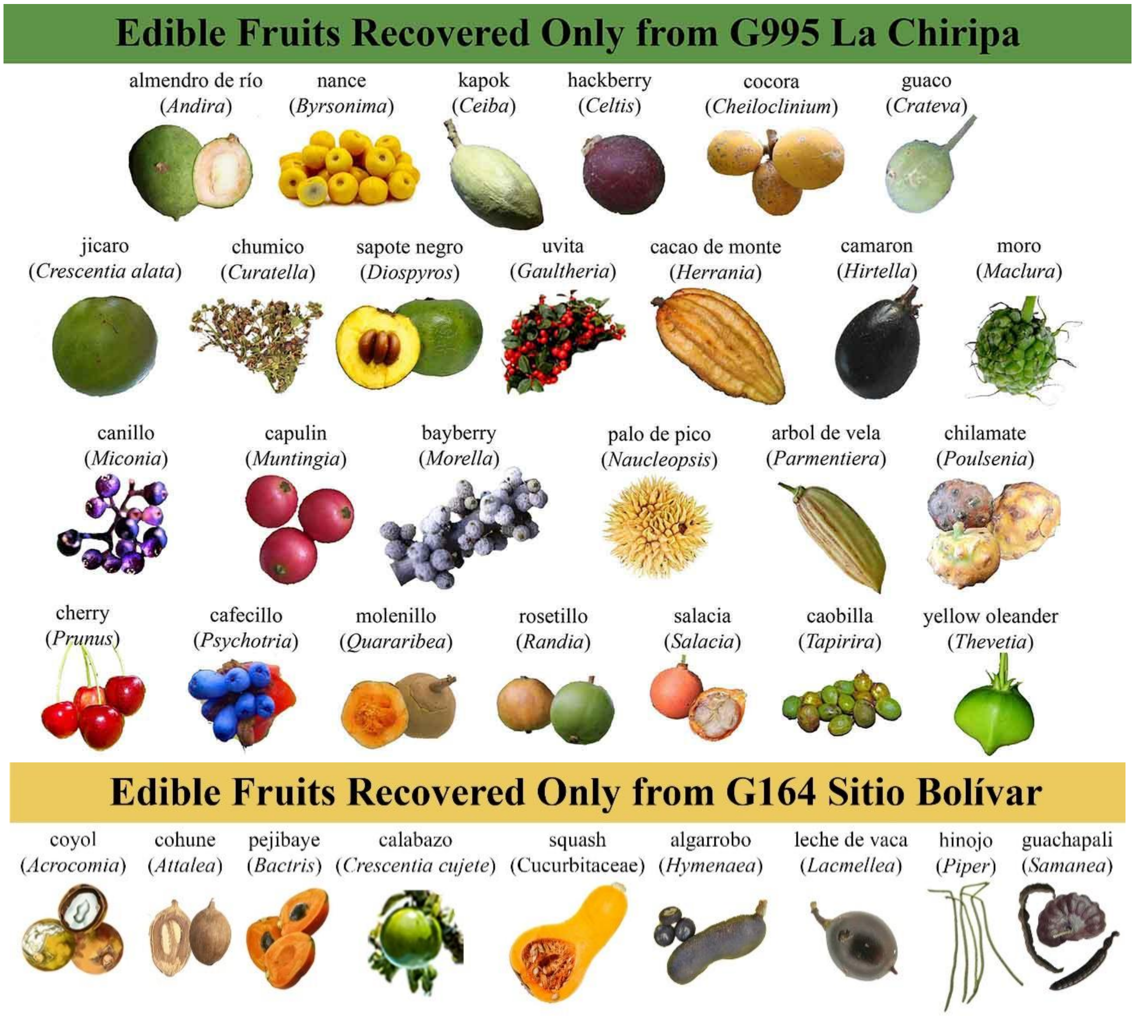


Figure 9-5: *Taxa that produce edible fruit which were recovered and identified from only one of the archaeological sites in this study, G995 La Chiripa (n=26) or G164 Sitio Bolívar (n=9).*

The most well-known fruit tree which was only identified at La Chiripa is nance (*Byrsonima*), which is a tropical tree whose fruit can be eaten raw or cooked, squeezed into a juice, and when fermented has also been incorporated as an ingredient in *chicha* beer (Medina-Torres et al. 2004). The wood charcoal fragments of *Byrsonima* were recovered exclusively from Rasgo 2, the hearth feature. Nance wood is valued as a household fuel because it is "clean burning" (Aguilar and Condit 2001). Archaeobotanical evidence in southern Mexico demonstrates a long history of human interaction with the nance tree, dating back to 11,800 years ago (Trabanino 2010). Although it is slow-growing, the tree is commonly used today in ecological restoration efforts because its heavy leaf fall can help to restore soil fertility.

Jicaro (*Crescentia alata*) was identified at La Chiripa and calabazo (*C. cujete* L.) only at Sitio Bolívar. While the fruits and seeds of both species are technically edible, the more common application of the fruits would have been to use their hard shells as containers or rattles, much like the bottle gourd (Facciola 1990, Standley and Steyermark 1946). The containers could serve as drinking vessels or as a means to store something, although the poor preservation at these sites does not allow us to envision exactly what may have been stored in these woody fruit shells.

Today, both of these species are often included within homegardens in Central America (Bass 2004) or grown as living fences (Avendaño-Reyes and Acosta-Rosado 2000).

At Sitio Bolívar, the wood charcoal assemblage does not reveal as many trees and shrubs that bear edible fruit which were exclusively found at this site, since the majority are also found at the La Chiripa site. The palms coyol, cohune, and pejibaye, discussed earlier, may have been present at La Chiripa as well, but the preservation of the wood did not allow for a genus level identification.

Many of the trees identified at La Chiripa and Sitio Bolívar also produce edible seeds. Some of these seeds could be eaten raw whereas others become more appetizing when cooked or roasted, including acacia (*Acacia*), cacao (*Theobroma*), carabeen (*Sloanea*), cashew (*Anacardium* spp.), ceibo (*Ceiba*), cherry or plum (*Prunus*), guayabillo (*Terminalia*), hogplum (*Spondias*), ramon (*Brosimum*), and sarigua (*Parkinsonia*). Other seeds could have been used to produce edible oils, such as from cashew, *Casearia*, *Cedrela*, *Ouratea*, *Psidium*, *Swietenia*, and *Virola*. All of these taxa were only recovered in the form of wood charcoal, so unfortunately it is unclear if their seeds were consumed.

Many of the edible fruit trees and cultivated plants found at these two archaeological settlements are commonly found within home garden surveys today of indigenous Guaymí dwellings of Costa Rica and Panama (Hazlett 1985:344, Koshear 1995:86-88) including achiote, avocado, cacao, cashew, guanabana, guava, jicaro, jocote, manioc, mamey sapote, nance, papaya, passionfruit, pejibaye, squash, and tobacco. This demonstrates the longevity of the incorporation of these plants into the diets of people within this region. While few indigenous populations survived the colonial period in Costa Rica, the prevalence of these edible plants in the landscape clearly has had such a strong influence on dietary patterns that it continues today. Useful tree species, such as those that bear edible fruit, create spaces that can be utilized long term for the collection of foodstuffs, especially during periods of ecological recovery where low lying vegetation is not yet thriving or when agricultural fields are left in fallow.

9.6 The Use of Space

Ethnoarchaeological experiments by Barba and Lazos (2000) demonstrated that archaeochemical analysis can aid in the interpretation of food related activity areas within domestic structures. Barba conducted such analyses at the La Chiripa site in search of the presence of phosphates, carbohydrates, and proteins, and pH determinations (Figures 9-6 and 9-7).

Such molecular research has noted that food consumption areas contain lower pH values. Whereas, food preparation areas include heat sources, and consequently, ashes, carbonized plant remains, and higher pH values (Barba and Lazos 2000: 62-63). At La Chiripa, the pH determinations did not reveal a wide range of values (Figure 9-6), with values ranging from neutral (7) to slightly elevated and alkaline (8). The entirety of the structural floor revealed slightly alkaline pH values, and the exterior of the structure had more neutral levels. This suggests that the interior of the home was the location of food preparation activities involving heat, which is corroborated by the presence of carbonized wood remains throughout the floor surface (Figure 7-13). Other than the hearth (which dates to a completely different time period than the rest of the structure), no clear activity areas were revealed from the pH analysis at La Chiripa.

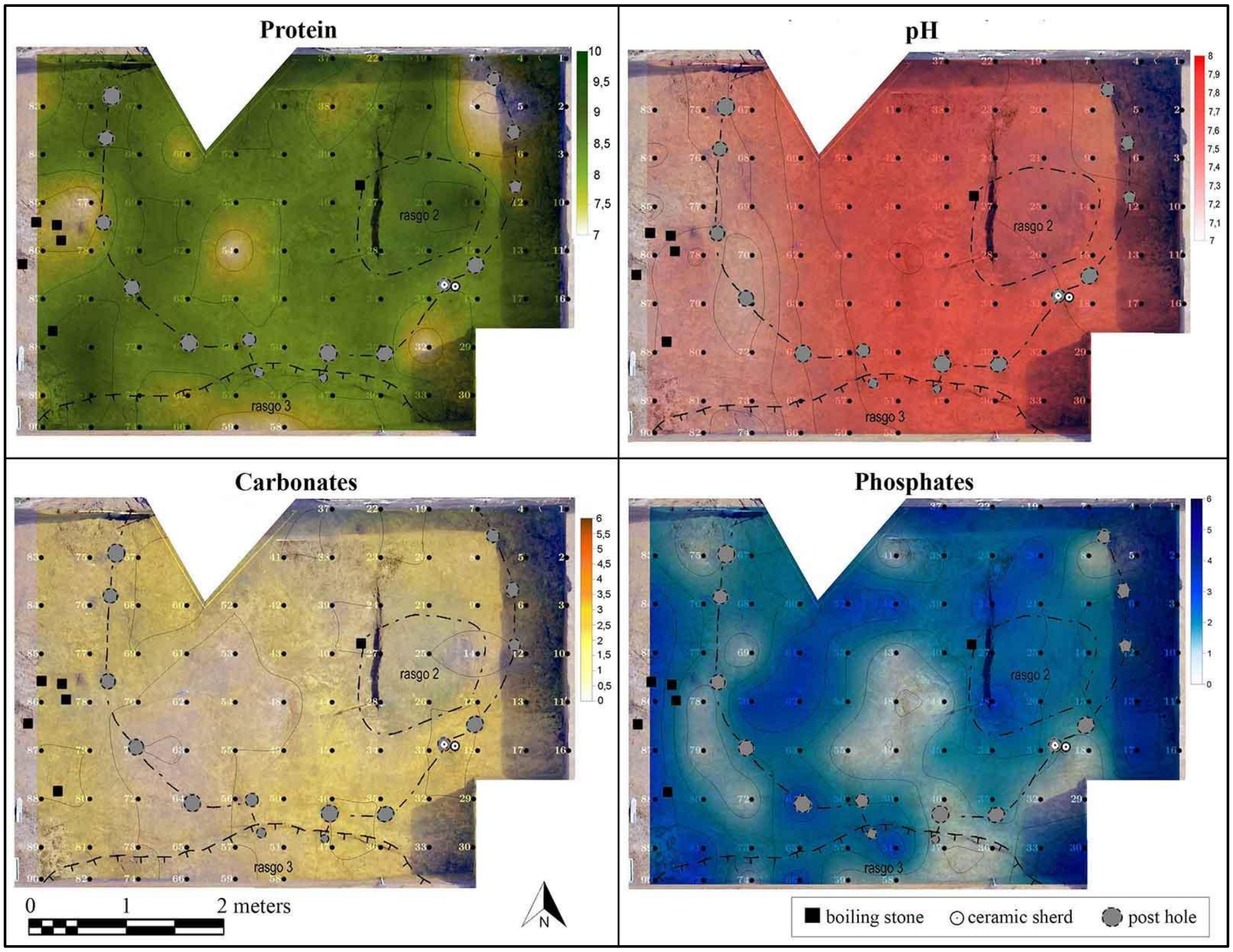


Figure 9-6: *Archaeochemical residue spatial distribution from Un. 61 at La Chiripa, the structural floor (modified from maps provided by Luis Barba).*

Luis Barba's sampling of the hearth (Rasgo 2) at La Chiripa revealed high values of phosphates, carbohydrates and proteins (Figure 9-6). Phosphate and protein residues can usually be associated with fire-transformed animal products. Other than this chemical signature, no faunal remains were recovered at La Chiripa. The carbohydrate residues are usually associated with starchy vegetables that may have been cooked, suggesting that starchy underground storage organs (USOs) or geophytes were a component of subsistence strategies. Thus, the chemical residue results suggest that this hearth was indeed used to cook foods. Spatially, the hearth feature at La Chiripa also had the greatest density of remains within that stratigraphic level (see Figure 7-13). Not only was the hearth densely filled with organic material, it was also botanically diverse with 75 identified plant taxa. Thirty-nine of these taxa produce edible plant parts (see Table 7-9) including the cultivars maize, common beans, and manioc as well as many well-known trees that produce edible fruits and seeds such as achiote, cacao, cashew, cherry, guava, hackberry, hog plum, and mamey. Flavorings that may have been added to a meal such as the spicy floral parts of *Acmella* were also quite prevalent within the hearth feature.

The presence of maize at La Chiripa was entirely within the post-occupation hearth feature, providing further evidence that this feature was used to process and cook food remains. As was suggested with Chapter 7, the ignition of this fire pit dates to a much later time period than the floor of the house structure and actually coincides with the abandonment of the home. Therefore, the act of cooking and burning material within this hearth may have been part of a ceremony to commemorate the many years and generations of people who lived within that space in the past. With over 75 taxa identified within the feature, this hearth may have been used repeatedly or was lit for a considerable amount of time in order to build up such a collection of woods and food remains. It is also possible that this hearth was a secondary deposit, where the ashes of a fire elsewhere deposited in the center of the abandoned structure. Dussol (2019) found that *in situ* hearth features (determined by the presence of burn marks) revealed a low taxa diversity and high remain density and were likely a single fire event. Whereas secondary deposits had a much higher taxa diversity but lower density. The density of plant material within the hearth at La Chiripa was .086 g/L, which is much lower than anything discussed by Dussol (2019), whose work may have been in an area with better preservation. However, the hearth feature at La Chiripa exhibited a higher taxa diversity (n=75), and higher quantity of identified fragments (n=414) compared to any hearths discussed by Dussol (2019) and an overall high density of plant material within this site, suggesting that multiple fire events occurred in this space. Just as the pathways were used to visit ancestors and significant locations across the landscape, such as natural springs (Sheets 2011), this hearth signifies a physical space used to perpetuate the social memory of those who lived within the La Chiripa structure.

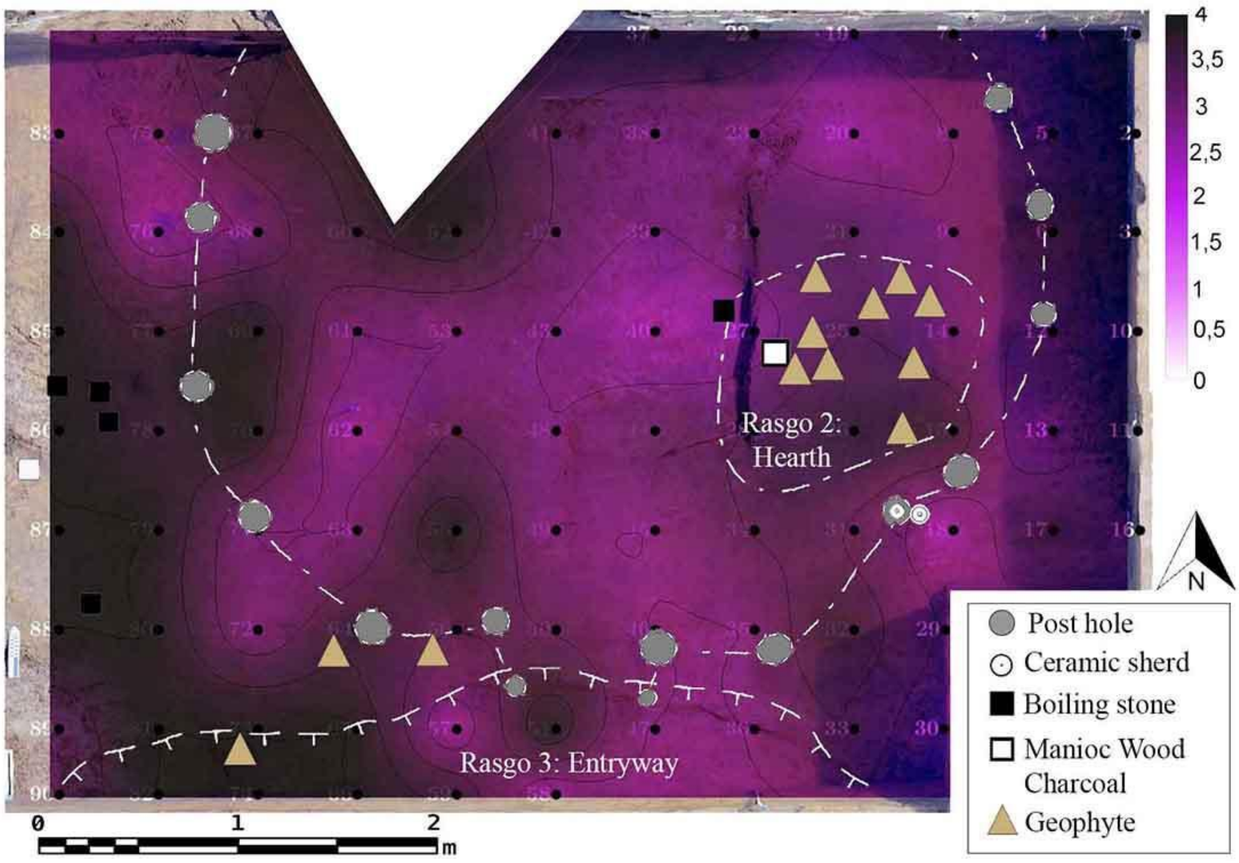


Figure 9-7: *Map of Un. 61 at La Chiripa that shows the carbohydrate residue distribution compared to the macrobotanical geophyte remains and wood charcoal remain identified to be from Manihot sp. (manioc). The main map has been provided by Luis Barba and then modified.*

The paleoethnobotanical data corroborates the carbohydrate residue results of 8 geophyte fragments identified from within the feature, one of which was manioc (*Manihot*) (Figure 9-8). Manioc, also known as yuca, is a tropical small tree or bush that produces carbohydrate-rich roots and is a significant root crop in traditional swidden cultivation systems today in the Neotropics (Piperno and Smith 2006, Sheets et al. 2011). Underground storage organs (USOs) are one of the most frequently consumed carbohydrates in the human diet and are also an important source of energy and sugars (Kubiak-Martens 2016). Preservation of archaeological parenchyma is rare compared to seeds and wood charcoal for various reasons. Vegetative parenchyma contains a high amount of water and oil (Hather 2000) and is not necessarily exposed to fire in a way that could lead to carbonization. Therefore, although the presence of USOs within the macrobotanical assemblage at La Chiripa is nearly identical in terms of quantity and ubiquity to maize, it likely formed a larger portion of the diet because it is much less likely to preserve in comparison to the much more durable maize cob fragments.

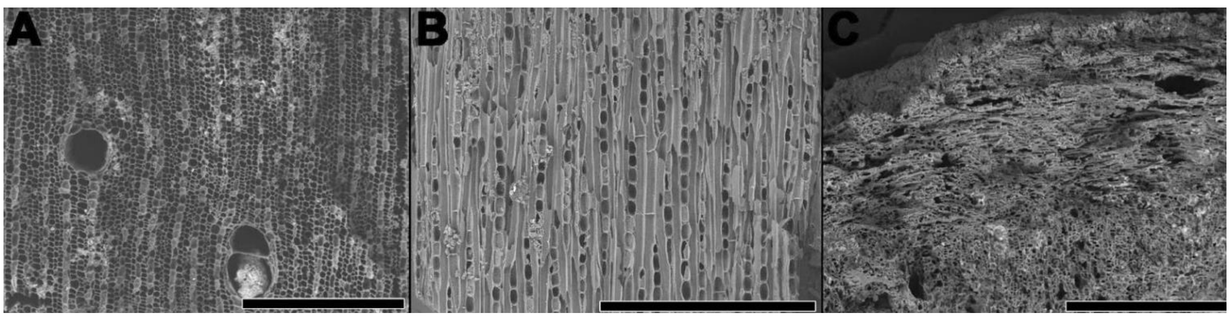


Figure 9-8: *Scanning electron micrographs of Manihot sp. A) Transverse view of wood charcoal, B) tangential view of wood charcoal, C) root fragment. All scale bars are 500µ*m. *The root fragment was identified to this genus due to its exceptionally thick periderm and the presence of vertical chains of xylem cells, both of which are diagnostic features.*

Macrobotanical identification of USOs is not always possible because it requires that both parenchymatous tissue and vascular tissue are preserved (Hather 1991, 2000). Since the roots are typically prepared by being boiled, they are unlikely to be burned and preserved archaeologically in a form that can be recovered through macrobotanical investigations. Manioc starch grains from Panamanian archaeological sites show that the root crop was in the region by 5000-4000 BCE, along with arrowroot (*Maranta arundinaceae*) and yams (*Dioscorea trifida*) (Dickau 2005, 2010, Dickau, Ranere, and Cooke 2007). Both the leaves and roots of manioc are edible, although the bitter variety requires some processing to remove its high level of acidity. Manioc was preserved in multiple forms at La Chiripa, both as a root structure and as wood charcoal, suggesting that it was growing in the vicinity of the structure. Manioc grows well in a wider range of soils compared to maize and produces a considerably greater harvest in terms of both weight and calories per unit area (Sheets et al. 2011). Manioc, along with sweet potato, lerén, and arrowroot, were identified from Formative period settlements (1600-900 BCE) in northwestern Honduras through microbotanical analysis (Morell-Hart 2011, Morell-Hart, Joyce, and Henderson 2014), thus documenting a similar significance of underground storage tissues in the diet of Isthmo-Colombian peoples around a similar time as the La Chiripa settlement. Elsewhere in Costa Rica, evidence for the use of root crops such as lerén, sweet potato, and ñampi alongside maize and beans is also evident (Azofeifa López 2023, Hoopes and Bozarth 2012, López-Rojas et al. 2024, Stone 1977), demonstrating the widespread practice of incorporating both into subsistence regimes in the past.

Historically, root crops have formed the basis for subsistence on both the Atlantic and Pacific slopes of Costa Rica (Koshear 1995: 68, Stone 1977). In the 17th century, Fray Adrián (de Ufeldre) noted that "yucas [manioc], patatas [potatoes], ahuyam [ayote], otóes, y narnes" were staple root crops consumed year-round on the Nicoya peninsula (Fray Adrián, in Torres de Araúz 1965:73). Common root crops grown in Costa Rican home gardens of the indigenous Guaymí today include sweet potato or camote (*Ipomea batatas*), tequisque and malanga (*Xanthosoma sagittifolium* [L.] Schott.), and ñampi (*Dioscorea trifida*) (Koshear 1995: 83). It is quite possible that the other geophyte fragments in the assemblages at both sites belong to these other root taxa, but sufficient reference material from these other taxa was not obtained and identification of the rooty tissue is still in development methodologically. The Guaymí only harvest their root crops when they are needed, since they keep better in the ground, stored alive and continually growing (Koshear 1995: 83). For the past residents of Arenal, root crops such as manioc would still be available underground after an environmental disaster such as a volcanic eruption, making it a more reliable food source than maize in such a setting.

At Sitio Bolívar, the presence of a hearth feature was not as obvious visually compared to the one found at La Chiripa (which was created after the structure was abandoned). No major changes in soil color or concentrations of stones in a configuration suggestive of a fire pit were located. Therefore, additional actions were taken during excavations as an effort to locate such a space where the cooking of foods may have taken place within this domestic setting. While Luis Barba did not collect samples from Sitio Bolívar, the excavation team was able to still conduct pH determinations. The pH analysis at Sitio Bolívar was carried out following the procedure established by Barba, Rodríguez, and Córdoba (1991) using soil samples equivalent to 50mg from all sublevels of Nv. 5 (A, B, and C) of the excavations, amounting to a total of 104 samples from the floor of this domestic space. The determination of pH from this level is presented within Figure 9-9. This resulted in 82.7% of the sampled contexts presenting a neutral value of 7. Other spaces of this stratum ranged from a pH level of 5 (acidic) to 9 (alkaline). This is a high level of variability compared to La Chiripa, where all contexts sampled revealed a narrower range of pH values between 7 and 8, without any clear areas of a high concentration of alkaline soil (Figure 9-6). Fortunately, this allows more differentiation of food related activity areas at Sitio Bolívar compared to La Chiripa.

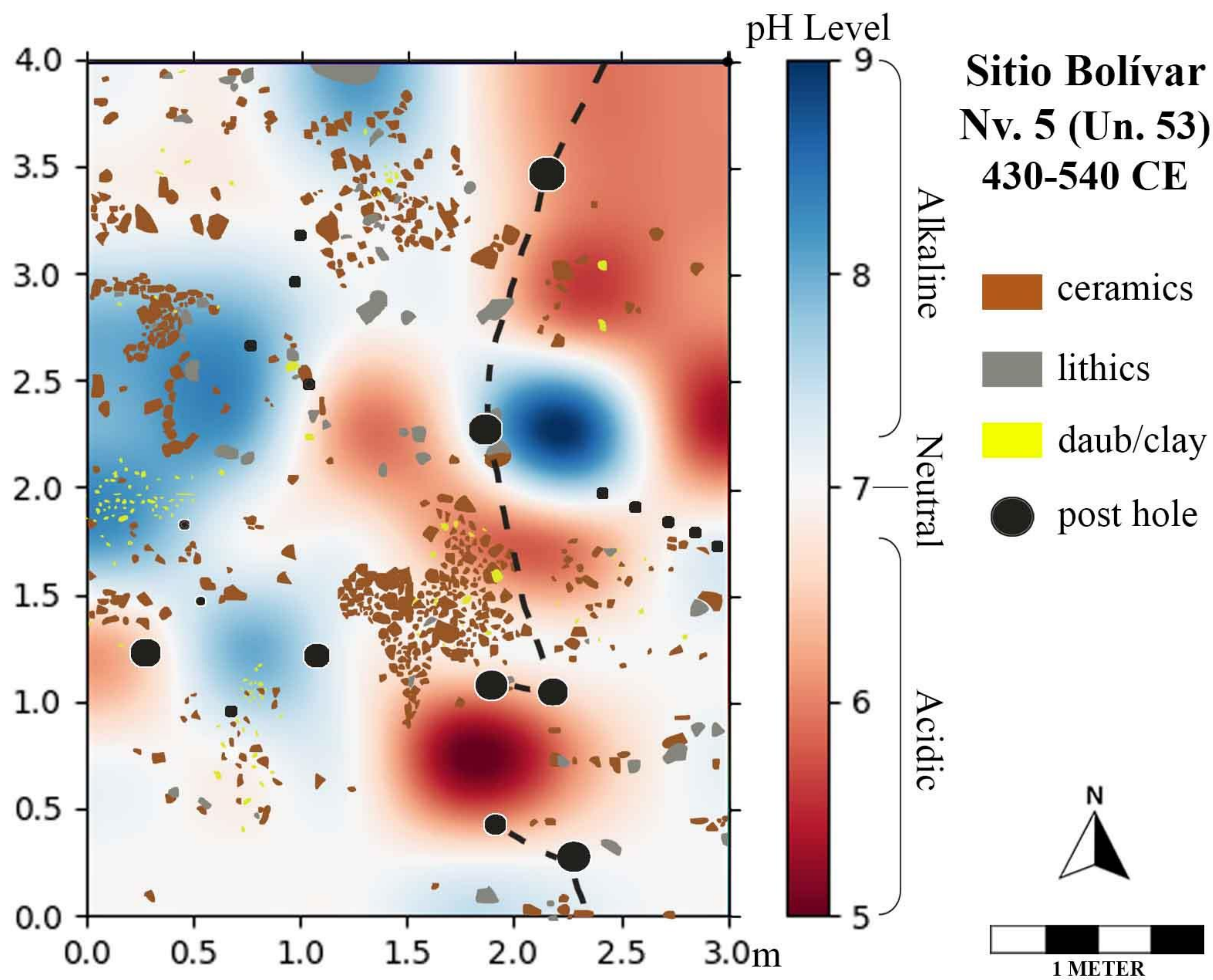


Figure 9-9: *Map of the pH distribution across Nv. 5 at Sitio Bolívar in relation to the artifacts and features found within this stratum. This map combines the results from each sublevel (A, B, C) because they revealed complementary pH values.*

At Sitio Bolívar high pH values, which are alkaline, indicating the presence of ashes and therefore a hearth, occurred within several locations. Most of the areas with alkaline soil were in contexts exterior to the main domestic structure. This is consistent with other excavations in the region, where hearths are found exclusively outside of homes (Bradley 1994a, 1994b, Hoopes and Chenault 1994). However, none of these spaces had a clear distribution of stones indicating an outline of a firepit. Additionally, the density of plant materials was actually low in all areas at Sitio Bolívar that contained a non-neutral soil in terms of pH levels (Figure 7-23), which does not aid in the interpretation of these spaces. A greater density of boiling stones was located in the northwest region of the excavation level (Figure 9-10), with 120 boiling stone fragments recovered the 4 northwest most square meters outside of the structure. A couple of other lithic materials related to food preparation were also located within this corner, including 2 scrapers and 2 knives. This corresponds to the higher pH determinations, but still does not highlight a specific area for a fire pit feature. It is possible that the exact feature was just outside of the excavation unit and the debris and materials discarded to its side are all that were recovered. The alkaline area located within the central western side of the excavation corresponds with a lot of broken ceramic sherds and a scattering of unfired clay, perhaps indicating that the hearths in this space were not limited to the preparation and cooking of food materials. There is a space within the house structure with a highly alkaline concentration of soil. This particular space may have been a pile of ash deposited in the corner of a room, since the orientation of the post holes in this location suggests some sort of partition separating the interior space into different sections.

Other indications of food preparation can be marked by the presence of materials like manos and metates, which would have been used to grind food materials prior to consumption. No metates were encountered at either of these sites unfortunately, but a single mano was found at Sitio Bolívar (see Figure 6-21). However, the context in which it was found does not allow for in depth interpretations of its use, since it was encountered in Nv. 2, which is quite close to the ground surface and not associated with any cultural features from the Arenal phase occupation.

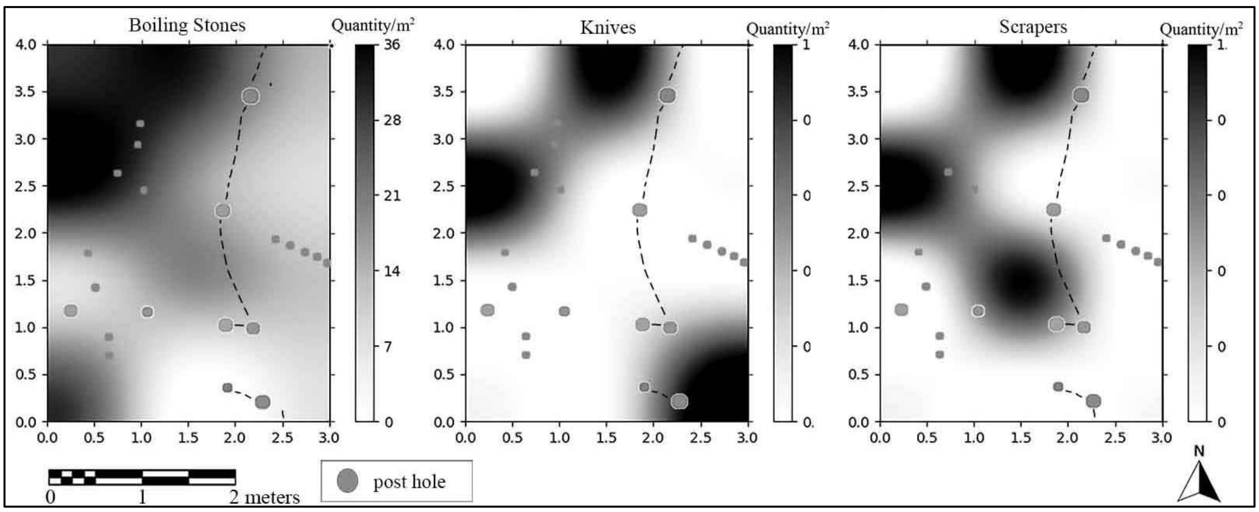


Figure 9-10: *Map of the spatial distribution of lithic artifacts relating to food preparation from Nv. 5 at Sitio Bolívar in relation to the domestic structure and post holes.*

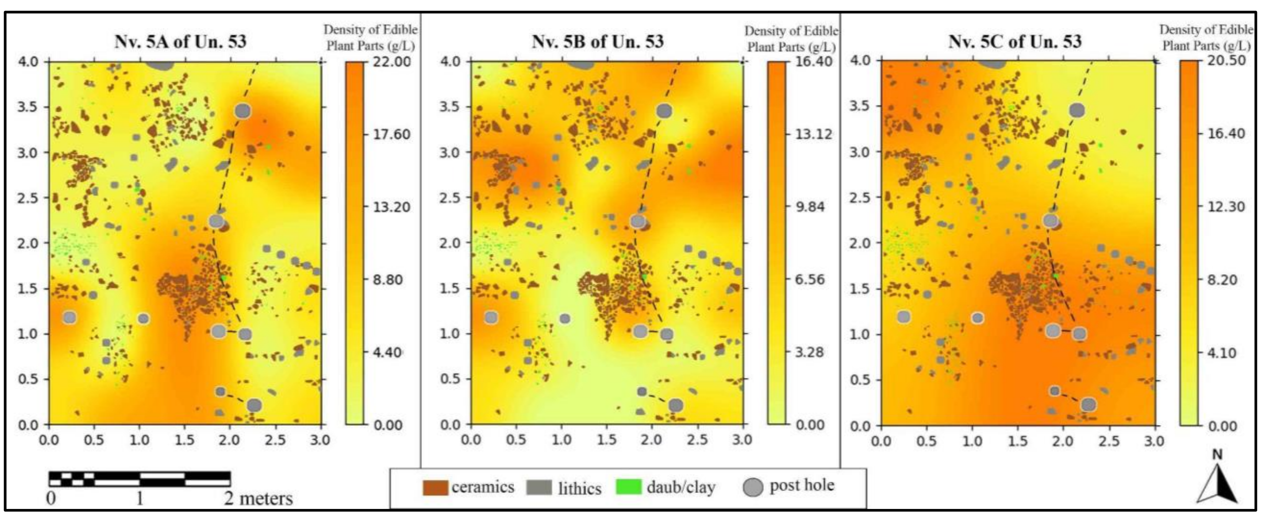


Figure 9-11: *Map of directly edible plant materials from Nv. 5 (Un. 53, 430-540 CE), the level most associated with the house structure at Sitio Bolívar.*

Interestingly, the areas from the floor surface of the structure at Sitio Bolívar with lower pH values and acidic soil are more concentrated within the interior of the structure, suggesting that food consumption took place indoors. There was a lower presence of ceramic and lithic artifacts within the interior space as well, perhaps indicating that the interior space was more for storage and sleeping, and was swept regularly. However, the distribution of directly edible plant remains (Figure 9-11) such as the crop taxa maize, beans, squash, and geophytes, the *Acmella* achenes, and coyol fruits are found across the entire excavation with every single sampled location containing at least some preserved edible plant parts (Figure 9-11, Appendix I). The distribution of these directly edible plant parts varies by sublevel, suggesting a change of the use of this space through time. Within the earliest portion of the occupation (Nv. 5C), the highest density of plant material is found within the interior of the assumed structure. As time went on and the sediment within this space built up (Nv. 5A and 5B), edible plant parts are more concentrated in areas exterior of the structure, suggesting a different use of space over time. Perhaps this change resulted from the increased up-keep of the space as time progressed.

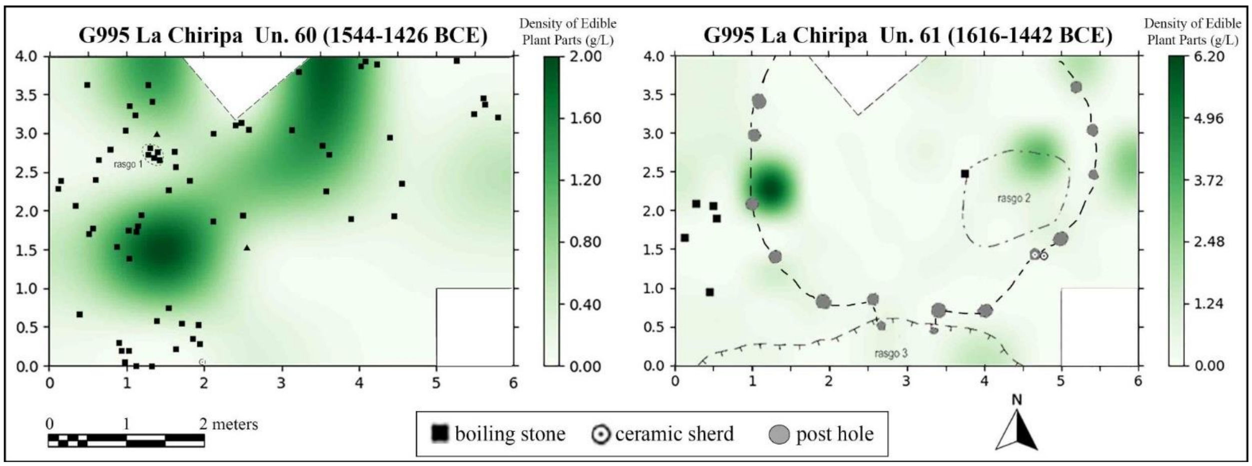


Figure 9-12: *Map of directly edible plant materials from levels associated with the house structure at La Chiripa.*

As a comparison, the distribution of directly edible plant material identified at La Chiripa (Figure 9-12), which is composed largely of the same taxa as at Sitio Bolívar, reveals that very few of this type of preserved plant material was recovered from the structural floor of the dwelling (Un. 61). The few instances of concentrations in this level were found in a single location exterior to the structure, and also within the hearth feature. However, since the hearth feature was created at a separate time hundreds of years later, it does not demonstrate direct consumption of food materials at the time in which the structure was inhabited. The same type of distribution within the lived surface of the structure (Un. 60) reveals higher concentrations of edible plant parts within what would have been the interior of the structure.

While this discussion has focused primarily on the food-related aspects and use of space within these two settlements, an interesting finding that resulted from the paleoethnobotanical investigation is that these spaces were used by their inhabitants for a variety of purposes. The focus on food paints a mundane, domestic view of daily life at La Chiripa and Sitio Bolívar. However, the taxa identified within this study also reveal other types of activities which are a part of daily life surely happened within these structures as well. It is especially intriguing that plant taxa that are primarily associated with ritual or ceremonial activities are present at both La Chiripa and Sitio Bolívar.

For example, *Protium* (copal), *Hymenaea* (guapinol), and *Tetragastris panamensis* (Engl.) Kuntze (kerosin) all produce hard resins which were traditionally used as incense in the Americas (Figure 9-13) (Lundell 1937, Neels 2000, Standley and Steyermark 1946). The presence of these taxa allows us to think about the olfactory dimension and the smells that may have been filling these homes, beyond just what was cooking for dinner. Fragrant materials burned as an incense may have transformed these dwellings so that their inhabitants' lives felt connected spiritually to others in their cultures, their communities, and also their ancestors as they practiced rituals passed down from generations before them.

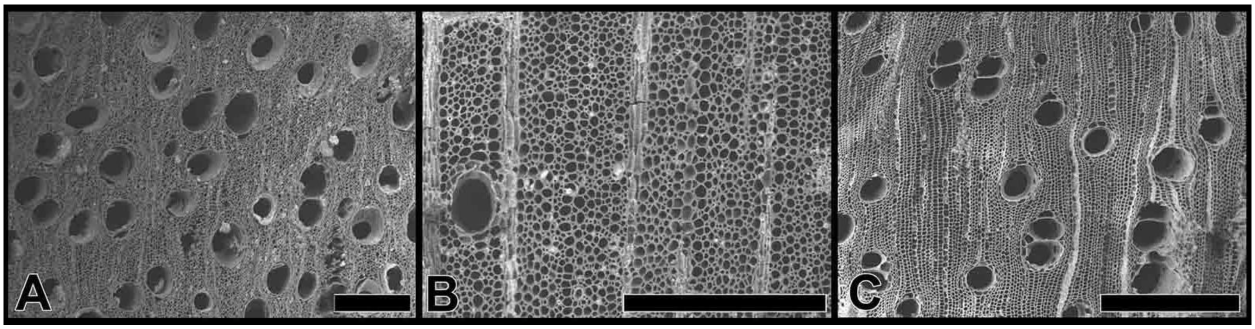


Figure 9-13: *Scanning electron micrographs of wood charcoal identified to taxa which are traditionally used for their resin to burn as an incense:* ***A*** *Protium,* ***B*** *Hymenaea, and* ***C*** *Tetragastris. All scale bars are 300 µm in length. Tangential and radial views can be found within Appendices F and H.*

These resin producing trees were not the only ritually significant taxa recovered from both archaeological settlements; tobacco and cacao have strong connections to ritual and ceremonial activities among native groups of the Americas (Joyce and Henderson 2007, McNeil 2006, Rafferty 2021). Both of these taxa have been discussed previously within this dissertation, but their presence is relevant here as well with considerations of their use in these domestic spaces.

Tobacco was the most pervasive intoxicant throughout the Americas at the time of European contact (Moerman 1998), and even exhibited a wider distribution than maize (Rafferty 2021:145). The nicotine found in tobacco can have hallucinogenic effects in high doses, interfering with color perception (Winter 2000: 267). It has been viewed as a means of bridging the gap between this world and others in native spirituality (Furst 1976: 23). At La Chiripa, the two tobacco seeds were recovered from the structural floor in Un. 61, indicating that ceremonial practices took place within the dwelling. At Sitio Bolívar, the *Nicotiana* seeds were found immediately outside the entrance to the structure, suggesting that the awning or porch either provided a place for these activities involving its use or that remnants of the product were disposed of right outside the dwelling.

Fermented cacao beverages were likely consumed at both of these settlements and were perhaps incorporated into feasts to transform the consciousness of participants (Dietler 2001:73, Joyce and Henderson 2007). Cacao was not the only taxon identified from these sites that can be used to produce fermented beverages. It is quite possible that these people participated in the tradition of fermenting maize to produce chicha (McGovern 2017). The pith of the trunk of coyol (*Acrocomia aculeata*), which has a high starch content and produces a sap, has been fermented to produce an alcoholic drink by native communities from Mexico to Costa Rica (Ambrocio-Ríos et al. 2021, Blombery and Rodd 1983, Lentz 1990). Additionally, the pulp that surrounds algarrobo

(*Hymenaea*) seeds nance (*Byrsonima*) fruits and can be fermented into an alcoholic beverage as well (Barwick 2004, Facciola 1998, Medina-Torres et al. 2004).

Several other trees identified at the sites are well known for their use in pre-hispanic rituals and mind-altering practices. While the main ingredient of ayahuasca (*Banisteriopsis*), a psychedelic drink that when consumed causes an altered state of consciousness, is not present at either site -- two different trees that are common admixtures into a mind-altering beverage were identified from the wood charcoal remains at both sites (*Psychotria* and *Tabernaemontana*). The leaves of *P. viridis* contain the potent hallucinogenic alkaloid dimethyltryptamine (DMT) and are considered essential in the ayahuasca decoction in order to get a psychoactive effect (McKenna 2006). Other *Psychotria* species are similarly utilized in the Amazon, but *P. viridis* is the most common (Schultes 1972). A pharmacopeia of admixtures were added to the drink, including two plants found in this macrobotanical assemblage: tobacco (*Nicotiana*) and *Tabernaemontana* (McKenna 2006, Pinkley 1969). There's also *Virola* (ucuhuba) wood charcoal recovered from the hearth feature at La Chiripa. A hallucinogenic snuff is prepared from the reddish inner bark resin of the *Virola* tree by groups in northern South America (Plotkin and Schultes 1990). The snuff is thought to treat fevers by Venezuelan shamans and recent ethnopharmacological investigations identify the tree as an antifungal treatment. There are over 1,500 species of *Psychotria* and over 40 species within the genus of *Virola*. Anthracological analysis can rarely identify wood charcoal all the way to the species level, especially when a genus is so large. Therefore, it is difficult to determine if the trees identified at La Chiripa and Sitio Bolívar through charcoal were the hallucinogenic varieties.

This assortment of plants suggest that ceremonial and mind-altering practices likely occurred at both of these settlements. Were the inhabitants of these two different structures, placed within very distant periods of time, both shaman or religious practitioners? Or were they ordinary members of their communities, whose cultural practices involved the use of incense and intoxicants? Intoxicants have a long history of enhancing cognition, providing stimulation, enabling sociability, and aiding in physical activities (Rafferty 2021:10). What is certain and most notable from these findings is that the use of this space cannot be so narrowly defined to just food consumption. Even within the realm of food consumption, the ceramic assemblage at Sitio Bolívar did contain a variety of decorative elements and appliqué traditions (see Figures 6-19 and 6-20), suggesting deeper meanings and significance behind meals and the food consumed. Exterior decorations of serving vessels can be associated with shared ritual performances and feasting activities (Mills 2007). While discussion of the results has been limited to a focus on food, these residents surely practiced spiritual, medicinal, and other types of activities within these settlements as well.

9.7 Daily Meals

With multiple datasets in mind, the archaeological findings at these sites and others in the region more broadly help to depict daily meals and food practices in Arenal during the Tronadora and Arenal phases. The paleoethnobotanical analyses reveal the available food ingredients that could have been incorporated into meals and the artifact assemblages portray the associated food processing, cooking, and serving practices. The macrobotanical assemblage indicates that a mixture of subsistence strategies was included in the daily lives of these villagers who incorporated arboriculture of fruiting trees, milpa agricultural systems with maize beans, and squash, as well as the cultivation of roots and stems such as manioc into their diet. Fruits collected from forested spaces and home gardens would have been cut and prepared using stone knives prior to consumption. Some foodstuffs would have been processed on manos and metates, which would have been used to grind starchy products such as root crops in addition to maize into a flour that could be then transformed into tortillas, tamales, prepared as a gruel, or included in soups or stews.

The vast majority of macrobotanical material were wood charcoal fragments, which in this form merely provides evidence for the use of wood as a source fuel in fire pits. This leads to the question of how the Arenal residents used fire to cook their meals? The high prevalence of boiling stones recovered from both of these village settlements suggests that the majority of cooked meals were porridges, soups, and stews. Both the low frequency of charred plant materials that would have been directly edible at both La Chiripa and Sitio Bolívar and the small number of taxa identified in this form indicate that most meals were not roasted directly over a fire. These boiled dishes could have incorporated both plants and animal foodstuffs. The marshy lake of Arenal probably provided a rich supply of fish, birds, amphibians, and other animals for the inhabitants of these settlements, but the absence of faunal remains due to poor preservation prevents any specificity of this aspect of the past diets of these peoples (Hoopes 1987:47). Nevertheless, the past people of Arenal would have been able to obtain various sources of protein, whether it be from local fauna, vegetable protein, or nut-bearing trees such as cashew (Beckerman 1979, Clement 2019). Protein consumed from fruit tree harvests can supply an immense amount of protein to a diet (Clement 2019).

A diachronic depiction of the primary edible taxa identified at both sites is presented in Figure 9-14, illustrating the ubiquity values of these plants which produce edible fruits, nuts, seeds, roots, and grains through time using data from all sampled stratigraphic levels within this study, whether sterile or cultural. This graphic demonstrates the continuity of the majority of these foods within the cuisine of Arenal residents from the Tronadora phase structure at La Chirpa to the Late Arenal phase village at Sitio Bolívar. Some of these foods were identified within the macrobotanical assemblage in nearly every stratigraphic level (*Acmella*, Arecaceae, *Pouteria*, *Spondias*, *Terminalia*, *Theobroma*, and geophytes), which indicates their strong dominance on the Arenal landscape and also within the resident's lives and subsistence regime, likely as signature foods or staples. The edible taxa in these datasets are overwhelmingly dominated by tree fruits, thus portraying the past people of Arenal as foragers and arboriculturalists who tended to their forests for food products. Their efforts were so productive that even stratigraphic levels without artifacts or cultural contexts revealed wood charcoal from fruit trees.

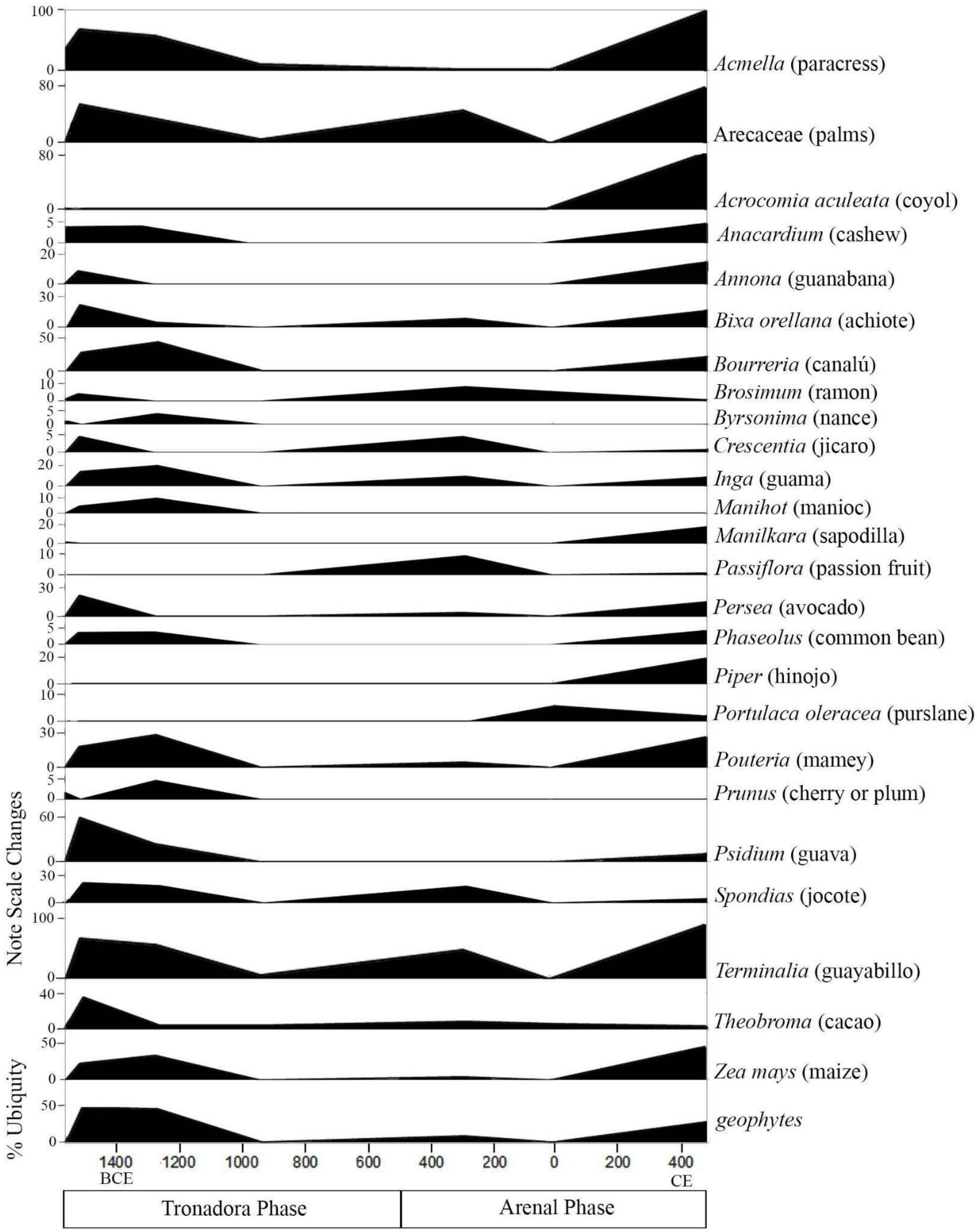


Figure 9-14: *Diagram presenting the ubiquity values of the primary edible plant taxa recovered from La Chiripa and Sitio Bolívar through time (using the median year of the radiocarbon dates representing each sampled stratigraphic level).*

Today, we know that people need a variety of nutrients to survive and live a healthy lifestyle, including proteins, fats, carbohydrates, vitamins, and water (Hall 2014:10). There are groups of people today who pursue a fruitarian lifestyle, with the belief that humans evolved as frugivores rather than carnivores or omnivores. This is demonstrably untrue, a fruit-only diet can lead to nutritional deficiencies due to low levels of protein, iron, calcium, and essential fatty acids. Additionally, fruit production phenology, i.e. the seasonal variation in fruit harvests, can be a limitation to a predominantly frugivorous subsistence strategy (Clement 2006:165). Nevertheless, it is clear that Arenal's residents shaped their diets around locally available fruits. Many fruits are not cooked in order to be consumed. Figure 9-1, at the beginning of this chapter, illustrates that the majority of edible plant foods identified at these sites would have been fruits consumed raw (62 taxa at la Chiripa, 47 taxa at Sitio Bolívar). Only a handful of these fruits may have been cooked prior to consumption (15 taxa at La Chiripa, 10 taxa at Sitio Bolívar), and most could be eaten raw, thus registering the act of cooking more of a dietary preference rather than a need. The low density of charred seeds recovered from either site corroborates this conclusion, further emphasizing the consumption of raw fruits in these people's daily meals. Various foods identified in this assemblage would have provided enough nutrition to sustain these populations, whether it was the great variety of essential nutrients available in avocados, the high fat-content in palm fruits, or the protein available in various tree nuts.

9.8 Conclusions

In this chapter I have presented a view of foods at both of these settlements, painting a picture of the villagers and their homes surrounded by the most ubiquitous edible taxa identified within the macrobotanical assemblage, illustrated in Figures 9-15 and 9-16. As this chapter has noted, the paleoethnobotanical assemblage was dominated by edible plants, especially trees, which would have supplied tasty and nutritious fruits to enjoy. The paleoethnobotanical data from these two settlements in the Arenal region demonstrates that the villagers had a very large range of food resources to choose from to form their diet, with 95 of the 194 identified taxa producing edible plant parts. The results do show that agriculture was present, but it was not dominant in the samples. These people clearly did not need to rely upon agriculture for their food needs. Instead, the villagers incorporated a mixture of agricultural and arboreal foods into their diet, taking advantage of both wild and domesticated foodstuffs and the abundance of resources offered by the tropical forests.

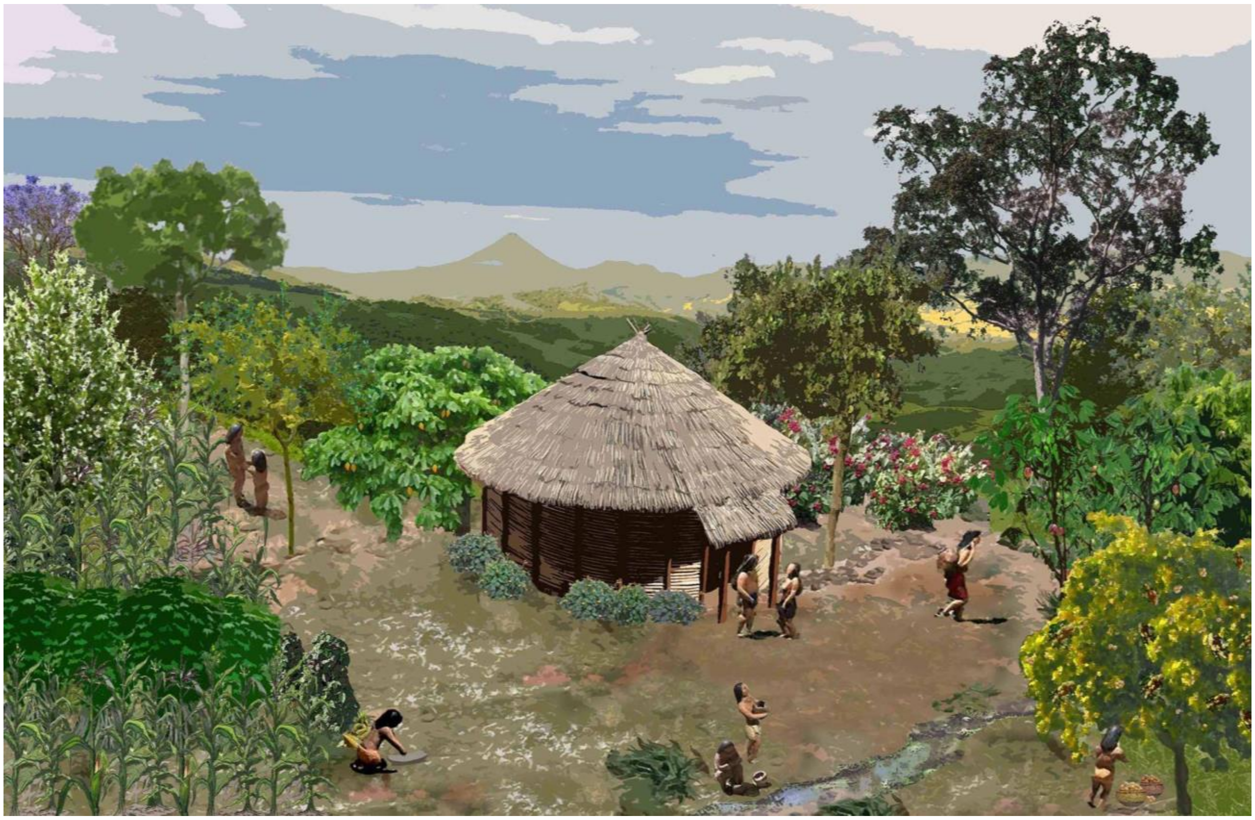


Figure 9-15: *An artistic reconstruction of the La Chiripa house structure surrounded by the most ubiquitous edible plant taxa identified within this investigation. This includes tree and shrub taxa (achiote, cacao, cashew, cherry, mamey, jocote, guava, ramón, and nance), agricultural crops (maize, beans, and manioc), as well as herbs such as paracress.*

The Tronadora phase structure at La Chiripa is pictured within Figure 9-14, surrounded by the most ubiquitous taxa associated with the main occupation of the settlement. The residents tend to their home garden which is filled with a mixture of trees in which they can collect ripened and ready to eat fruits such as cacao, cashew, mamey, jocote, guava, ramón, and nance. A small agricultural plot of maize, beans, and manioc is planted close to the home as well, for easy access to these cultigens. The home is situated just uphill from a natural spring, which supplies a local source of water and an ideal spot to wash the ceramic dishes from that day's meal. Paracress herbs line the perimeter of the dwelling and some achiote shrubs are growing nearby, providing local flavorings to enhance one's next meal. In the distance, flowering trees and shrubs such as jacaranda and lloró (*Cornus*) brighten the landscape and lift the moods of these villagers as they look out across the landscape.

Figure 9-16: *An artistic reconstruction of the Sitio Bolívar village surrounded by the most ubiquitous plant taxa identified within this investigation. This includes tree and shrub taxa that produce edible parts such as achiote, avocado, and mamey as well as other trees and shrubs: canalú (Bourreria), black olive (Terminalia buceras), jaboncillo (Sapindus), hinojo (Piper), madroño (Garcinia), sigua (Nectandra) and various palm trees. Agricultural crops (maize, beans, and manioc), herbs (paracress), as well as herbs such as paracress are also pictured.*

The Late Arenal phase village at Sitio Bolívar is pictured within Figure 9-16 with the most ubiquitous taxa identified at the settlement. This includes tree and shrub taxa that produce edible parts such as achiote, avocado, and mamey. Other trees fill the landscape including a variety of palms, black olive (*Terminalia buceras*), canalú (*Bourreria*), jaboncillo (*Sapindus saponaria*), madroño (*Garcinia*), and sigua (*Nectandra*). Similar to the La Chiripa settlement, agricultural crops (maize, beans, and manioc) are located in a home garden near the dwelling, but with the hinojo shrub integrated as well, providing a source of spice and flavoring. The herbaceous paracress is scattered throughout the village along with other flowering Asteraceae. Ceramic vessels reminiscent of the Arenal phase are distributed throughout the settlement and placed outside of and within various structures, reflecting the abundance of ceramic sherds recovered archaeologically. Villagers travel in the distance to gather arboreal resources while others tend to a fire to cook a meal.

The mixed diet of agricultural and arboreal products that was employed at both settlements in the Arenal region was an adaptive strategy to living in an environment that experienced periodic volcanic eruptions. The locations where these peoples settled would have been impacted by the very edges of volcanic activity in a way where low lying vegetation would not survive. However, trees as well as underground foods could have survived such as roots, tubers, and geophytes. A mixed diet as seen at these sites would have been able to withstand ecological changes, as will be discussed further within the final chapter of this dissertation.

CHAPTER 10

CONCLUSIONS:
STABILITY AND RESILIENCE IN ARENAL

So far, humanity has survived a range of hazardous events, but natural disasters are a major concern for people today; their increasing incidences, arguably due to climate change, also increases the vulnerability of societies (Grattan and Torrence 2016). As populations grow on a global scale, even more people are exposed to hazardous environmental events and the frequency in which populations must deal with such scenarios is continually increasing (Grattan and Torrence 2016, Sheets 2016). It is estimated that nearly a quarter of the entire world's population is affected by disasters every year (Faas 2016). Seismic, volcanic, and tectonic activity heavily impact the Isthmo-Colombian area, where earthquakes have commonly destroyed parts of cities in the recent past and undoubtedly affected Pre-Columbian settlements as well (Hoopes, McEwan, and Cockrell 2021:2). Disasters are now seen as social and environmental phenomena, as the ability to separate the two elements from one another is becoming more prevalent among academic discussions (Oliver-Smith and Hoffman 2002, Grattan and Torrence 2016, Holmberg 2016, Sorenson and Albris 2015). The level of impact of a disaster is influenced by a society's conditions, therefore the life of a disaster is inherently social. Furthermore, disasters are not just events that strike societies from the outside; they have a continuous life as they are integrated into the history and organization of communities (Sorenson and Albris 205:66). "Vulnerability, disaster, and recovery are stages in a process that unfolds over a reasonably long period of time" (Grattan and Torrence 2016:3). This dissertation has addressed these stages at Arenal, Costa Rica as the region is volcanically active and has a rich archaeological history that has thus far demonstrated a cultural continuity among its residents for several millennia.

A volcano has an unquestionable impact upon a landscape after an eruption (Holmberg 2016). Volcanoes are especially dangerous hazards due to their unpredictability, sudden occurrences without an extensive amount of time to respond, and often catastrophic impact (Grattan and Torrence 2016). Nearly 500 million people around the world live in active volcanic zones and are at risk to such unpredictable disasters (Torrence 2008). Rather than discuss volcanic disasters or society in a way that focuses on failure and collapse (Grattan 2006), this case study of the Arenal region is a story of resilience and stability in the face of volcanic events that regularly transformed the region both socially and ecologically. This is a significant topic that addresses the innovative and positive aspects of disaster. This research thus moves beyond the often negative explanations of how people have coped with disasters. Rather than being perceived as 'victims' of Arenal Volcano's eruptions, I argue that the residents achieved a more or less stable and resilient lifestyle as they routinely found ways to reap the benefits of their unique ecological setting. These people did not merely respond to their regularly hazardous environment, they remembered the past experiences during new hazardous events, to create a way of life that permitted perturbations and was flexible even in times of ecological or social stress (Grattan and Torrence 2016).

10.1 Resilience in Arenal

Case studies such as this one from the Arenal region contributes to our understanding of how past societies have lived and coped with environmental perturbations over millennia. Environmental and archaeological research of crises and disasters over a long time span is well equipped to inform on contemporary issues (Fisher and Feinman 2005, van der Leeuw and Redman 2002). Many case studies have shown that people have been incredibly resilient throughout history, recovering from events that led to widespread destruction of landscapes and settlements in addition to significant mortality (Moseley 2002, Torrence and Grattan 2002). The people of the Arenal region lived in a risky environment for thousands of years, thus these populations had a considerable amount of experience dealing with volcanic and other hazardous events. The archaeological data documents the continuation of certain cultural practices within this region diachronically, demonstrating that people remained resilient and better adapted to the high magnitude of events that they experienced (Egan 2019:241, Hoopes 1987, Sheets and McKee 1994). Mechanisms such as oral histories and myths must have been components among life in the past within Arenal, with a belief system that developed and kept responses to volcanic eruptions in the social memory of the residents, thus maintaining awareness of productive forms of action to avoid particularly dangerous locations. The initial appearance of both ceramics and agricultural cultigens at early sites in Arenal that were occupied during the Tronadora phase such as La Chiripa and Tronadora Vieja is not accompanied by any noticeable change in settlement patterns for thousands of years, thus characterizing the long-term stability of these people and their way of life (Hoopes 1987:517). This pattern is interesting because the introduction of new domesticates such as maize did not dramatically alter subsistence practices. This suggests that the adoption and inclusion of maize into dietary practices was not viewed by these people as a staple food that could transform their lifeways, but rather a foodstuff that could supplement their already established and successful arboriculture-based subsistence regime.

Scholars have argued that not all societies have the same potential for survival (eg, Sheets 2016, Torrence and Doelman 2016, Van der Leeuw and Redman 2002). Risks may be greater for those who are more dependent upon infrastructure (Sheets 2016). Archaeological sites in Arenal have only revealed earthen structures and the only durable construction discovered were burials capped with stone or stone-paved pathways and patios. Additionally, societies with strong social networks and social links to groups that span great distances can benefit from safe refuges in times of need, in addition to long-term assistance in recovery. The extensive network of pathways recorded within the Arenal region document the strong social network these peoples had with their landscape and neighboring communities. The egalitarian lifestyle noted by Sheets and McKee (1994) may have been especially well-suited for such a hazardous volcanic environment where maintaining wealth differences could periodically prove to be difficult because accumulated possessions could be unpredictably destroyed or lost. Additionally, traditional ecological knowledge (Whyte 2018) must have been maintained through time in this region in order to continue a specific dietary regime, as was demonstrated with the diachronic view of plant foods in the Arenal region. These peoples achieved a level of stability within an otherwise unstable setting.

Volcanic tephra, especially when it decomposes, can enhance the fertility of soil and increase the productivity of agricultural fields (Grattan and Torrence 2016:9, Sheets and Grayson 1979:2, Walker 2011). In fact, reports following volcanic eruptions in recent history noted that gardens with thin dustings of tephra actually result in higher crop yields and healthier foliage post event (Lentfer and Boyd 2001:50). This is partially because thin layers of tephra can in a way act as a layer of mulch that restricts the growth of competing vegetation, regulates soil temperature, reduces evaporation within soils, and promotes growth through an organically rich layer of rotting vegetation (Elson et al. 2016, Grattan and Torrence 2016:9, Lentfer and Boyd 2001:50).

The results of the archaeobotanical dataset from the La Chiripa and Sitio Bolívar structures presented here corroborates early suggestions by Sheets (2008, 2012) that people in the Arenal region did not heavily rely on agriculture for their food and subsistence. While some cultigens are present, the vast majority of these edible plant products come from wild and perhaps even managed arboreal species, supporting the project's early hypothesis that agricultural crops did not form the majority of the diet in the Arenal region. Trees would have been able to withstand minor volcanic eruptions, whereas low-lying vegetation such as agricultural fields (*milpas)* would not have survived such conditions. Whereas, underground storage organs such as manioc roots would have continued to be available below the ground surface suggesting these would have been more important than above ground maize, squash, and beans. Many root and tuber foods such as manioc only last a few weeks in storage above ground, but if left in "storage" growing below ground they can remain available for at least a full growing season (Sheets et al. 2011, 2012). Volcanic soils are highly porous, which is ideal for underground root crops because the plants can expand more freely in the well-drained soil (Neall 2006). Thus it is not surprising that both settlements had geophyte fragments as one of the most ubiquitous plant remains.

A reliance on agriculture can quickly become problematic in a region that experiences frequent environmental fluctuations. The specific ecological zone where the La Chiripa site is currently situated is not suitable for agricultural crops such as maize (Holdridge et al. 1971, Tosi 1980), therefore it would likely have been difficult to support such agriculture in the past as well. This is reflected by the limited preserved remains of maize and beans at the site. At Sitio Bolívar, which is in a lifezone more suitable for agriculture, does reveal that cultivars like maize formed a greater portion of the diet than at La Chiripa. However, the paleoethnobotanical assemblage shows that rooty taxa and arboreal resources were still the more abundant foods. It is interesting to consider the relatively low presence of maize at both sites with the implements recovered in the region that could potentially be related to its consumption, such as manos and metates. Such groundstone tools could have been used to process a variety of foods, not just maize. Starch analysis of groundstone artifacts in the Orinoco Valley of Venezuela revealed that lithic tools cannot be exclusively linked to a single taxon and that implements such as manos and metates at the Los Mangos del Parguaza site contained starch granules from a variety of plants including maize and several root crops (Perry 2004). Nevertheless, the elaborate metates, which have been found throughout the country, suggest that if they were in fact associated with the preparation or processing of maize, the activity of grinding maize was not simply utilitarian and that there were cultural meanings tied to its consumption. Maize may have been ritually prepared upon these metates for consumption of chicha or to prepare medicines (Hoopes 2007). For this reason, maize may have served a more ritualistic purpose in these people's lives and was not necessarily considered a staple food. This interpretation aligns with the stable isotope studies on human bones. Norr's (1991) stable isotope analysis of human bone collagen in the prehistoric diets of this region revealed that diets were generally mixed and the importance of maize as a carbohydrate source varied both spatially and through time. Stable isotope analysis from the El

Silencio cemetery site in the Arenal region, which indicate that maize was a very minor component of dietary patterns for the area, with less than 12% of carbon coming from C-4 photosynthetic pathway plants (Friedman and Gleason 1984, Sheets 1994b: 321). Thus, maize likely has been overemphasized in subsistence reconstructions of Costa Rica and the region more broadly.

The macrobotanical results from both domestic structures suggest that the past inhabitants of this domestic structure employed mixed strategies for food subsistence and may have preferred food resources that favored their ecological setting and that would have remained accessible during times of ecological stress, such as underground storage organs like manioc, and fruit, and nut products grown on woody vegetation such as achiote, breadnut, cashew, cacao, guava, jocote, mamey, and nance.

This paleoethnobotanical investigation proves the great depth of knowledge these people had regarding their forests and arboreal resources. An interesting aspect of this relationship between people and their surrounding forests is that trees can be viewed as agentive socially; people's experiences with the environment are positively associated with wellbeing and a reduction or calming of stress levels (Grahn et al. 2021, Hastorf 2024, Huang et a. 2020). Perhaps the strong relationship that the people of Arenal formed with their forests counterbalanced the fear of not knowing when one would need to relocate and temporarily abandon their immediate surroundings. The continuity of food practices through time in the Arenal region highlights the social memory these residents had of productive and dependable food-related resource procurement practices. Consuming their core suite of food ingredients not only served as a reminder of their ancestors' foodways, but also of their deep ecological knowledge and preparedness for environmental crises.

The periodic flowering and fruiting of the trees identified from these two settlements can aid in the assessment of if the past people of Arenal were able to collect fruit harvests from their forests throughout the year. Studies of the phenology of fruiting trees in the tropical forests of Costa Rica indicate that the sequence of flowering and fruiting is not necessarily linked to seasonal climatic patterns, but rather data suggests that competition for pollinators is the significant factor affecting phenological patterns (Lobo et al. 2003). Anthophoridae bees are the most common pollinator of this region's forests and are abundant seasonally (Daubenmire 1972, Janzen 1967, Opler 1980), suggesting that fruiting varies in productivity throughout the year. While continuous flowering is rare among wet forest trees and shrubs of Guanacaste, Costa Rica (the province in which Arenal is situated today), the majority of species have several flowering and fruiting episodes each year (Opler et al. 1980). The vast majority of tree species in the region have fleshy fruits, and fruits are more numerous during the wet season and the early portions of the dry season (Frankie et al. 1974, Opler et al. 1980, Koptur et al. 1988). Opler and colleagues (1980) have found that tree species with a single brief flowering period are rare in both the wet and dry tropical forests of Guanacaste and that most taxa have flowering episodes in intervals of 3 to 5 months. Most trees and shrubs within Wet forests exhibit a short period of fruit maturation of 4 months, but some have been observed to take up to 27 months.

Arboriculture involves a long-term investment in the landscape compared to the short-term returns of grains like maize. Perennial fruit-producing trees and shrubs can be planted across a landscape, and harvests could be collected throughout the year, thus ensuring a continual supply of foodstuffs. It has been documented that during times of greater than usual rainfall in these tropical forests, there are considerably fewer species fruiting (Koptur et al. 1988), suggesting that past peoples would certainly have dealt with varying abundances of fruit harvests. However, no direct evidence for the storage of foodstuffs were identified at either of these archaeological sites. It has been established that these populations were sedentary, living within their homes in Arenal year-round (Hoopes 1987, 1994, Sheets and McKee 1994). These observations in combination with the extensive macrobotanical and associated phenological data indicate that the villagers were able to sustain themselves throughout the year and did not need to collect and prepare ingredients for long-term storage, at least not on a scale prominent enough to be identifiable archaeologically.

Volcanic eruptions can have lasting impacts besides just the tephra deposits blanketing a landscape, they can also be accompanied by noxious gasses that can spread over large regions (Grattan et al. 2016). Such a scenario would require that any inhabitants within a certain range of the Arenal Volcano travel and relocate for some time, perhaps every 10 generations. The dry Pacific side of the country is susceptible to droughts, whereas the Caribbean side must deal with the hazardous volcanic activity. Each of these landscapes could serve as a refuge while the other is temporarily uninhabitable. With a flexible food regime based less on farming, would make traveling and relocating to a neighboring region less stressful as it would be for sedentary farmers. There would still be the need to construct new homes and replant the manioc and seed crops, but these populations wouldn’t have to worry as much about how to locate food to survive. The plant taxa which formed the core of their diets could be found throughout their region even on a broad scale. With the food complex that was illustrated through the macrobotanical remains, these populations could potentially relocate to areas with abandoned tree crops and root foods, thus potentially transporting themselves away from a disastrous area and to a refuge that contains a bank of food and potentially more nutrient-rich soils due to thinner deposits of volcanic tephra.

Through these most recent excavations at both La Chiripa and Sitio Bolívar, there is archaeological evidence of these settlements being long-lived with inhabitants returning to those exact spaces over time. At La Chiripa, there are three stratigraphic levels that I interpret to be related to the house structure and residential occupation during the Tronadora phase, spanning potentially 500 years, from 1616 to 1108 BCE. Residents of this home lived there for possibly centuries, and the descendants (or possibly related descendants) even returned to that space to commemorate its history with a ceremony in which they burned culturally significant plant taxa over a great stretch of time as a form of social memory of that structure and its generations of occupants. At Sitio Bolívar, a series of structures were uncovered via the presence of post holes within multiple stratigraphic levels situated directly atop one another. This discovery suggests that the residents rebuilt their village after periods of forced abandonment, solidifying their commitment to this settlement and its exact location.

Similar evidence of reoccupation of a village after residents were displaced due to volcanic activity has also been documented at the Cañales village site (G-156, see Figure 5-8), which is located just 2 km southeast of Sitio Bolívar on the southern shore of Lake Arenal. The Cañales village was also inhabited during the Arenal phase (Sheets 2011). The village was reoccupied after a period of ecological recovery that may have lasted decades by direct descendants of the pre-disaster villagers, as evidenced by the use of the same path leading to the village cemetery. Sheets (2011) argues that the village was reinhabited for not just ecological reasons but also so that people could remain in contact with the spirits of their deceased ancestors buried within their village’s cemetery (located over a dozen kilometers away), thus perpetuating social memory through regular processions along the same path in spite of challenging terrain and regular volcanic disasters.

10.2 Future Considerations

Efforts to recover paleoethnobotanical remains in the Isthmo-Colombian area can be productive, especially when a systematic and robust sampling strategy is employed and integrated into the research strategy. The evidence presented here demonstrates that there are over 100 different plant taxa preserved in each of the domestic spaces investigated that can be used to depict the past lifeways in the Arenal region, which presents an incredibly biodiverse assemblage. Statistical analyses of the paleoethnobotanical collection indicate that these datasets aren't complete, in that the full range of diversity in this setting was not identified through this already robust sampling regime. While these analyses are quite time-consuming and intensive, I feel that it is worthwhile to employ an even more rigorous effort in the future, in order to achieve a more accurate depiction of the past human-environmental interactions within the Arenal region, as these data help portray how people successfully coped with a disaster-prone setting. Since paleoethnobotanical studies are not yet a common practice on archaeological investigations in southern Central America, these dataset invites such investigations to be implemented and practiced more regularly. While these particular sites do occupy a volcanically active landscape, neither site exhibited direct preservation from an eruption that would aid in the recovery of otherwise fragile and easily degradable plant materials. The results suggest that future efforts elsewhere in the Isthmo-Colombian area to recover macrobotanical remains could prove to be fruitful as well, especially with the incorporation of a mixed collection strategy that aims to identify not just the preserved seeds, achenes, and fruits, but also the wood charcoal.

10.3 Concluding Thoughts

The scope of this analysis takes a long-term perspective, thus making it possible to make a connection between cultural practices and the history of volcanic events in this region that occurred during periods of human occupation. This diachronic perspective is critical because the impacts of these catastrophes extend beyond just the initial event and the people living in such a space maintain a social memory of successful (and failed) responses, strategies, and ways of living. The past residents' focus on dependable resources such as the large, canopy trees that dominate the wood assemblages or the roots and tubers growing in a protected area underground show that they anticipated the risks associated with their environment that formed practices to reduce the potential impacts of a disaster. Such a resource procurement strategy allowed for a continuity in diet throughout countless generations that called this landscape home. People were able to thrive in this setting despite the frequent and sometimes severe volcanic eruptions.

The initial botanical results suggest that the past people of the Arenal region lived at a steady level of resilience. Gunderson and Holling (2002:17) define resilience as the "ability of a biological system, an ecosystem, or a social system to withstand disturbance and still continue to function." These people relied on foodstuffs that would have been more accessible in the event of a volcanic eruption such as arboreal food products and starchy roots rather than cultigens such as maize and beans. The archaeological evidence in the Arenal region proves that these people did achieve resilience to their volcanic setting and a form of long-term stability through their subsistence strategies, strong social networks, and flexible lifestyles.

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Appendix A: Flotation Processing Times

The table below presents the processing data from the flotation samples collected from the G995 La Chiripa site during the 2018 field season and from G164 Sitio Bolívar during the 2021 field season, including the sample number, the volume of the sediment when measured in the field, the re-measured volume prior to flotation, and the processing time. Samples tested with poppy seeds are denoted with an asterisk. Samples were not processed in numerical order.

G995 La Chiripa 2018 Field Season Flotation							
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**	**Sample No.**	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1001	10	10	20	1062	10	10	25
1002	10	10	20	1070	10	10	20
1003	10	10	30	1082	10	10	30
1004	10	10	25	1083	10	9	20
1005	10	9.5	35	1084	10	10	30
1006	10	10	45	1085	10	10	30
1007	10	10	30	1086	10	10	35
1008	10	10	30	1087	10	10	20
1009	10	10	20	1088	10	10	35
1011	10	9.5	25	1089	10	10	35
1012	10	10	35	1090	10	10	20
1013	10	10	30	1092	10	10	30
1014	10	10	40	1093	10	10	30
1015	10	10	30	1094	10	10	30
1037	10	10	30	1095	10	10	30
1040	10	10	25	1096	10	10	30
1043	10	10	30	1097	10	10	20
1046	10	9	30	1098	10	10	30
1050	10	10	45	1099	10	10	25
1054	10	10	25	1100	10	10	35

G995 La Chiripa 2018 Field Season Flotation							
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**	**Sample No.**	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1103	10	10	30	1129	5	5	25
1106	10	10	30	1130	5	5	20
1109	10	10	45	1131	5	5	25
1112	10	9	25	1132	5	6	25
1113	5	5	20	1133	5	5	20
1114	5	6	20	1134	5	5	25
1115	5	5	15	1135	5	5	15
1116	5	6	20	1136	5	5	25
1117	5	5	20	1136	5	5.5	40
1118	5	6	20	1137	5	5	20
1119	5	6	20	1138	5	5	25
1120	5	5	20	1140	5	6	22
1121	5	5	15	1141	5	6	30
1122	5	5	25	1142	5	6	20
1123	5	5	20	1143	5	5	30
1124	5	5	20	1144	5	5	20
1125	5	5	25	1145	5	5	15
1126	5	5	20	1146	5	5	20
1127	5	5	25	1147	5	5	15
1128	5	6	60	1148	5	5	20

G995 La Chiripa 2018 Field Season Flotation							
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**	**Sample No.**	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1149	5	5	20	1175	5	5	25
1150	5	5	20	1176	5	6	25
1151	5	5	15	1177	5	5	40
1152	5	5	30	1178	5	7	20
1153	5	5	20	1179	5	5	20
1154	5	5	30	1180	5	5	20
1155	5	5	20	1182	5	5	20
1156	5	5	15	1183	5	5	20
1159	5	5	21	1184	5	5	20
1160	5	5	30	1185	5	5	17
1161	5	5	30	1186	5	5	25
1162	5	5	20	1187	5	5	20
1163	5	6	25	1188	5	5	16
1167	5	5	23	1189	10	10	30
1168	5	5	38	1190	10	8	25
1169	5	5	20	1191	10	6	20
1170	5	4	30	1192	10	9	35
1171	5	6	20	1200	1	1	18
1172	5	5	20	1202	3	3	20
1174	5	5	16	1203	3	3	20

G995 La Chiripa 2018 Field Season Flotation							
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**	**Sample No.**	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1204	2	2	20	1028X	10	10	30
1205	3	3	20	1031X	10	10	35
1209	3	3	20	1034X	10	10	27
1210	2	2	20	1037X	10	9	35
1211	3	3	38	1040X	10	10	40
1215	10	9	40	1058*	10	10	30
1216	10	10	20	1127A*	4	3.5	35
2106	10	10	50	1127B	5	5	20
1001X	10	8	20	1128A	5	4	25
1002X	10	10	23	1128B	5	4	35
1003X	10	10	25	1135A	5	5	30
1004X	10	10	30	1135B	5	6	30
1005X	10	10	26	1136A	5	4.5	20
1007X	10	10	25	1136B	5	5.5	20
1008X	10	10	28	1201*	2	2	30
1009X	10	9	25	1206*	1	1	30
1011X	10	10	25	1207*	3	3	20
1012X	10	10	30	1208*	1	1	20
1013X	10	10	25	1212*	3	3	20
1014X	10	8	25	1213*	2	1.5	35
1015X	10	10	35	1214*	3	3	40
1016X	10	10	30	1216*	5	6	45
1017X	10	10	20	2006X	10	10	45
1018X	10	9	30				

G164 Sitio Bolívar 2021 Field Season Flotation							
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**	**Sample No.**	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1001	10	6	50	1030	10	5	35
1002 *	10	6	50	1031	10	6	34
1003	10	6.5	55	1032	10	6	24
1004	10	6	30	1033	10	4.5	20
1005	1	1	15	1034	1.5	1.5	30
1006	1	0.5	10	1035	10	5	32
1007	10	5	60	1036*	10	5	38
1008	3	2.5	15	1037A	2	2	41
1009	10	6	55	1037B	3	2.5	30
1010	10	5	30	1032	10	5	33
1011	10	5	26	1039	10	5	32
1012 *	10	6	38	1040	10	5.5	34
1013	1	1	17	1041	10	5	36
1014	10	6	27	1042	10	5	31
1015	10	6.5	28	1043	10	5	26
1016	10	6.5	35	1044	10	5	20
1017	10	5	40	1045	10	5.5	28
1018	10	5	32	1046	10	5	25
1019	10	6.5	50	1047	10	5	22
1020	5	2	25	1048	10	4.5	30
1021	5	2	20	1049	10	6	15
1022 *	10	6	35	1050*	10	4	45
1023 *	10	5	32	1051	10	5	35
1024	5	2	28	1052	10	6	50
1025	5	2	33	1053	10	6	35
1026	10	4	24	1054	10	6	20
1027	10	5	20	1055	10	6.5	30
1028	10	5	30	1056	10	7	21
1029	10	6	37	1057	10	6	20

G164 Sitio Bolívar 2021 Field Season Flotation							
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**	**Sample No.**	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1057B	10	6.5	23	1085	10	5	300
1058B1	5	3	23	1086*	10	5	24
1058B2	5	3	28	1087	5	4	27
1058	10	7	30	1088	10	5	22
1059	10	6	40	1089	10	4.5	24
1060	10	5.5	35	1090	10	5	28
1061	10	6	22	1091	10	5.5	29
1062	10	5.5	34	1092	10	5.5	25
1063*	10	6	42	1093	10	5.5	41
1064	10	5	20	1094	10	6	20
1065	10	5.5	34	1095	10	5	20
1066	10	5	22	1096	10	4.5	25
1067	10	5.5	21	1097	10	5.5	35
1068	10	6	31	1098	10	5	33
1069*	10	6.5	50	1099*	10	5	60
1070	10	6	37	1100	10	5	45
1071	10	6	33	1101	10	5	30
1072	10	6	40	1103	10	5	20
1073	10	6	35	1104	10	5	20
1074	10	5.5	25	1105	10	5	20
1075	10	5.5	29	1106	10	5	30
1076	10	5.5	24	1107	10	5	22
1077*	10	6	25	1108	10	5.5	31
1078	10	5.5	35	1109*	10	5	20
1079	10	6	45	1110	10	5	20
1080	10	6	30	1111*	1	1	40
1081	10	7	35	1112	1	1	20
1082	10	6	40	1113	10	5.5	34
1083	10	5	20	1114	10	4.5	50
1084	10	5	25	1115	10	5	35

G164 Sitio Bolívar 2021 Field Season Flotation			
Sample No.	**Field Volume (L)**	**Actual Volume (L)**	**Time (min)**
1116	10	5.5	40
1117	10	6	34
1118	10	5.5	30
1119	10	6	30
1120	10	6	35
1121	10	5	25
1122	10	5.5	34
1123	10	6	33
1124	10	5	20
1125	4	2	22
1126	1	1	22
1127*	10	6	18
1128	6	3	20

Appendix B: Macrobotanical Sorting Forms

Proyecto Prehistorico Arenal: La Chiripa Sorting Sheet					Flot #	Year
Sorter Name & Date			ID Date			
Fraction Type	Light	Heavy	Screen	Manual	Depth	Volume
Items Pulled			Spot Checked			
			Entered into Database		N/S	E/W

Material	>4mm	Wt.(g)	>2mm	Wt.(g)	>1mm	Wt.(g)	>0.5mm	Wt.(g)	Pan	Scan
	%S	Blown Y / N	%S	Blown Y / N	%S	Blown Y / N	%S	Blown Y / N	%S	Blown Y / N
	Wt.	Count	Wt.	Count	Wt.	Count	Wt.	Count	Wt.	Count
Wood										
Lump (parenchyma)										
Asteraceae										
Cyperaceae										
Fabaceae										
Malvaceae										
Poaceae										
Portulaceae										
Rosaceae										
Solanaceae										
Amaranthus sp.										
Capsicum sp.										
Cucurbita sp.										
Phaseolus sp.										
Phaseolus lunatus										
Phaseolus vulgaris										
Spilanthes acmella										
Zea mays cupule										
Zea mays kernel										
Unidentified seed fragment										
Dung										
Bone										
Fish Scales										
Shells										
Unidentifiable seed fragment										

Proyecto Prehistorico Arenal: Sitio Bolivar Sorting Sheet					
Nombre del analista				Fecha	
tipo de fracción	Ligera	Pesado	Pantalla	Escogido a mano	
Notas		Semillas de *Papaver*?			
		Artifactos?			N/S
Flot #	Año	Profundidad	Volumen(L)	E/O	

Material	**>4mm**	**Wt.(g)**	**>2mm**	**Wt.(g)**	**>1mm**	**Wt.(g)**	**>0.5mm**	**Wt.(g)**
		%S						
	Wt.	**cantidad**	**Wt.**	**cantidad**	**Wt.**	**cantidad**	**Wt.**	**cantidad**
Madera								
geófito								
Asteraceae								
Poaceae								
Phaseolus sp.								
Acmella sp.								
Zea mays								
semilla no identificado								
semilla no identificable								

Appendix C: Wood Identification Form

Sample #	Fragment Count	Weight (g)	Vessel Diameter □ <50 □ S □ 50-100 □ M □ 100-200 □ L □ 200+	# of Vessels Per sq. mm □ <5 □ 5-20 □ 20-40 □ 40-100 □ 100+	Vessel Arrangement □ Solitary □ Pairs □ Chains □ Clusters	Parenchyma Type □ Absent □ Apotracheal □ Diffuse □ in aggregates □ Paratracheal □ Vasicentric □ Winged □ Aliform □ Confluent □ Unilateral □ Banded (thick / thin) □ Scalariform		Condition □ Fungus □ High Heat □ Poor
Taxa		SEM Box: Stub:	Rays Per mm □ <4 □ 4 to 12 □ 12 +	Ray width (cells) □ uniseriate □ 1 to 3 cells □ 4 + cells □ of 2 sizes	Porosity □ Diffuse □ Semi Ring Porous □ Ring Porous	Tyloses □ Yes □ No	Est. Diameter (Age) □ Young □ Old	□ Dry □ Moist

Sample #	Fragment Count	Weight (g)	Vessel Diameter □ <50 □ S □ 50-100 □ M □ 100-200 □ L □ 200+	# of Vessels Per sq. mm □ <5 □ 5-20 □ 20-40 □ 40-100 □ 100+	Vessel Arrangement □ Solitary □ Pairs □ Chains □ Clusters	Parenchyma Type □ Absent □ Apotracheal □ Diffuse □ in aggregates □ Paratracheal □ Vasicentric □ Winged □ Aliform □ Confluent □ Unilateral □ Banded (thick / thin) □ Scalariform		Condition □ Fungus □ High Heat □ Poor
Taxa		SEM Box: Stub:	Rays Per mm □ <4 □ 4 to 12 □ 12 +	Ray width (cells) □ uniseriate □ 1 to 3 cells □ 4 + cells □ of 2 sizes	Porosity □ Diffuse □ Semi Ring Porous □ Ring Porous	Tyloses □ Yes □ No	Est. Diameter (Age) □ Young □ Old	□ Dry □ Moist

Sample #	Fragment Count	Weight (g)	Vessel Diameter □ <50 □ S □ 50-100 □ M □ 100-200 □ L □ 200+	# of Vessels Per sq. mm □ <5 □ 5-20 □ 20-40 □ 40-100 □ 100+	Vessel Arrangement □ Solitary □ Pairs □ Chains □ Clusters	Parenchyma Type □ Absent □ Apotracheal □ Diffuse □ in aggregates □ Paratracheal □ Vasicentric □ Winged □ Aliform □ Confluent □ Unilateral □ Banded (thick / thin) □ Scalariform		Condition □ Fungus □ High Heat □ Poor
Taxa		SEM Box: Stub:	Rays Per mm □ <4 □ 4 to 12 □ 12 +	Ray width (cells) □ uniseriate □ 1 to 3 cells □ 4 + cells □ of 2 sizes	Porosity □ Diffuse □ Semi Ring Porous □ Ring Porous	Tyloses □ Yes □ No	Est. Diameter (Age) □ Young □ Old	□ Dry □ Moist

Sample #	Fragment Count	Weight (g)	Vessel Diameter □ <50 □ S □ 50-100 □ M □ 100-200 □ L □ 200+	# of Vessels Per sq. mm □ <5 □ 5-20 □ 20-40 □ 40-100 □ 100+	Vessel Arrangement □ Solitary □ Pairs □ Chains □ Clusters	Parenchyma Type □ Absent □ Apotracheal □ Diffuse □ in aggregates □ Paratracheal □ Vasicentric □ Winged □ Aliform □ Confluent □ Unilateral □ Banded (thick / thin) □ Scalariform		Condition □ Fungus □ High Heat □ Poor
Taxa		SEM Box: Stub:	Rays Per mm □ <4 □ 4 to 12 □ 12 +	Ray width (cells) □ uniseriate □ 1 to 3 cells □ 4 + cells □ of 2 sizes	Porosity □ Diffuse □ Semi Ring Porous □ Ring Porous	Tyloses □ Yes □ No	Est. Diameter (Age) □ Young □ Old	□ Dry □ Moist

Sample #	Fragment Count	Weight (g)	Vessel Diameter □ <50 □ S □ 50-100 □ M □ 100-200 □ L □ 200+	# of Vessels Per sq. mm □ <5 □ 5-20 □ 20-40 □ 40-100 □ 100+	Vessel Arrangement □ Solitary □ Pairs □ Chains □ Clusters	Parenchyma Type □ Absent □ Apotracheal □ Diffuse □ in aggregates □ Paratracheal □ Vasicentric □ Winged □ Aliform □ Confluent □ Unilateral □ Banded (thick / thin) □ Scalariform		Condition □ Fungus □ High Heat □ Poor
Taxa		SEM Box: Stub:	Rays Per mm □ <4 □ 4 to 12 □ 12 +	Ray width (cells) □ uniseriate □ 1 to 3 cells □ 4 + cells □ of 2 sizes	Porosity □ Diffuse □ Semi Ring Porous □ Ring Porous	Tyloses □ Yes □ No	Est. Diameter (Age) □ Young □ Old	□ Dry □ Moist

Sample #	Fragment Count	Weight (g)	Vessel Diameter □ <50 □ S □ 50-100 □ M □ 100-200 □ L □ 200+	# of Vessels Per sq. mm □ <5 □ 5-20 □ 20-40 □ 40-100 □ 100+	Vessel Arrangement □ Solitary □ Pairs □ Chains □ Clusters	Parenchyma Type □ Absent □ Apotracheal □ Diffuse □ in aggregates □ Paratracheal □ Vasicentric □ Winged □ Aliform □ Confluent □ Unilateral □ Banded (thick / thin) □ Scalariform		Condition □ Fungus □ High Heat □ Poor
Taxa		SEM Box: Stub:	Rays Per mm □ <4 □ 4 to 12 □ 12 +	Ray width (cells) □ uniseriate □ 1 to 3 cells □ 4 + cells □ of 2 sizes	Porosity □ Diffuse □ Semi Ring Porous □ Ring Porous	Tyloses □ Yes □ No	Est. Diameter (Age) □ Young □ Old	□ Dry □ Moist

Appendix D:
Botanical Data G995 La Chiripa - Raw Counts and Weights

<u>Description of column headings:</u>

Sample #	Sample ID number associated with each sample
Site	Archaeological site associated with the sample: G995 La Chiripa
Type	Processing method: flotation (F) / screening (S) / manual (M)
Depth	Excavation level (as described in Chapter 6)
Context	Distance from Datum in meters: south (S) / north (N) / east (E) / west (W) Contexts may include a feature (F) or a post hole (PH)
Vol	Volume as measured prior to processing in liters
Taxon	The most specific taxonomic rank associated with each item
Plant Part	Type of plant part recovered archaeologically
Qt	Quantity/Count of carbonized botanical remains
Wt (g)	Weight of total botanical remains measured in grams

Sample	Site	Type	Depth	Context	Vol	Taxon	Plant Part	Qt	Wt (g)
1002	G995	F	AR 16-15	S 2, E 3	10	POACEAE	seed	4	0.0000
						unidentifiable	seed fragment	2	0.0000
1003	G995	F	AR 16-15	S 3, E 3	10	ASTERACEAE	achene	3	0.0000
1004	G995	F	AR 16-15	S 3, E 2	10	cf. *Viburnum* sp.	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	2	0.0020
						ASTERACEAE	achene	2	0.0000
						POACEAE	seed	4	0.0000
1005	G995	F	AR 16-15	S 2, E 2	9.5	unidentifiable	wood charcoal	1	0.0010
1007	G995	F	AR 16-15	S 1, E 1	10	ASTERACEAE	achene	1	0.0000
1008	G995	F	AR 16-15	S 2, E 1	10	POACEAE	seed	1	0.0000
						unidentifiable	seed fragment	2	0.0000
1009	G995	F	AR 16-15	S 3, E 1	10	POACEAE	seed	2	0.0010
1012	G995	F	AR 16-15	S 3, E 0	10	unidentifiable	wood charcoal	1	0.0010
1013	G995	F	AR 16-15	S 1, W 1	10	unidentifiable	wood charcoal	1	0.0070
1015	G995	F	AR 16-15	S 3, W 1	10	*Zanthoxylum* sp.	wood charcoal	3	0.0500
						unidentifiable	wood charcoal	5	0.0510
						ASTERACEAE	achene	17	0.0000
						Drymaria cordata	seed	11	0.0001
						unidentifiable	testa	3	0.0000
1037	G995	F	AR 16-15	S 4, W 1	10	*Amphipterygium* sp.	wood charcoal	11	0.0200
						Cornus cf. *florida*	wood charcoal	1	0.0040
						Brosimum sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	11	0.0200
						Drymaria cordata	seed	1	0.0001
1040	G995	F	AR 16-15	S 4, W 2	10	unidentifiable	wood charcoal	3	0.0040
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	4	0.0000
1043	G995	F	AR 16-15	S 4, W 3	10	unidentifiable	seed fragment	5	0.0090
1002X	G995	F	UN 54	S 2, E 3	10	*Calliandra* sp.	wood charcoal	1	0.0110
						Bixa cf. *orellana*	wood charcoal	3	0.0130
						Capparis sp.	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	4	0.0560
						unidentifiable	testa	1	0.0000
1003X	G995	F	UN 54	S 3, E 3	10	*Sloanea* sp.	wood charcoal	3	0.1310
						Bixa cf. *orellana*	wood charcoal	2	0.0190
						Inga sp.	wood charcoal	1	0.0080
						Andira inermis	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	2	0.0050
						unidentifiable	wood charcoal	3	0.0010
						Chenopodium sp.	seed	1	0.0000

1004X	G995	F	UN 54	S 3, E 2	10	unidentifiable	wood charcoal	2	0.0050
						Persea sp.	wood charcoal	1	0.0030
						Terminalia sp.	fruit	2	0.0200
						POACEAE	seed	6	0.0000
						Drymaria cordata	seed	1	0.0001
1005X	G995	F	UN 54	S 2, E 2	10	*Palicourea* sp.	wood charcoal	20	0.2110
						Nectandra/Ocotea	wood charcoal	1	0.0520
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	1	0.0000
						unidentifiable	stem	1	0.0000
1006X	G995	F	UN 54	S 1, E 2	10	*Spondias* cf. *mombin*	wood charcoal	1	0.1670
						ASTERACEAE	achene	5	0.0000
						POACEAE	seed	4	0.0000
						unidentifiable	fungal spores	7	0.0000
1007X	G995	F	UN 54	S 1, E 1	10	unidentifiable	wood charcoal		0.0300
						Palicourea sp.	wood charcoal	4	0.0320
						ASTERACEAE	achene	2	0.0000
						POACEAE	seed	6	0.0000
						Oxalis sp.	seed	1	0.0000
						unidentifiable	seed fragment	1	0.0000
1008X	G995	F	UN 54	S 2, E 1	10	*Cosmibuena* sp.	wood charcoal	1	0.0100
						MELASTOMATACEAE	wood charcoal	6	0.0120
						ARECACEAE	wood charcoal	1	0.0030
						cf. Sloanea sp.	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	1	0.0020
						Palicourea sp.	wood charcoal	11	0.0810
						Terminalia sp.	fruit	2	0.0400
1009X	G995	F	UN 54	S 3, E 1	9	unidentifiable	wood charcoal	1	0.0020
						Spondias sp.	wood charcoal	2	0.0100
						POACEAE	seed	1	0.0000
						Sapium sp.	seed	1	0.0090
						Terminalia sp.	fruit	3	0.0160
						Passiflora sp.	seed	1	0.0000
						unidentifiable	seed	1	0.0000
1011X	G995	F	UN 54	S 2, E 0	10	*Swietenia* sp.	wood charcoal	1	0.0280
						Zygia sp.	wood charcoal	1	0.0240
						Hieronyma alchorneoides	wood charcoal	1	0.0090
						Cheiloclinium cognatum	wood charcoal	1	0.0080
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	1	0.0000
						UNID seed A	seed	2	0.0000
1012X	G995	F	UN 54	S 3, E 0	10	*Brosimum* sp.	wood charcoal	1	0.0190

						Escallonia sp.	wood charcoal	1	0.0060
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	1	0.0000
1013X	G995	F	UN 54	S 1, W 1	10	unidentifiable	wood charcoal	1	0.0020
						ASTERACEAE	achene	5	0.0000
						POACEAE	seed	19	0.0000
						Cecropia sp.	seed	1	0.0000
						unidentifiable	seed	1	0.0000
						unidentifiable	stem	1	0.0000
1014X	G995	F	UN 54	S 2, W 1	10	*Cornus* sp.	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	1	0.0040
						ASTERACEAE	achene	81	0.0050
						POACEAE	seed	4	0.0000
1015X	G995	F	UN 54	S 3, W 1	10	*Sloanea* sp.	wood charcoal	1	0.0140
						Brosimum sp.	wood charcoal	3	0.0230
						Aspidosperma sp.	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0200
						ASTERACEAE	achene	3	0.0000
						Mollugo veriticillata	seed	1	0.0000
1016X	G995	F	UN 54	S 1, W 2	10	ARECACEAE	wood charcoal	2	0.0450
						unidentifiable	wood charcoal	1	0.0050
						RHAMNACEAE	wood charcoal	1	0.0030
						Clidemia sp.	wood charcoal	1	0.0020
						ASTERACEAE	achene	5	0.0000
						POACEAE	seed	1	0.0000
1017X	G995	F	UN 54	S 2, W 2	10	*Escallonia* sp.	wood charcoal	1	0.0220
						Hamelia sp.	wood charcoal	1	0.0250
						ARECACEAE	wood charcoal	1	0.0120
						Maclura tinctoria	wood charcoal	1	0.0060
						Theobroma sp.	wood charcoal	1	0.0070
						unidentifiable	wood charcoal	3	0.0010
						geophyte	geophyte	1	0.0100
						ASTERACEAE	achene	69	0.0000
						POACEAE	seed	10	0.0000
						unidentifiable	testa	2	0.0000
1018X	G995	F	UN 54	S 3, W 2	9	ARECACEAE	wood charcoal	1	0.0100
						Randia sp.	wood charcoal	5	0.0260
						CLUSIACEAE	wood charcoal	1	0.0070
						Pouteria sp.	wood charcoal	1	0.0070
						Nectandra/Ocotea	wood charcoal	1	0.0090
						Cornus sp.	wood charcoal	2	0.0130
						ASTERACEAE	achene	3	0.0000
						POACEAE	seed	5	0.0000

						unidentifiable	testa	2	0.0000
1028X	G995	F	UN 54	S 4, E 2	10	*Aspidosperma* sp.	wood charcoal	2	0.0130
						Inga sp.	wood charcoal	2	0.0100
						Acacia sp.	wood charcoal	1	0.0040
						ARECACEAE	wood charcoal	1	0.0060
						Trichilia sp.	wood charcoal	1	0.0040
						Spondias sp.	wood charcoal	1	0.0020
						Dendropanax sp.	wood charcoal	1	0.0020
						Schinus cf. *terebinthifolius*	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	21	0.0080
						ASTERACEAE	achene	16	0.0000
1031X	G995	F	UN 54	S 4, E 1	10	*Dendropanax* sp.	wood charcoal	4	0.0300
						Hamelia sp.	wood charcoal	2	0.0140
						Cupania sp.	wood charcoal	1	0.0050
						Pourouma sp.	wood charcoal	1	0.0030
						Spondias sp.	wood charcoal	3	0.0740
						FABACEAE	wood charcoal	1	0.0060
						Psychotria sp.	wood charcoal	1	0.0040
						Terminalia sp.	fruit	2	0.0300
						ASTERACEAE	achene	3	0.0000
						Terminalia sp.	fruit	2	0.0130
						geophyte	geophyte	3	0.0240
						unidentifiable	stem	2	0.0000
1034X	G995	F	UN 54	S 4 E 0	10	*Zanthoxylum* sp.	wood charcoal	1	0.0150
						Cornus sp.	wood charcoal	6	0.0430
						unidentifiable	testa	2	0.0020
						Passiflora sp.	seed	5	0.0010
						Terminalia sp.	fruit	2	0.0100
1037X	G995	F	UN 54	S 4, W 1	10	*Coccoloba* sp.	wood charcoal	1	0.0040
						Terminalia sp.	fruit	1	0.0000
1040X	G995	F	UN 54	S 4, W 2	10	*Clidemia* sp.	wood charcoal	1	0.1320
						Zanthoxylum sp.	wood charcoal	3	0.1430
						Lonchocarpus sp.	wood charcoal	1	0.0100
						Dalbergia sp.	wood charcoal	1	0.0070
						ARECACEAE	wood charcoal	1	0.0030
						Cupania sp.	wood charcoal	2	0.3360
						ASTERACEAE	achene	48	0.0000
						POACEAE	seed	42	0.0000
						Drymaria cordata	seed	1	0.0001
1046	G995	F	AR 14-9	S 1, E 3	10	unidentifiable	wood charcoal		0.0170
						Terminalia sp.	fruit	1	0.0100
						ASTERACEAE	achene	4	0.0000
						POACEAE	seed	1	0.0000

						Acmella sp.	achene	1	0.0000
1050	G995	F	AR 14-9	S 2, E 2	10	*Aspidosperma* sp.	wood charcoal	2	0.0220
						unidentifiable	wood charcoal	2	0.0010
						ASTERACEAE	achene	1	0.0000
						Acmella sp.	achene	1	0.0000
1054	G995	F	AR 14-9	S 3, E 1	10	*Adelia* sp.	wood charcoal	1	0.0030
						Theobroma sp.	wood charcoal	1	0.0030
1058	G995	F	AR 14-9	S 1, W 1	10	*Clidemia* sp.	wood charcoal	1	0.0040
						ASTERACEAE	achene	11	0.0000
						POACEAE	seed	3	0.0000
1062	G995	F	AR 14-9	S 2, W 2	10	*Clidemia* sp.	wood charcoal	1	0.0110
						unidentifiable	wood charcoal	1	0.0000
						ASTERACEAE	achene	3	0.0000
						POLYGONACEAE	seed	2	0.0000
1070	G995	F	AR 14-9	S 4, E 0	10	cf. Sloanea sp.	wood charcoal	1	0.0030
						Cornus sp.	wood charcoal	1	0.0080
						Margaritaria nobilis	wood charcoal	2	0.0130
						ARECACEAE	wood charcoal	1	0.0030
						unidentifiable	testa	1	0.0000
1082	G995	F	UN 60	S 1, E 3	10	*Theobroma* sp.	wood charcoal	4	0.0160
						Campnosperma panamense	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	1	0.0070
						Nectandra/Ocotea	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	4	0.0040
						Terminalia sp.	fruit	1	0.0100
						ASTERACEAE	achene	3	0.0000
						POACEAE	seed	1	0.0000
1083	G995	F	UN 60	S 2, E 3	10	*Bixa* cf. *orellana*	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0060
						Trophis sp.	wood charcoal	2	0.0140
						Casearia sp.	wood charcoal	6	0.0230
						Pouteria sp.	wood charcoal	2	0.0070
						Aspidosperma sp.	wood charcoal	1	0.0050
						MORACEAE	wood charcoal	5	0.0110
						Parkinsonia aculeata	wood charcoal	1	0.0030
						unidentifiable	seed	3	0.0000
						Acmella sp.	achene	1	0.0000
						ASTERACEAE	achene	2	0.0000
						Cecropia sp.	seed	3	0.0000
						Terminalia sp.	fruit	1	0.0100
1084	G995	F	UN 60	S 3, E 3	10	*Eugenia* sp.	wood charcoal	2	0.0210
						Coccoloba sp.	wood charcoal	2	0.0120

						Magnolia sp.	wood charcoal	2	0.0120
						Bourreria sp.	wood charcoal	1	0.0070
						Simaba cf. cedron	wood charcoal	1	0.0040
						cf. *Diospyros* sp.	wood charcoal	3	0.0070
						Erythrochiton sp.	wood charcoal	5	0.0100
						Abarema sp.	wood charcoal	1	0.0030
						ASTERACEAE	achene	1	0.0000
						Terminalia sp.	fruit	1	0.0100
						Acmella sp.	achene	1	0.0000
1085	G995	F	UN 60	S 1, E 2	10	*Bourreria* sp.	wood charcoal	1	0.0480
						cf. *Ficus* sp.	wood charcoal	1	0.0040
						Tapirira sp.	wood charcoal	1	0.0050
						Theobroma sp.	wood charcoal	1	0.0040
						Psychotria sp.	wood charcoal	1	0.0030
						Psidium sp.	wood charcoal	2	0.0040
						unidentifiable	wood charcoal	1	0.0020
						ARECACEAE	wood charcoal	2	0.0050
						Zea mays	cupule	2	0.0100
						ASTERACEAE	achene	2	0.0000
						Terminalia sp.	fruit	1	0.0100
						POACEAE	seed	4	0.0020
1086	G995	F	UN 60	S 2, E 2	10	*Psidium* sp.	wood charcoal	1	0.0080
						Calycophyllum candidissimum	wood charcoal	1	0.0630
						RUBIACEAE	wood charcoal	1	0.0020
						Campnosperma panamense	wood charcoal	1	0.0210
						Terminalia sp.	fruit	1	0.0060
						geophyte	geophyte	1	0.0050
						POACEAE	seed	1	0.0000
						ASTERACEAE	achene	2	0.0000
						Acmella sp.	achene	1	0.0000
						unidentifiable	insect	1	0.0000
						unidentifiable	seed	1	0.0000
1087	G995	F	UN 60	S 3, E 2	10	unidentifiable	wood charcoal	1	0.0350
						Casearia sp.	wood charcoal	6	0.0350
						Palicourea sp.	wood charcoal	5	0.0350
						Hedyosmum sp.	wood charcoal	1	0.0100
						Annona sp.	wood charcoal	2	0.0120
						Ardisia sp.	wood charcoal	3	0.0160
						Cecropia cf. *peltata*	wood charcoal	1	0.0080
						geophyte	geophyte	1	0.0140
						Terminalia sp.	fruit	1	0.0160
						Inga sp.	wood charcoal	1	0.0060
						Tecoma stans	wood charcoal	1	0.0040

						ANACARDIACEAE	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	1	0.0030
						Aspidosperma sp.	wood charcoal	14	0.0970
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	1	0.0000
1088	G995	F	UN 60	S 1, E 1	10	*Aspidosperma* sp.	wood charcoal	2	0.0190
						Zanthoxylum sp.	wood charcoal	2	0.0160
						Ryania speciosa	wood charcoal	1	0.0120
						ANNONACEAE	wood charcoal	2	0.0060
						SAPINDACEAE	wood charcoal	3	0.0080
						unidentifiable	wood charcoal	4	0.0120
						ARECACEAE	wood charcoal	1	0.0030
						Zea mays	cupule	1	0.0100
						Melampodium sp.	achene	2	0.0040
						unidentifiable	fungus	2	0.0030
						ASTERACEAE	achene	19	0.0030
						unidentifiable	seed fragment	4	0.0003
						unidentifiable	seed	3	0.0000
						Saponaria sp.	seed	1	0.0010
						Cecropia sp.	seed	16	0.0030
						Acmella sp.	achene	1	0.0000
1089	G995	F	UN 60	S 2, E 1	10	SIMAROUBACEAE	wood charcoal	1	0.0240
						Casearia sp.	wood charcoal	4	0.0200
						Parmentiera sp.	wood charcoal	2	0.0160
						Faramea sp.	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	1	0.0030
						Pouteria sp.	wood charcoal	1	0.0030
						Aspidosperma sp.	wood charcoal	2	0.0040
						ANNONACEAE	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	4	0.0010
						Terminalia sp.	fruit	1	0.0100
						ASTERACEAE	achene	112	0.0140
						unidentifiable	seed	1	0.0020
						POACEAE	seed	21	0.0030
						unidentifiable	seed fragment	1	0.0010
						Cecropia sp.	seed	11	0.0010
						unidentifiable	leaf	2	0.0020
1090	G995	F	UN 60	S 3, E 1	10	*Quararibea* sp.	wood charcoal	2	0.0190
						Psidium sp.	wood charcoal	5	0.0570
						ANNONACEAE	wood charcoal	2	0.0550
						Bellucia sp.	wood charcoal	2	0.0320
						Simarouba amara	wood charcoal	3	0.0470

						Casearia sp.	wood charcoal	7	0.0570
						Calliandra sp.	wood charcoal	2	0.0170
						cf. *Ficus* sp.	wood charcoal	1	0.0040
						Cornus sp.	wood charcoal	7	0.0180
						ARECACEAE	wood charcoal	2	0.0050
						FABACEAE	wood charcoal	1	0.0030
						Hasseltia sp.	wood charcoal	1	0.0030
						Acmella sp.	achene	1	0.0130
						ASTERACEAE	achene	4	0.0060
						unidentifiable	seed	2	0.0030
1092	G995	F	UN 60	S 2, E 0	10	*Sebastiania* sp.	wood charcoal	4	0.0950
						Psidium sp.	wood charcoal	2	0.0370
						Trema sp.	wood charcoal	2	0.0200
						Cornus sp.	wood charcoal	5	0.0470
						Casearia sp.	wood charcoal	2	0.0160
						Sloanea sp.	wood charcoal	6	0.0590
						Weinmannia sp.	wood charcoal	1	0.0090
						Enterolobium cyclocarpum	wood charcoal	1	0.0080
						Clidemia sp.	wood charcoal	3	0.0180
						Hasseltia sp.	wood charcoal	1	0.0060
						Pouteria sp.	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	32	0.0470
						unidentifiable	nut shell fragment	1	0.1200
						Acmella sp.	achene	7	0.0000
						Terminalia sp.	fruit	2	0.0500
						Saponaria sp.	seed	1	0.0010
1093	G995	F	UN 60	S 3, E 0	10	*Sloanea* sp.	wood charcoal	1	0.0310
						Psidium sp.	wood charcoal	2	0.0220
						Nectandra/Ocotea	wood charcoal	2	0.0090
						Perrottetia sp.	wood charcoal	1	0.0060
						ARECACEAE	wood charcoal	1	0.0110
						Theobroma sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0230
						Gaultheria sp.	wood charcoal	1	0.0060
						Hieronyma alchorneoides	wood charcoal	1	0.0030
						Acalypha sp.	wood charcoal	3	0.0090
						Bellucia sp.	wood charcoal	1	0.0030
						ASTERACEAE	achene	23	0.0010
						Drymaria cordata	seed	1	0.0001
						Sapium sp.	seed	1	0.0200
						Acmella sp.	achene	4	0.0000
						POACEAE	seed	3	0.0000
1094	G995	F	UN 60	S 1, W 1	10		wood charcoal	12	0.0870

						Swietenia humilis	wood charcoal	2	0.0530
						Macrocnemum roseum	wood charcoal	3	0.0470
						Pouteria sp.	wood charcoal	1	0.0030
						Clidemia sp.	wood charcoal	1	0.0030
						RUBIACEAE	wood charcoal	1	0.0030
						Spondias cf. *mombin*	wood charcoal	3	0.0150
						Eugenia sp.	wood charcoal	1	0.0060
						Schinus sp.	wood charcoal	4	0.0150
						Licania sp.	wood charcoal	2	0.0060
						unidentifiable	wood charcoal	~~1~~	~~0.0030~~
						Manihot sp.	geophyte	1	0.0060
						Terminalia sp.	fruit	1	0.0500
						unidentifiable	fruit	4	0.0140
						unidentifiable	seed fragment	1	0.0070
						Zea mays	cupule	1	0.0050
						ASTERACEAE	achene	58	0.0230
						POACEAE	seed	16	0.0130
						Cecropia sp.	seed	1	0.0000
						UNID seed D	seed fragment	1	0.0030
						geophyte	geophyte	4	0.0220
						unidentifiable	nut shell fragment	4	0.0090
1095	G995	F	UN 60	S 2, W 1	10	*Zanthoxylum* sp.	wood charcoal	4	0.0370
						Weinmannia sp.	wood charcoal	2	0.0140
						Aspidosperma sp.	wood charcoal	1	0.0090
						Spondias cf. *mombin*	wood charcoal	2	0.0130
						Hieronyma alchorneoides	wood charcoal	1	0.0080
						unidentifiable	wood charcoal	2	0.0070
						Parkinsonia aculeata	wood charcoal	3	0.0060
						POACEAE	seed	18	0.0010
						Zea mays	cupule	1	0.0030
						ASTERACEAE	achene	29	0.0010
						Acmella sp.	achene	1	0.0000
						unidentifiable	wood charcoal	1	0.0040
						Salacia sp.	wood charcoal	1	0.0030
						unidentifiable	fruit	1	0.0030
						geophyte	geophyte	1	0.0020
						Cecropia sp.	seed fragment	1	0.0000
1096	G995	F	UN 60	S 3, W 1	10	*Aspidosperma cf. megalocarpon*	wood charcoal	1	0.0180
						Bixa cf. *orellana*	wood charcoal	3	0.0200
						unidentifiable	wood charcoal	1	0.0110
						Inga sp.	wood charcoal	3	0.0120
						Psidium sp.	wood charcoal	1	0.0080
						Viburnum sp.	wood charcoal	3	0.0110

						Casearia sp.	wood charcoal	7	0.1020
						Cornus sp.	wood charcoal	1	0.0160
						unidentifiable	wood charcoal	4	0.0200
						Ouratea sp.	wood charcoal	4	0.0340
						Clidemia sp.	wood charcoal	3	0.0150
						LECYTHIDACEAE	wood charcoal	4	0.0130
						unidentifiable	wood charcoal	2	0.0070
						Anacardium excelsum	wood charcoal	2	0.0060
						Phaseolus sp.	cotyledon	1	0.0100
						Acmella sp.	achene	16	0.0050
						unidentifiable	testa	1	0.0000
						Zea mays	cupule	1	0.0140
						geophyte	geophyte	2	0.0470
						ASTERACEAE	achene	3	0.0030
						POACEAE	seed	3	0.0070
1097	G995	F	UN 60	S 1, W 2	10	*Theobroma* sp.	wood charcoal	1	0.0230
						Clidemia sp.	wood charcoal	1	0.0050
						Bourreria sp.	wood charcoal	1	0.0030
						Terminalia sp.	fruit	4	0.0130
						ASTERACEAE	achene	38	0.0230
						unidentifiable	seed fragmet	1	0.0000
						unidentifiable	fruit	4	0.0030
						unidentifiable	fruit	2	0.0600
						Wimmeria sp.	wood charcoal	1	0.0110
						Persea sp.	wood charcoal	1	0.0060
						POACEAE	seed	41	0.0060
						unidentifiable	seed fragment	4	0.0420
						unidentifiable	seed fragment	2	0.0080
						unidentifiable	seed	1	0.0000
1098	G995	F	UN 60	S 2, W 2	10	*Astronium graveolens*	wood charcoal	3	0.1570
						cf. *Genipa americana*	wood charcoal	5	0.0740
						unidentifiable	wood charcoal	1	0.0600
						Allophylus sp.	wood charcoal	4	0.0210
						Zanthoxylum sp.	wood charcoal	1	0.0050
						Coutarea/Exostema	wood charcoal	1	0.0030
						Bourreria sp.	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	1	0.0030
						unidentifiable	fungus	1	0.0000
						ASTERACEAE	achene	9	0.0000
						POACEAE	seed	16	0.0090
						Acmella sp.	achene	1	0.0000
1099	G995	F	UN 60	S 3, W 2	10	*Cornus* sp.	wood charcoal	4	0.0190
						Cupania sp.	wood charcoal	2	0.0060

						unidentifiable	wood - bark	1	0.0810
						Terminalia sp.	fruit	1	0.0100
						unidentifiable	nut shell fragment	1	0.0560
						unidentifiable	wood charcoal	1	0.0120
						Aspidosperma sp.	wood charcoal	2	0.0110
						ASTERACEAE	achene	10	0.0010
						geophyte	geophyte	1	0.0030
						Acmella sp.	achene	4	0.0030
						Oxalis sp.	seed	1	0.0000
1100	G995	F	UN 60	S 4, E 2	10	*Cornus* cf. *peruviana*	wood charcoal	2	0.0360
						cf. *Sapindus saponaria*	wood charcoal	1	0.0110
						Psychotria sp.	wood charcoal	2	0.0110
						ASTERACEAE	achene	8	0.0010
						POACEAE	seed	14	0.0010
						unidentifiable	fungus	1	0.0000
						unidentifiable	seed	2	0.0000
						unidentifiable	wood charcoal	3	0.0150
1103	G995	F	UN 60	S 4, E 1	10	*Theobroma* sp.	wood charcoal	1	0.0040
						Zanthoxylum sp.	wood charcoal	1	0.0040
						Aspidosperma sp.	wood charcoal	1	0.0040
						Weinmannia sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	8	0.0200
						ASTERACEAE	achene	11	0.0010
						POACEAE	seed and leaf blade	2	0.0010
						Acmella sp.	achene	1	0.0000
1106	G995	F	UN 60	S 4, E 0	10	*Casearia* sp.	wood charcoal	4	0.0170
						Morella sp.	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	2	0.0050
						Psychotria sp.	wood charcoal	4	0.1390
						Nectandra/Ocotea	wood charcoal	2	0.0620
						Cheiloclinium cognatum	wood charcoal	2	0.0370
						Tabebuia sp.	wood charcoal	1	0.0080
						Psidium sp.	wood charcoal	3	0.0380
						EUPHORBIACEAE	wood charcoal	1	0.0060
						Zanthoxylum sp.	wood charcoal	3	0.0130
						Persea sp.	wood charcoal	2	0.0070
						Faramea sp.	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0100
						ASTERACEAE	achene	3	0.0000
						geophyte	geophyte	1	0.0070
						Acmella sp.	achene	1	0.0000
1109	G995	F	UN 60	S 4, W 1	10	*Coutarea/Exostema*	wood charcoal	6	0.0460
						Annona sp.	wood charcoal	2	0.0830

						Hieronyma alchorneoides	wood charcoal	1	0.0240
						Swietenia sp.	wood charcoal	2	0.0280
						Meliosma sp.	wood charcoal	3	0.0980
						Zanthoxylum sp.	wood charcoal	1	0.0220
						Casearia sp.	wood charcoal	7	0.0800
						cf. *Abarema* sp.	wood charcoal	4	0.0410
						Aspidosperma sp.	wood charcoal	6	0.0510
						SAPINDACEAE	wood charcoal	1	0.0100
						Bourreria sp.	wood charcoal	1	0.0120
						Tabebuia sp.	wood charcoal	1	0.0030
						BIGNONIACEAE	wood charcoal	1	0.0030
						geophyte	geophyte	1	0.0090
						ASTERACEAE	achene	22	0.0030
						POACEAE	seed	14	0.0010
						unidentifiable	fruit	1	0.0100
						Acmella sp.	achene	2	0.0000
1112	G995	F	UN 60	S 4, W 2	10	ARECACEAE	wood charcoal	3	0.1070
						RUBIACEAE	wood charcoal	1	0.0050
						Inga sp.	wood charcoal	1	0.0050
						Dalbergia sp.	wood charcoal	1	0.0760
						Diospyros sp.	wood charcoal	2	0.0410
						Clidemia sp.	wood charcoal	1	0.0100
						cf. *Curatella americana*	wood charcoal	2	0.0170
						Heliocarpus sp.	wood charcoal	1	0.0060
						Psychotria sp.	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	1	0.0030
						Coutarea/Exostema	wood charcoal	1	0.0030
						ASTERACEAE	achene	7	0.0000
						POACEAE	seed	14	0.0090
						ASTERACEAE	achene	1	0.0000
						unidentifiable	seed	1	0.0000
						Acmella sp.	achene	2	0.0000
1113	G995	F	UN 61	S 0.5, E 3.5	5	*Aspidosperma* cf. *excelsum*	wood charcoal	1	0.0140
						Spondias cf. *mombin*	wood charcoal	2	0.0160
						Eugenia sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	7	0.0040
1114	G995	F	UN 61	S 1.0, E 3.5	6	*Coussarea* sp.	wood charcoal	1	0.0030
						Inga sp.	wood charcoal	1	0.0020
1115	G995	F	UN 61	S 1.5, E 3.5	5	POACEAE	seed	3	0.0000
						unidentifiable	endocarp	11	0.0010
						unidentifiable	seed	1	0.0060
1116	G995	F	UN 61	S 2.0, E 3.5	6	unidentifiable	wood charcoal	1	0.0020

						unidentifiable	endocarp	1	0.0030
						unidentifiable	testa	2	0.0020
1117	G995	F	UN 61	S 2.5, E 3.5	5	unidentifiable	testa	1	0.0000
						unidentifiable	testa	1	0.0000
1118	G995	F	UN 61	S 3.0, E 3.5	6	MALVACEAE	seed	1	0.0030
						POACEAE	seed	5	0.0000
						POACEAE	seed	23	0.0020
						cf. *Saponaria* sp.	seed	1	0.0010
						unidentifiable	seed fragment	1	0.0000
						unidentifiable	leaf	1	0.0000
1119	G995	F	UN 61	S 0.5, E 3.0	6	*Acmella* sp.	achene	1	0.0000
1120	G995	F	UN 61	S 1.0, E 3.0	5	*Cornus* cf. *disciflora*	wood charcoal	1	0.0050
						ASTERACEAE	achene	1	0.0010
1121	G995	F	UN 61	S 1.5, E 3.0	5	unidentifiable	wood charcoal	4	0.0400
						unidentifiable	seed	1	0.0300
1122	G995	F	UN 61	S 2.0, E 3.0	5	*Acmella* sp.	achene	1	0.0010
						Theobroma sp.	wood charcoal	1	0.0080
						unidentifiable	seed	1	0.0000
						unidentifiable	tissue	2	0.0040
1123	G995	F	UN 61	S 2.5, E 3.0	5	*Acmella* sp.	achene	1	0.0010
						unidentifiable	endocarp	1	0.0020
1124	G995	F	UN 61	S 3.0, E 3.0	5	*Acmella* sp.	achene	1	0.0010
						UNID fruit B	fruit	1	0.0010
1125	G995	F	UN 61	S 0.5, E 2.5	5	unidentifiable	wood charcoal		0.1400
						Vochysia sp.	wood charcoal	8	0.0770
						unidentifiable	endocarp	1	0.0000
1126	G995	F	UN 61	S 1.0, E 2.5	5	*Acacia* sp.	wood charcoal	1	0.0150
						Coutarea/Exostema	wood charcoal	1	0.0030
						ASTERACEAE	achene	2	0.0000
1127	G995	F	UN 61	S 1.5, E 2.5	5	*Theobroma* sp.	wood charcoal	1	0.0060
				F 2		*Ouratea* sp.	wood charcoal	1	0.0060
						Coccoloba sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0030
						Magnolia sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0050
						Calliandra sp.	wood charcoal	2	0.0290
						Eugenia sp.	wood charcoal	10	0.0640
						Alchornea sp.	wood charcoal	2	0.0100
						Miconia sp.	wood charcoal	1	0.0130
						Schefflera sp.	wood charcoal	4	0.0390

						Zanthoxylum sp.	wood charcoal	4	0.0270
						Naucleopsis sp.	wood charcoal	2	0.0090
						cf. *Neea* sp.	wood charcoal	1	0.0050
						Croton sp.	wood charcoal	3	0.0100
						ANONNACEAE	wood charcoal	1	0.0030
						Terminalia sp.	fruit	3	0.0170
						Acmella sp.	achene	14	0.0020
1127A	G995	F	UN 61	S 1.5, E 2.5	3.5	*Ouratea* sp.	wood charcoal	5	0.1040
				F 2/Nivel 1	3.5	*Croton* sp.	wood charcoal	13	0.0810
					3.5	*Coutarea/Exostema*	wood charcoal	7	0.0590
					3.5	*Gaultheria* sp.	wood charcoal	2	0.0080
					3.5	*Casearia* sp.	wood charcoal	7	0.0440
					3.5	*Campnosperma panamense*	wood charcoal	1	0.0130
					3.5	*Aspidosperma* cf. *megalocarpon*	wood charcoal	3	0.0280
					3.5	*Eugenia* sp.	wood charcoal	5	0.0550
					3.5	*Celtis* sp.	wood charcoal	3	0.0210
					3.5	*Miconia* sp.	wood charcoal	3	0.0200
					3.5	*Pouteria* sp.	wood charcoal	2	0.0210
					3.5	*Zanthoxylum* sp.	wood charcoal	2	0.0260
					3.5	*Faramea* sp.	wood charcoal	1	0.0190
					3.5	*Cornus* cf. *peruviana*	wood charcoal	5	0.0160
					3.5	*Sloanea* sp.	wood charcoal	3	0.0240
					3.5	BIGNONIACEAE	wood charcoal	1	0.0070
					3.5	ARECACEAE	wood charcoal	1	0.0060
					3.5	*Acacia* sp.	wood charcoal	1	0.0040
					3.5	*Theobroma* sp.	wood charcoal	1	0.0040
					3.5	*Zea mays*	cupule	1	0.0100
					3.5	POACEAE	seed	2	0.0000
					3.5	*Acmella* sp.	achene	9	0.0000
					3.5	geophyte	geophyte	1	0.0120
					3.5	*Manihot* sp.	geophyte	1	0.0080
1127B	G995	F	UN 61	S 1.5, E 2.5	5	*Aspidosperma* sp.	wood charcoal	1	0.0070
				F 2/Nivel 2	5	ASTERACEAE	achene	1	0.0000
1128	G995	F	UN 61	S 2.0, E 2.5	6	*Crateva* sp.	wood charcoal	2	0.0460
				F2		*Maquira costaricana*	wood charcoal	2	0.0850
						Magnolia sp.	wood charcoal	2	0.0280
						Enterolobium schomburgkii	wood charcoal	3	0.0330
						Casearia sp.	wood charcoal	1	0.0110
						Zanthoxylum sp.	wood charcoal	2	0.0180
						Clidemia sp.	wood charcoal	1	0.0090
						Bourreria sp.	wood charcoal	1	0.0030

						Cheiloclinium cognatum	wood charcoal	1	0.0030
						POACEAE	seed		
						UNID seed C	seed	1	0.0000
1128A	G995	F	UN 61	S 2.0, E 2.5 F 2/Nivel 1	4	*Magnolia* sp.	wood charcoal	2	0.0090
						Aspidosperma sp.	wood charcoal	3	0.0120
						Maytenus sp.	wood charcoal	5	0.0120
						unidentifiable	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	1	0.0030
							wood charcoal	1	0.0150
						Acmella sp.	achene	3	0.0000
						geophyte	geophyte	1	0.0030
1128B	G995	F	UN 61	S 2.0, E 2.5 F 2/Nivel 2	4	*Aspidosperma* sp.	wood charcoal	2	0.0080
1129-	G995	F	UN 61	S 2.5, E 2.5	5	*Buchenavia* sp.	wood charcoal	4	0.0300
						EUPHORBIACEAE	wood charcoal	1	0.0180
						Swietenia macrophylla	wood charcoal	1	0.0100
						Magnolia sp.	wood charcoal	3	0.0200
						Tabernaemontana sp.	wood charcoal	1	0.0110
						Dalbergia sp.	wood charcoal	1	0.0090
						Psidium sp.	wood charcoal	6	0.0290
						Peltogyne sp.	wood charcoal	2	0.0130
						ARECACEAE	wood charcoal	1	0.0040
						Crateva sp.	wood charcoal	1	0.0040
						cf. *Zea mays*	cupule	1	0.0560
						Terminalia sp.	fruit	1	0.0100
						Phaseolus sp.	cotyledon	1	0.0250
						unidentifiable	wood charcoal	1	0.0140
						Quararibea sp.	wood charcoal	1	0.0140
						Parmentiera sp.	wood charcoal	10	0.0440
						Gaultheria sp.	wood charcoal	2	0.0130
						Ouratea sp.	wood charcoal	1	0.0110
						Casearia sp.	wood charcoal	4	0.0270
						Cornus sp.	wood charcoal	1	0.0040
						Virola sp.	wood charcoal	1	0.0030
						Alchornea sp.	wood charcoal	1	0.0030
						geophyte	geophyte	1	0.0040
1130	G995	F	UN 61	S 3.0, E 2.5	5	unidentifiable	wood charcoal	2	0.0020
						POACEAE	seed	1	0.0000
1131	G995	F	UN 61	S 3.5, E 2.5	5	*Trichilia* sp.	wood charcoal	1	0.0050
						Tabernaemontana sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0030

						ASTERACEAE	achene	1	0.0000
1132	G995	F	UN 61	S 4.0, E 2.5	6	unidentifiable	wood charcoal	3	0.0030
						unidentifiable	testa	2	0.0030
1134	G995	F	UN 61	S 1.0, E 2.0	5	*Gaultheria* sp.	wood charcoal	1	0.0030
1135	G995	F	UN 61	S 1.5, E 2.0	5	*Zanthoxylum* sp.	wood charcoal	2	0.0210
				F2		*Muntingia calabura*	wood charcoal	2	0.0100
						unidentifiable	testa	1	0.0000
						Acmella sp.	achene	4	0.0000
						Terminalia sp.	fruit	1	0.0000
						ASTERACEAE	achene	2	0.0000
						unidentifiable	seed	1	0.0000
						POACEAE	seed	1	0.0000
						geophyte	geophyte	1	0.0030
1135A	G995	F	UN 61	S 1.5, E 2.0	5	*Aspidosperma* sp.	wood charcoal	1	0.0100
				F 2/Nivel 1		unidentifiable	wood charcoal	1	0.0050
						Pouteria sp.	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	1	0.0030
						Acmella sp.	achene	6	0.0030
1135B	G995	F	UN 61	S 1.5, E 2.0 F 2/Nivel 2	6	*Acmella* sp.	achene	6	0.0030
1136	G995	F	UN 61	S 2.0, E 2.0	10.5	*Clidemia* sp.	wood charcoal	5	0.0420
				F2		cf. *Pterocarpus* sp.	wood charcoal	3	0.0290
						Aspidosperma sp.	wood charcoal	5	0.0370
						Hirtella sp.	wood charcoal	1	0.0150
						Sloanea sp.	wood charcoal	3	0.0260
						unidentifiable	wood charcoal	3	0.0190
						Swietenia sp.	wood charcoal	2	0.0170
						Ardisia sp.	wood charcoal	1	0.0110
						unidentifiable	wood charcoal	1	0.0060
						ARECACEAE	wood charcoal	1	0.0090
						Zanthoxylum sp.	wood charcoal	6	0.0720
						ANACARDIACEAE	wood charcoal	4	0.0310
						MYRTACEAE	wood charcoal	4	0.0420
						Cornus sp.	wood charcoal	10	0.0870
						Bixa cf. *orellana*	wood charcoal	4	0.0560
						Bourreria sp.	wood charcoal	3	0.0510
						Capparis sp.	wood charcoal	1	0.0500
						Hura crepitans	wood charcoal	9	0.0930
						Casearia sp.	wood charcoal	7	0.0960
						Coutarea/Exostema	wood charcoal	1	0.0190
						Manihot sp.	wood charcoal	3	0.0230

						Gaultheria sp.	wood charcoal	2	0.0250
						Sebastiania sp.	wood charcoal	1	0.0080
						Tabernaemontana sp.	wood charcoal	2	0.0150
						Zea mays	cuplule	1	0.0000
						Terminalia sp.	fruit	1	0.0060
						Acmella sp.	achene	1	0.0000
						unidentifiable	nut shell fragment	2	0.0700
						Zea mays	cuplule	1	0.0550
						geophyte	geophyte	1	0.0210
						POACEAE	seed	2	0.0000
						unidentifiable	lump	1	0.0070
						unidentifiable	testa	2	0.0050
1136A	G995	F	UN 61	S 2.0, E 2.0	4.5	*Casearia* sp.	wood charcoal	11	0.0870
				F 2/Nivel 1		*Prunus* sp.	wood charcoal	1	0.0130
						Aspidosperma sp.	wood charcoal	8	0.1010
						cf. *Myroxylon balsamum*	wood charcoal	2	0.0400
						Jacaranda cf. *caucana*	wood charcoal	3	0.0600
						Sloanea sp.	wood charcoal	1	0.0160
						Cornus sp.	wood charcoal	2	0.0130
						Clidemia sp.	wood charcoal	1	0.0110
						Peltogyne sp.	wood charcoal	1	0.0100
						Platymiscium sp.	wood charcoal	1	0.0060
						cf. *Byrsonima* sp.	wood charcoal	1	0.0060
						ASTERACEAE	achene	1	0.0000
1136B	G995	F	UN 61	S 2.0, E 2.0	5.5	cf. *Byrsonima* sp.	wood charcoal	1	0.0060
				F 2/Nivel 2		*Tabernaemontana* sp.	wood charcoal	1	0.0030
						Margaritaria nobilis	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	20	0.0230
						geophyte	geophyte	2	0.0330
						POACEAE	seed	2	0.0000
						unidentifiable	seed fragment	3	0.0000
1137	G995	F	UN 61	S 2.5, E 2.0 F2	5	unidentifiable	wood charcoal	1	0.0030
1138	G995	F	UN 61	S 3.0, E 2.0	5	unidentifiable	wood charcoal	2	0.0010
						unidentifiable	endocarp	1	0.0000
1140	G995	F	UN 61	S 4.0, E 2.0	6	MYRTACEAE	wood charcoal	1	0.0030
						unidentifiable	endocarp	7	0.0010
1141	G995	F	UN 61	S 0.5, E 1.5	6	unidentifiable	wood charcoal	1	0.0020
						ANACARDIACEAE	wood charcoal	1	0.0020
						cf. *Byrsonima* sp.	wood charcoal	4	0.0300
						ARECACEAE	wood charcoal	1	0.0150

						ASTERACEAE	achene	1	0.0000
						unidentifiable	endocarp	1	0.0000
						Acmella sp.	achene	2	0.0000
1142	G995	F	UN 61	S 1.0, E 1.5	6	*Cornus* sp.	wood charcoal	4	0.0250
						cf. HUMIRIACEAE	wood charcoal	1	0.0120
						ASTERACEAE	achene	1	0.0000
						FABACEAE	bean	1	0.0020
						Mollugo verticillata	seed	1	0.0000
						Acmella sp.	achene	1	0.0000
1143	G995	F	UN 61	S 1.5, E 1.5	5	cf. *Genipa americana*	wood charcoal	2	0.0190
						cf. *Tachigali* sp.	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	4	0.0070
						ASTERACEAE	achene	1	0.0000
1144	G995	F	UN 61	S 2.0, E 1.5	5	*Hasseltia* sp.	wood charcoal	1	0.0060
						Zanthoxylum sp.	wood charcoal	1	0.0070
						Coussarea sp.	wood charcoal	1	0.0020
						unidentifiable	endocarp	1	0.0000
1145	G995	F	UN 61	S 2.5, E 1.5	5	*Theobroma* sp.	wood charcoal	2	0.0120
						unidentifiable	wood charcoal	4	0.0030
						Acmella sp.	achene	2	0.0000
1146	G995	F	UN 61	S 3.0, E 1.5	5	*Spondias* cf. *mombin*	wood charcoal	1	0.0070
						Nicotiana sp.	seed	1	0.0000
1147	G995	F	UN 61	S 3.5, E 1.5	5	unidentifiable	wood charcoal		0.0100
						cf. *Perrottetia* sp.	wood charcoal	2	0.0140
1148-	G995	F	UN 61	S 4.0, E 1.5	5	unidentifiable	seed	1	0.0430
						unidentifiable	endocarp	5	0.0020
						Acmella sp.	achene	1	0.0000
1149	G995	F	UN 61	S 0.5, E 1.0	5	*Swietenia* sp.	wood charcoal	76	0.8850
						Ceiba sp.	wood charcoal	13	0.1990
						Hedyosmum sp.	wood charcoal	4	0.0440
						Sloanea sp.	wood charcoal	1	0.0060
						Palicourea sp.	wood charcoal	9	0.0570
						ASTERACEAE	achene	1	0.0000
						unidentifiable	endocarp	1	0.0010
						Acmella sp.	achene	3	0.0000
						unidentifiable	seed fragment	1	0.0000
1150	G995	F	UN 61	S 1.0, E 1.0	5	*Cornus* spp.	wood charcoal	32	0.9210
						Sloanea sp.	wood charcoal	136	2.0240
						Anacardium occidentale	wood charcoal	4	0.0500
						Dendropanax sp.	wood charcoal	6	0.0830

						Apeiba sp.	wood charcoal	29	0.3510
						Thevetia sp.	wood charcoal	6	0.0500
						Tabernaemontana sp.	wood charcoal	2	0.0080
						Bellucia sp.	wood charcoal	1	0.0060
						Acmella sp.	achene	1	0.0000
						ASTERACEAE	achene	1	0.0000
						unidentifiable	seed fragment	2	0.0010
1151	G995	F	UN 61	S 1.5, E 1.0	5	MELIACEAE	wood charcoal	2	0.0060
						ASTERACEAE	achene	1	0.0000
						Nicotiana sp.	seed	1	0.0000
						unidentifiable	endocarp	2	0.0000
1152	G995	F	UN 61	S 2.0, E 1.0	5	*Weinmannia* sp.	wood charcoal	4	0.0180
						Cavanillesia platanifolia	wood charcoal	1	0.0100
						Trichilia sp.	wood charcoal	1	0.0050
						Psidium sp.	wood charcoal	1	0.0040
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	1	0.0000
1153	G995	F	UN 61	S 2.5, E 1.0	5	*Perrottetia* sp.	wood charcoal	5	0.0250
						Parkinsonia aculeata	wood charcoal	2	0.0100
1154	G995	F	UN 61	S 3.0, E 1.0	5	unidentifiable	wood charcoal	7	0.0070
						unidentifiable	endocarp	2	0.0000
1155	G995	F	UN 61	S 3.5, E 1.0	5	unidentifiable	seed fragment	1	0.0000
1156	G995	F	UN 61	S 4.0, E 1.0	5	unidentifiable	testa	2	0.0000
						cf. *Rumex* sp.	seed	1	0.0000
1159	G995	F	UN 61	S 1.5, E 0.5	5	*Aspidosperma* sp.	wood charcoal	1	0.0080
						unidentifiable	wood charcoal	2	0.0090
						unidentifiable	wood charcoal	1	0.0040
1160	G995	F	UN 61	S 2.0, E 0.5	5	*Zanthoxylum* sp.	wood charcoal	1	0.0560
						Clidemia sp.	wood charcoal	1	0.0170
1161	G995	F	UN 61	S 2.5, E 0.5	5	unidentifiable	wood charcoal	2	0.0040
						Heisteria sp.	wood charcoal	1	0.0080
						ASTERACEAE	achene	1	0.0000
						POACEAE	seed	1	0.0000
						unidentifiable	endocarp	1	0.0010
1162	G995	F	UN 61	S 3.0, E 0.5	5	unidentifiable	wood charcoal	3	0.0010
						POACEAE	seed	1	0.0000
						unidentifiable	seed	1	0.0000
						unidentifiable	testa	1	0.0000
1163	G995	F	UN 61	S 3.5, E 0.5	6	unidentifiable	wood charcoal	1	0.0070
						Capparis sp.	wood charcoal	1	0.0030

						unidentifiable	wood charcoal	2	0.0010
						unidentifiable	endocarp	3	0.0010
						unidentifiable	seed	1	0.0000
						POACEAE	seed	1	0.0000
1164	G995	F	UN 61	S 4.0, E 0.5	5	*Theobroma* sp.	wood charcoal	1	0.0120
						CELASTRACEAE	wood charcoal	1	0.0100
						POACEAE	seed	2	0.0000
						Acmella sp.	achene	1	0.0000
						unidentifiable	endocarp	2	0.0010
1167	G995	F	UN 61	S 1.5, E 0	5	unidentifiable	wood charcoal	1	0.0030
						unidentifiable	endocarp	1	0.0000
1168	G995	F	UN 61	S 2.0, E 0	5	FABACEAE	wood charcoal	1	0.0030
						Poulsenia armata	wood charcoal	1	0.0030
1169	G995	F	UN 61	S 2.5, E 0	5	unidentifiable	wood charcoal	3	0.0010
1170	G995	F	UN 61	S 3.0, E 0	4	unidentifiable	wood charcoal	1	0.0070
						POACEAE	seed	3	0.0000
						Acmella sp.	achene	1	0.0000
1171	G995	F	UN 61	S 3.5, E 0	6	*Jacaranda* cf. *caucana*	wood charcoal	1	0.0220
						Margaritaria nobilis	wood charcoal	1	0.0030
						geophyte	geophyte	1	0.0080
1172	G995	F	UN 61	S 4.0, E 0	8	*Manilkara* sp.	wood charcoal	1	0.0110
						Weinmannia sp.	wood charcoal	2	0.0110
						Bourreria sp.	wood charcoal	1	0.0080
						POACEAE	seed	1	0.0000
						Acmella sp.	achene	1	0.0000
1174	G995	F	UN 61	S 1.0, W 0.5	5	*Spondias* cf. *mombin*	wood charcoal	14	0.1080
						unidentifiable	testa	1	0.0010
1175	G995	F	UN 61	S 1.5, W 0.5	5	*Sloanea* sp.	wood charcoal	1	0.0070
						Coccoloba sp.	wood charcoal	1	0.0050
1176	G995	F	UN 61	S 2.0, W 0.5	6	unidentifiable	wood charcoal	1	0.0010
						ASTERACEAE	achene	59	0.0010
						POACEAE	seed	3	0.0000
1177	G995	F	UN 61	S 2.5, W 0.5	5	unidentifiable	wood charcoal	2	0.0010
						Acmella sp.	achene	2	0.0000
1178	G995	F	UN 61	S 3.0, W 0.5	7	*Acmella* sp.	achene	3	0.0000
						unidentifiable	testa	1	0.0010
1179	G995	F	UN 61	S 3.5, W 0.5	5	*Symphonia globulifera*	wood charcoal	7	0.0430
						unidentifiable	wood charcoal	20	0.0330
						geophyte	geophyte	1	0.0400

						Acmella sp.	achene	2	0.0000
1180	G995	F	UN 61	S 4.0, W 0.5	5	*Escallonia* sp.	wood charcoal	1	0.0280
						unidentifiable	wood charcoal	10	0.0060
						POACEAE	seed	1	0.0000
1182	G995	F	UN 61	S 1.0, W 1.0	5	*Sloanea* sp.	wood charcoal	1	0.0150
						unidentifiable	wood charcoal	4	0.0070
						ASTERACEAE	achene	1	0.0000
						Acmella sp.	achene	1	0.0000
1183	G995	F	UN 61	S 1.5, W 1.0	5	*Theobroma* sp.	wood charcoal	1	0.0030
						CHRYSOBALANACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	4	0.0060
						POACEAE	seed	4	0.0000
						unidentifiable	endocarp	1	0.0010
						Acmella sp.	achene	6	0.0000
1184	G995	F	UN 61	S 2.0, W 1.0	5	*Clidemia* sp.	wood charcoal	2	0.0850
						Prunus sp.	wood charcoal	5	0.0190
						ASTERACEAE	achene	3	0.0000
						POACEAE	seed	4	0.0000
						Acmella sp.	achene	31	0.0010
1185	G995	F	UN 61	S 2.5, W 1.0	5	POACEAE	seed	1	0.0000
						Acmella sp.	achene	1	0.0000
						unidentifiable	testa	1	0.0000
1186	G995	F	UN 61	S 3.0, W 1.0	5	unidentifiable	wood charcoal	3	0.0030
						ASTERACEAE	achene	2	0.0000
						Acmella sp.	achene	6	0.0000
1187	G995	F	UN 61	S 3.5, W 1.0	5	unidentifiable	wood charcoal	2	0.0020
						POACEAE	seed	1	0.0000
						Acmella sp.	achene	1	0.0000
1188	G995	F	UN 61	S 4.0, W 1.0	5	*Jacaranda* cf. *caucana*	wood charcoal	3	0.0810
						Cornus sp.	wood charcoal	7	0.0830
						Theobroma sp.	wood charcoal	2	0.0460
						Weinmannia sp.	wood charcoal	2	0.0160
						Aspidosperma sp.	wood charcoal	1	0.0150
						Cecropia sp.	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	28	0.0880
						Acmella sp.	achene	1	0.0000
						unidentifiable	testa	2	0.0010
						geophyte	geophyte	1	0.0040
1189	G995	F	UN 61	S 1.0, W 2.0	10	*Clidemia* sp.	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	1	0.0020

						Simarouba amara	wood charcoal	1	0.0080
						Sloanea sp.	wood charcoal	3	0.0190
						MYRTACEAE	wood charcoal	2	0.0060
						unidentifiable	wood charcoal	4	0.0030
						ASTERACEAE	achene	2	0.0000
						Acmella sp.	achene	5	0.0000
						unidentifiable	endocarp	1	0.0000
1190	G995	F	UN 61	S 2.0, W 2.0	8	*Psidium* sp.	wood charcoal	2	0.0160
						ARECACEAE	wood charcoal	1	0.0080
							wood charcoal	1	0.0060
						Faramea sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	3	0.0010
						Acmella sp.	achene	6	0.0000
						unidentifiable	endocarp	1	0.0000
1191	G995	F	UN 61	S 3.0, W 2.0	6	cf. *Croton* sp.	wood charcoal	1	0.0030
						Platymiscium sp.	wood charcoal	1	0.0030
						Brosimum sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	2	0.0010
						ASTERACEAE	achene	1	0.0000
1192	G995	F	UN 61	S 4.0, W 2.0	9	*Simarouba glauca*	wood charcoal	2	0.0080
						Avicennia sp.	wood charcoal	1	0.0030
						geophyte	geophyte	1	0.0040
						Acmella sp.	achene	2	0.0000
						cf. *Rumex* sp.	seed	1	0.0000
1200	G995	F	UN 61	S 1.0, E 3.0	1	*Bourreria* sp.	wood charcoal	1	0.0190
				PH5		MYRTACEAE	wood charcoal	2	0.0050
						Acmella sp.	achene	1	0.0000
1201	G995	F	UN 61	S 1.0, E 3.0	2	*Zanthoxylum* sp.	wood charcoal	4	0.2080
				PH6		*Pourouma* sp.	wood charcoal	2	0.0310
						Aspidosperma sp.	wood charcoal	3	0.0380
						EUPHORBIACEAE	wood charcoal	1	0.0900
						Trichilia sp.	wood charcoal	1	0.0800
						unidentifiable	wood charcoal	2	0.0610
						Clethra sp.	wood charcoal	1	0.0050
						Escallonia sp.	wood charcoal	1	0.0160
						Jacaranda sp.	wood charcoal	1	0.0090
						Palicourea sp.	wood charcoal	3	0.0170
						cf. *Tetragastris panamensis*	wood charcoal	1	0.0050
						Nectandra/Ocotea	wood charcoal	1	0.0040
						RUBIACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	36	0.0480

1202	G995	F	UN 61	S 2.0, E 3.0	3	*Coutarea/Exostema*	wood charcoal	3	0.1170
				PH7		*Bourreria* sp.	wood charcoal	1	0.0030
						Inga sp.	wood charcoal	3	0.0070
						unidentifiable	wood charcoal	6	0.0240
1203	G995	F	UN 61	S 2.0, E 3.0	3	*Casearia* sp.	wood charcoal	19	0.1350
				PH8		*Cornus* cf. *peruviana*	wood charcoal	3	0.0240
						Psidium sp.	wood charcoal	6	0.0340
						unidentifiable	wood charcoal	4	0.0190
						Inga sp.	wood charcoal	3	0.0130
						Bourreria sp.	wood charcoal	2	0.0090
						Coutarea/Exostema	wood charcoal	1	0.0120
						FABACEAE	wood charcoal	2	0.0060
						Gliricidia sepium	wood charcoal	2	0.0060
						Zea mays	cupule	1	0.0000
						Terminalia sp.	fruit	1	0.0000
						unidentifiable	testa	1	0.0100
1204	G995	F	UN 61	S 2.5, E 2.5	2	*Swietenia macrophylla*	wood charcoal	9	0.1410
				PH9		*Magnolia* sp.	wood charcoal	3	0.0210
						unidentifiable	wood charcoal	3	0.0280
						Bourreria sp.	wood charcoal	1	0.0090
						Spondias sp.	wood charcoal	5	0.0950
						Casearia sp.	wood charcoal	1	0.0510
						Coussarea sp.	wood charcoal	4	0.0410
						Inga sp.	wood charcoal	2	0.0150
						ARECACEAE	wood charcoal	1	0.0280
						Aspidosperma sp.	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	2	0.0280
						Dendropanax sp.	wood charcoal	1	0.0050
						Mabea sp.	wood charcoal	1	0.0060
						Terminalia sp.	fruit	1	0.0000
						geophyte	geophyte	1	0.0080
1205	G995	F	UN 61	S 3.5, E 2.0	3	*Clidemia* sp.	wood charcoal	18	0.2240
				PH10		*Zanthoxylum* sp.	wood charcoal	24	0.1010
						Cecropia sp.	wood charcoal	15	0.0790
						Faramea sp.	wood charcoal	2	0.0180
						MYRTACEAE	wood charcoal	4	0.0230
						Calycophyllum candidissimum	wood charcoal	3	0.0200
						Allophylus sp.	wood charcoal	2	0.0100
						SALICACEAE	wood charcoal	4	0.0150
						Casearia sp.	wood charcoal	3	0.0070
						ASTERACEAE	achene	1	0.0000
						Acmella sp.	achene	1	0.0000

						Zea mays	cupule	1	0.0000
						unidentifiable	seed	1	0.0000
						UNID seed C	seed	1	0.0000
						geophyte	geophyte	5	0.0410
1206	G995	F	UN 61	S 3.0, E 1.5	1	unidentifiable	wood charcoal	6	0.0040
				PH11		unidentifiable	wood charcoal	5	0.0010
						geophyte	geophyte	4	0.0050
						Parkinsonia aculeata	wood charcoal	3	0.0260
						cf. *Croton* sp.	wood charcoal	1	0.0440
						Dendropanax sp.	wood charcoal	1	0.0080
						FABACEAE	wood charcoal	1	0.0060
						Clidemia sp.	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0200
						Terminalia sp.	fruit	1	0.0180
						Zea mays	cupule	1	0.0000
						unidentifiable	roots	2	0.0000
1208	G995	F	UN 61	S 3.5, E 1.5	1	unidentifiable	wood charcoal	1	0.0040
				PH12A		*Bellucia* sp.	wood charcoal	2	0.0070
						Clidemia sp.	wood charcoal	2	0.0050
						Cornus sp.	wood charcoal	3	0.0080
						Terminalia sp.	wood charcoal	3	0.0160
						Cecropia cf. *peltata*	wood charcoal	1	0.0040
1209	G995	F	UN 61	S 3.5, E 0.5	3	*Handroanthus* sp.	wood charcoal	2	0.0050
				PH12B		*Acmella* sp.	achene	1	0.0000
1210	G995	F	UN 61	S 3.0, E 0.0	2	*Erythrochiton* sp.	wood charcoal	2	0.0060
				PH13		*Bourreria* sp.	wood charcoal	2	0.0140
						unidentifiable	wood charcoal	1	0.0010
						Acmella sp.	achene	124	0.0020
1211	G995	F	UN 61	S 2.5, E 0.5	3	*Magnolia* sp.	wood charcoal	3	0.0260
				PH14		*Hamelia* sp.	wood charcoal	1	0.0060
						FABACEAE	wood charcoal	1	0.0060
						Acacia sp.	wood charcoal	2	0.0080
						Aspidosperma sp.	wood charcoal	1	0.0060
						Bourreria sp.	wood charcoal	1	0.0050
						POACEAE	seed	1	0.0000
						Acmella sp.	achene	110	0.0010
						geophyte	geophyte	1	0.0060
						unidentifiable	seed	2	0.0000
1212	G995	F	UN 61	S 2.0, W 1.0	3	*Schinus* cf. *terebinthifolius*	wood charcoal	7	0.0980
				PH15		*Psidium* sp.	wood charcoal	3	0.0230
						Bourreria sp.	wood charcoal	1	0.0050

						Naucleopsis sp.	wood charcoal	1	0.0090
						Spondias cf. *mombin*	wood charcoal	2	0.0170
						Sebastiania sp.	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	1	0.0050
						cf. *Morella* sp.	wood charcoal	1	0.0060
						Calycophyllum candidissimum	wood charcoal	12	0.1870
						Zanthoxylum sp.	wood charcoal	15	0.1740
						MELASTOMATACEAE	wood charcoal	7	0.1020
						Pouteria sp.	wood charcoal	4	0.0280
						Magnolia sp.	wood charcoal	1	0.0160
						Tetragastris panamensis	wood charcoal	2	0.0190
						Acacia sp.	wood charcoal	1	0.0050
						Aspidosperma sp.	wood charcoal	7	0.0260
						Campnosperma panamense	wood charcoal	4	0.0170
						Cornus sp.	wood charcoal	6	0.0260
						Sapindus saponaria	wood charcoal	7	0.0480
						Apeiba sp.	wood charcoal	1	0.0090
						ARECACEAE	wood charcoal	3	0.0190
						Terminalia sp.	fruit	1	0.0000
						geophyte	geophyte	1	0.0060
						Acmella sp.	achene	85 0	0.0210
						unidentifiable	seed fragment	3	0.0000
1213	G995	F	UN 61	S 1.0, W 1.0	1.5	*Spondias* cf. *mombin*	wood charcoal	19	0.1760
				PH16		*Astronium graveolens*	wood charcoal	3	0.0270
						Terminalia cf. *oblonga*	wood charcoal	3	0.0320
						Pouteria sp.	wood charcoal	2	0.0350
						Parmentiera sp.	wood charcoal	1	0.0150
						Psychotria sp.	wood charcoal	1	0.0110
						Swietenia humilis	wood charcoal	13	0.0630
						Aspidosperma sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0040
						Acmella sp.	achene	2	0.0000
1214	G995	F	UN 61	S 0.5, W 1.0	3	*Casearia* sp.	wood charcoal	12	0.0900
				PH17		*Trema* sp.	wood charcoal	6	0.0330
						unidentifiable	wood charcoal	1	0.0060
						Morella sp.	wood charcoal	4	0.0240
						Vochysia sp.	wood charcoal	5	0.0260
						Enterolobium sp.	wood charcoal	2	0.0090
						Alchornea sp.	wood charcoal	3	0.0170
						Psychotria sp.	wood charcoal	3	0.0120
						Poulsenia armata	wood charcoal	2	0.0150
						Clethra sp.	wood charcoal	1	0.0030

						Astronium graveolens	wood charcoal	1	0.0030
						Aspidosperma spp.	wood charcoal	13	0.2940
						Spondias cf. *mombin*	wood charcoal	13	0.1300
						Dendropanax sp.	wood charcoal	4	0.0460
						Cornus sp.	wood charcoal	7	0.0570
						Weinmannia sp.	wood charcoal	1	0.0240
						Zanthoxylum sp.	wood charcoal	12	0.0560
						Simarouba glauca	wood charcoal	2	0.0260
						MORACEAE	wood charcoal	2	0.0160
						Bellucia sp.	wood charcoal	3	0.0250
						Psidium sp.	wood charcoal	6	0.0400
						Pouteria sp.	wood charcoal	7	0.0420
						SAPOTACEAE	wood charcoal	2	0.0070
						ANNONACEAE	wood charcoal	1	0.0030
						Acmella sp.	achene	174	0.0050
						Terminalia sp.	fruit	2	0.0170
						unidentifiable	seed fragment	4	0.0000
1216	G995	F	UN 61	S 2.0, E 2.0	16	*Trema* sp.	wood charcoal	2	0.0940
				F2		*Terminalia* sp.	wood charcoal	3	0.0960
						Cornus spp.	wood charcoal	9	0.1380
						Hasseltia sp.	wood charcoal	2	0.0350
						Psidium sp.	wood charcoal	2	0.0440
						Anacardium excelsum	wood charcoal	1	0.0240
						Coussarea sp.	wood charcoal	2	0.0420
						MYRTACEAE	wood charcoal	2	0.0620
						Zanthoxylum sp.	wood charcoal	5	0.0580
						Faramea sp.	wood charcoal	2	0.0170
						Cedrela sp.	wood charcoal	3	0.0150
						Swietenia humilis	wood charcoal	1	0.0110
						Pouteria sp.	wood charcoal	2	0.0140
						Platymiscium sp.	wood charcoal	3	0.0210
						Coccoloba sp.	wood charcoal	1	0.0080
						Aspidosperma sp.	wood charcoal	4	0.0160
						Hura crepitans	wood charcoal	7	0.0780
						Tabernaemontana sp.	wood charcoal	2	0.0320
						Clidemia sp.	wood charcoal	1	0.0240
						Casearia sp.	wood charcoal	6	0.0900
						Acacia sp.	wood charcoal	1	0.0060
						Capparis sp.	wood charcoal	1	0.0120
						Bourreria sp.	wood charcoal	2	0.0190
						ASTERACEAE	achene	35	0.0000
						Zea mays	cupule	1	0.0050

						POACEAE	seed	4	0.0000
						Acmella sp.	achene	10	0.0000
						unidentifiable	leaf	1	0.0000
2002	G995	S	AR 16-15	S 2, E 3	10	*Theobroma* sp.	wood charcoal	2	0.0120
						unidentifiable	seed fragment	1	0.0030
						unidentifiable	testa	1	0.0010
2003	G995	S	AR 16-15	S 3, E 3	10	*Aspidosperma* cf. *australe*	wood charcoal	1	0.0030
						Warszewiczia sp.	wood charcoal	1	0.0030
2004	G995	S	AR 16-15	S 3, E 2	10	unidentifiable	wood charcoal	3	0.0080
						unidentifiable	stem	1	0.0040
2007	G995	S	AR 16-15	S 1, E 1	10	unidentifiable	wood charcoal	1	0.0010
2013	G995	S	AR 16-15	S 1, W 1	10	unidentifiable	wood charcoal	1	0.0040
2037	G995	S	AR 16-15	S 4, W 1	10	*Cornus* sp.	wood charcoal	4	0.0280
						Zanthoxylum sp.	wood charcoal	1	0.0070
						Trophis sp.	wood charcoal	2	0.0100
						Escallonia sp.	wood charcoal	1	0.0040
						Drymaria cordata	seed	3	0.0040
						Terminalia sp.	fruit	3	0.0370
2040	G995	S	AR 16-15	S 4, W 2	10	unidentifiable	wood charcoal	3	0.0050
2043	G995	S	AR 16-15	S 4, W 3	10	unidentifiable	wood charcoal	1	0.0040
						Crotalaria sp.	seed	2	0.0010
2002X	G995	S	UN 54	S 2, E 3	10	*Hedyosmum* sp.	wood charcoal	1	0.0090
						Crescentia alata	wood charcoal	2	0.0080
						unidentifiable	wood charcoal	1	0.0040
						ARECACEAE	wood charcoal	1	0.0030
2003X	G995	S	UN 54	S 3, E 3	10	*Muntingia calabura*	wood charcoal	2	0.0160
						Casearia sp.	wood charcoal	1	0.0070
						unidentifiable	wood charcoal	1	0.0040
						unidentifiable	seed	1	0.0000
2004X	G995	S	UN 54	S 3, E 2	10	*Trophis* sp.	wood charcoal	2	0.0180
						MELIACEAE	wood charcoal	1	0.0110
						Palicourea sp.	wood charcoal	3	0.0090
						Wimmeria sp.	wood charcoal	1	0.0050
						Terminalia sp.	fruit	1	0.0050
2005X	G995	S	UN 54	S 2, E 2	10	*Cornus* sp.	wood charcoal	2	0.0080
						unidentifiable	wood charcoal	3	0.0120
2006X	G995	S	UN 54	S 1, E 2	10	unidentifiable	wood charcoal	3	0.0160
2007X	G995	S	UN 54	S 1, E 1	10	unidentifiable	wood charcoal	1	0.0080
2009X	G995	S	UN 54	S 3, E 1	9	unidentifiable	wood charcoal	1	0.0050
						Terminalia sp.	fruit	1	0.0180
2011X	G995	S	UN 54	S 2, E 0	10	*Hamelia* sp.	wood charcoal	2	0.0160
						Terminalia sp.	fruit	2	0.0150

2012X	G995	S	UN 54	S 3, E 0	10	unidentifiable	wood charcoal	3	0.0150
						Terminalia sp.	fruit	3	0.0170
						unidentifiable	seed/fruit	1	0.0030
2013X	G995	S	UN 54	S 1, W 1	10	*Cheiloclinium cognatum*	wood charcoal	1	0.0110
						Dendropanax sp.	wood charcoal	2	0.0120
						ARECACEAE	wood charcoal	1	0.0230
						MELIACEAE	wood charcoal	1	0.0040
						Zea mays	cupule	1	0.0040
						UNID seed A	seed	1	0.0000
2015X	G995	S	UN 54	S 3, W 1	10	cf. *Garcinia* sp.	wood charcoal	3	0.0100
						Nectandra/Ocotea	wood charcoal	5	0.0120
						MELIACEAE	wood charcoal	1	0.0030
2016X	G995	S	UN 54	S 1, W 2	10	unidentifiable	wood charcoal	1	0.0800
						unidentifiable	wood charcoal	5	0.0710
						unidentifiable	wood charcoal	2	0.0270
2017X	G995	S	UN 54	S 2, W 2	10	unidentifiable	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0150
						unidentifiable	testa	2	0.0090
2018X	G995	S	UN 54	S 3, W 2	9	*Hedyosmum* sp.	wood charcoal	12	0.2970
						Swietenia sp.	wood charcoal	4	0.1580
						LAURACEAE	wood charcoal	4	0.1740
2028X	G995	S	UN 54	S 4, E 2	10	*Sloanea* sp.	wood charcoal	5	0.2190
						Theobroma sp.	wood charcoal	1	0.0590
						Casearia sp.	wood charcoal	6	0.1050
						Cornus sp.	wood charcoal	4	0.0170
						Terminalia sp.	fruit	1	0.0010
2031X	G995	S	UN 54	S 4, E 1	10	*Cornus* sp.	wood charcoal	2	0.0330
						Trichilia sp.	wood charcoal	2	0.0350
2034X	G995	S	UN 54	S 4 E 0	10	*Cornus* sp.	wood charcoal	12	0.0730
						Jacaranda cf. *copaia*	wood charcoal	5	0.0260
						unidentifiable	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	3	0.0060
2037X	G995	S	UN 54	S 4, W 1	10	*Tabebuia* sp.	wood charcoal	5	0.2250
						ARECACEAE	wood charcoal	1	0.0700
						Jacaranda cf. *copaia*	wood charcoal	3	0.1080
						unidentifiable	wood charcoal	1	0.0050
						Hamelia sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0040
2040X	G995	S	UN 54	S 4, W 2	10	*Jacaranda* sp.	wood charcoal	2	0.0160
						Andira inermis	wood charcoal	2	0.0190

						unidentifiable	wood charcoal	1	0.0040
2082	G995	S	UN 60	S 1, E 3	10	*Acacia* sp.	wood charcoal	4	0.0860
						ARECACEAE	wood charcoal	1	0.0130
						Cornus sp.	wood charcoal	3	0.0100
						Sebastiania sp.	wood charcoal	1	0.0040
						Terminalia sp.	fruit	1	0.0130
2083	G995	S	UN 60	S 2, E 3	10	geophyte	geophyte	1	0.0350
						Ouratea sp.	wood charcoal	4	0.0270
						MALVACEAE	wood charcoal	2	0.0120
						unidentifiable	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	1	0.0080
						Faramea sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	2	0.0080
						Gaultheria sp.	wood charcoal	1	0.0040
2084	G995	S	UN 60	S 3, E 3	10	*Aspidosperma* sp.	wood charcoal	5	0.0220
						Coccoloba sp.	wood charcoal	1	0.0050
						Tabernaemontana sp.	wood charcoal	5	0.0130
2085	G995	S	UN 60	S 1, E 2	10	*Magnolia* sp.	wood charcoal	5	0.1310
						cf. *Cedrela* sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0030
						cf. *Zea mays*	cupule	1	0.0010
2086	G995	S	UN 60	S 2, E 2	10	*Zanthoxylum* sp.	wood charcoal	5	0.0480
						Herrania sp.	wood charcoal	4	0.0250
						Spondias sp.	wood charcoal	1	0.0150
						ARECACEAE	wood charcoal	2	0.0160
						Aspidosperma sp.	wood charcoal	2	0.0150
						ANACARDIACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0030
						Terminalia sp.	fruit	3	0.0050
						unidentifiable	testa	1	0.0010
						unidentifiable	testa	1	0.0010
2087	G995	S	UN 60	S 3, E 2	10	*Heliocarpus* sp.	wood charcoal	1	0.0500
						Ouratea sp.	wood charcoal	1	0.0550
						Magnolia sp.	wood charcoal	2	0.0150
						Garcinia sp.	wood charcoal	3	0.0220
						unidentifiable	wood charcoal	2	0.0090
						Zanthoxylum sp.	wood charcoal	1	0.0060
						geophyte	geophyte	1	0.0040
2088	G995	S	UN 60	S 1, E 1	10	*Nectandra/Ocotea*	wood charcoal	4	0.1170
						Coutarea/Exostema	wood charcoal	2	0.0420
						unidentifiable	wood charcoal	4	0.0370
						Psidium sp.	wood charcoal	3	0.0420

						Aspidosperma sp.	wood charcoal	1	0.0090
						Margaritaria nobilis	wood charcoal	1	0.0070
						unidentifiable	wood charcoal	2	0.0090
						Psychotria sp.	wood charcoal	1	0.0030
						Garcinia macrophylla	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0080
						unidentifiable	testa	1	0.0040
2089	G995	S	UN 60	S 2, E 1	10	*Sideroxylon* sp.	wood charcoal	4	0.1190
						Bunchosia sp.	wood charcoal	2	0.0410
						Zanthoxylum sp.	wood charcoal	1	0.0350
						Coutarea/Exostema	wood charcoal	1	0.0210
						Cupania sp.	wood charcoal	3	0.0150
						Psidium sp.	wood charcoal	1	0.0080
						Magnolia sp.	wood charcoal	2	0.0090
						Cedrela sp.	wood charcoal	1	0.0100
						ASTERACEAE	achene	7	0.0000
						POACEAE	seed	3	0.0000
						geophyte	geophyte	1	0.0040
2090	G995	S	UN 60	S 3, E 1	10	*Aspidosperma* sp.	wood charcoal	5	0.1370
						unidentifiable	wood charcoal	1	0.0420
						Coutarea/Exostema	wood charcoal	4	0.0460
						Zanthoxylum sp.	wood charcoal	3	0.0230
						Trichilia sp.	wood charcoal	1	0.0120
						Parkinsonia aculeata	wood charcoal	1	0.0090
						Margaritaria nobilis	wood charcoal	1	0.0160
						geophyte	geophyte	1	0.0760
2092	G995	S	UN 60	S 2, E 0	10	*Cornus* cf. *florida*	wood charcoal	8	0.2920
						MELIACEAE	wood charcoal	8	0.1090
						Tabernaemontana sp.	wood charcoal	15	0.1080
						Bixa cf. *orellana*	wood charcoal	5	0.0470
						Bunchosia sp.	wood charcoal	2	0.0300
						ARECACEAE	wood charcoal	3	0.0630
						Weinmannia sp.	wood charcoal	1	0.0630
						unidentifiable	wood charcoal	1	0.0140
						Casearia sp.	wood charcoal	3	0.0320
						Parkinsonia aculeata	wood charcoal	4	0.0400
						Theobroma sp.	wood charcoal	2	0.0150
						Bourreria sp.	wood charcoal	2	0.0220
						Simarouba amara	wood charcoal	2	0.0150
						Psychotria sp.	wood charcoal	1	0.0050
2093	G995	S	UN 60	S 3, E 0	10	*Dendropanax* sp.	wood charcoal	1	0.0230
						unidentifiable	wood charcoal	1	0.0040
2095	G995	S	UN 60	S 2, W 1	10	*Swietenia* sp.	wood charcoal	4	0.0940

						Casearia sp.	wood charcoal	3	0.0460
						unidentifiable	seed fragment	1	0.0060
2096	G995	S	UN 60	S 3, W 1	10	*Tabernaemontana* sp.	wood charcoal	10	0.2440
						Coutarea/Exostema	wood charcoal	6	0.0510
						Psidium sp.	wood charcoal	1	0.0100
						Andira inermis	wood charcoal	2	0.0160
						Miconia sp.	wood charcoal	2	0.0140
						unidentifiable	wood charcoal	1	0.0080
						unidentifiable	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0120
2097	G995	S	UN 60	S 1, W 2	10	*Cornus* sp.	wood charcoal	1	0.0360
						Swietenia sp.	wood charcoal	1	0.0160
						Carapa sp.	wood charcoal	1	0.0050
						Terminalia sp.	fruit	3	0.0250
						unidentifiable	seed fragment	1	0.0010
2098	G995	S	UN 60	S 2, W 2	10	*Carapa* sp.	wood charcoal	2	0.0460
						unidentifiable	wood charcoal	1	0.0120
						LAURACEAE	wood charcoal	2	0.0050
						Psychotria sp.	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0110
2099	G995	S	UN 60	S 3, W 2	10	*Terminalia* cf. *amazonia*	wood charcoal	4	0.0760
						Theobroma sp.	wood charcoal	1	0.0300
						Swietenia sp.	wood charcoal	2	0.0210
						unidentifiable	wood charcoal	1	0.0230
						Cassia sp.	wood charcoal	3	0.0220
						unidentifiable	wood charcoal	1	0.0060
						Clidemia sp.	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0050
						Terminalia sp.	fruit	1	0.0090
2100	G995	S	UN 60	S 4, E 2	10	*Ouratea* sp.	wood charcoal	3	0.0490
2103	G995	S	UN 60	S 4, E 1	10	*Swietenia* sp.	wood charcoal	2	0.0490
						FABACEAE	wood charcoal	1	0.0050
2109	G995	S	UN 60	S 4, W 1	10	*Aspidosperma* cf. *excelsum*	wood charcoal	1	0.1050
						Tabernaemontana sp.	wood charcoal	8	0.2100
						Hieronyma alchorneoides	wood charcoal	5	0.0260
						EUPHORBIACEAE	wood charcoal	1	0.0190
						Coutarea/Exostema	wood charcoal	4	0.0360
						unidentifiable	wood charcoal	1	0.0160
						Theobroma sp.	wood charcoal	1	0.0090
						Parmentiera sp.	wood charcoal	5	0.0370
						Cornus sp.	wood charcoal	2	0.0160
						Gliricidia sepium	wood charcoal	7	0.0270

						Bixa cf. *orellana*	wood charcoal	3	0.0170
						Palicourea sp.	wood charcoal	2	0.0080
						Capparis sp.	wood charcoal	1	0.0030
						ARECACEAE	wood charcoal	1	0.0030
						Terminalia sp.	fruit	1	0.0100
2112	G995	S	UN 60	S 4, W 2	10	*Tabernaemontana* sp.	wood charcoal	11	0.1450
						Copaifera sp.	wood charcoal	6	0.0500
						Coutarea/Exostema	wood charcoal	3	0.0270
						Dendropanax sp.	wood charcoal	5	0.0250
						unidentifiable	wood charcoal	1	0.0080
						ARECACEAE	wood charcoal	1	0.0090
A	G995	M	Upper 50s	S2E3		geophyte	geophyte	7	0.1090
B	G995	M	Upper 50s	S2W1		*Sebastiania* sp.	wood charcoal	4	0.0930
C	G995	M	Upper 50s	S3E0		*Hamelia* sp.	wood charcoal	31	0.2360
D	G995	M	Upper 50s	S2E0		*Palicourea* sp.	wood charcoal	1	0.0900
E	G995	M	Upper 50s	S2E0		geophyte	geophyte	3	0.1280
F	G995	M	Upper 50s	S3E1		unidentifiable	wood charcoal	7	0.1720
G	G995	M	Upper 50s	S4E1		*Clidemia* sp.	wood charcoal	1	0.0630
H	G995	M	Upper 50s	S1E3		geophyte	geophyte	1	0.0480
I	G995	M	Upper 50s	S1E2		*Clidemia* sp.	wood charcoal	1	0.0350
J	G995	M	Upper 50s	S1E2		unidentifiable	wood charcoal	1	0.0110
K	G995	M	Upper 50s	S1E3		unidentifiable	wood charcoal	3	0.0410
L	G995	M	Upper 50s	S3W1		geophyte	geophyte	1	0.0400
M	G995	M	UN 60	S3W1		unidentifiable	wood charcoal	1	0.0250
N	G995	M	UN 60	S2W1		MELASTOMATACEAE	wood charcoal	6	1.0910
O	G995	M	Upper 50s	S3W1		geophyte	geophyte	1	0.0560
P	G995	M	UN 60	S2W1		*Zanthoxylum* sp.	wood charcoal	1	0.0330
Q	G995	M	UN 60	S4W1		*Clidemia* sp.	wood charcoal	1	0.0680
R	G995	M	Upper 50s	S2E3		unidentifiable	wood charcoal	1	0.0030
S	G995	M	Upper 50s	S1E3		*Cornus* sp.	wood charcoal	1	0.0330
T	G995	M	Upper 50s	S1E2		unidentifiable	wood charcoal	1	0.0280
U	G995	M	UN 60	S1E3		unidentifiable	wood charcoal	1	0.0100
V	G995	M	UN 60	S4W1		*Casearia* sp.	wood charcoal	1	0.0780
W	G995	M	UN 60	S4E1		unidentifiable	wood charcoal	1	0.3440
X	G995	M	UN 60	S3E1		*Casearia* sp.	wood charcoal	2	0.4320
Y	G995	M	UN 60	S4W2		unidentifiable	wood charcoal	1	0.0480
Z	G995	M	UN 60	S2W2		*Clidemia* sp.	wood charcoal	2	0.1210
AA	G995	M	UN 60	S2E0		*Gaultheria* sp.	wood charcoal	3	0.1020

AB	G995	M	UN 60	S4E0	*Spondias* sp.	wood charcoal	1	0.1070
AC	G995	M	UN 60	S3E1	*Aspidosperma* sp.	wood charcoal	3	0.2070
AD	G995	M	UN 60	S1E0	*Brosimum* sp.	wood charcoal	1	0.0300
					Casearia sp.	wood charcoal	3	0.0680
AE	G995	M	UN 60	S4E2	FABCEAE	wood charcoal	2	0.0780
AF	G995	M	UN 60	S2W1	*Bourreria* sp.	wood charcoal	2	0.0870
AG	G995	M	UN 60	S4E0	*Cornus* sp.	wood charcoal	3	0.3330
AH	G995	M	UN 60	S2W1	*Casearia* sp.	wood charcoal	1	0.5640
AI	G995	M	UN 60	S2W1	*Cornus* sp.	wood charcoal	1	0.1190
AJ	G995	M	UN 60	S2E3	*Psidium* sp.	wood charcoal	8	0.2280
AK	G995	M	UN 60	S2W2	*Psidium* sp.	wood charcoal	1	0.1130
AL	G995	M	UN 60	S2W1	*Aspidosperma* sp.	wood charcoal	3	0.0740
AM	G995	M	UN 60	S3W2	*Simarouba amara*	wood charcoal	5	0.1930
AN	G995	M	UN 60	S2W1	*Persea* sp.	wood charcoal	1	0.0420
AO	G995	M	UN 60	S2W1	*Cornus* sp.	wood charcoal	2	0.0400
AP	G995	M	UN 60	S1E3	*Cornus* sp.	wood charcoal	3	0.0600
AQ	G995	M	UN 60	S4W2	*Casearia* sp.	wood charcoal	3	0.7890
AR	G995	M	UN 60	S2E1	*Zanthoxylum* sp.	wood charcoal	1	0.2050
AS	G995	M	UN 60	S1E3	*Zanthoxylum* sp.	wood charcoal	9	0.2300
AT	G995	M	UN 60	S1E2	*Aspidosperma* sp.	wood charcoal	8	0.8580
AU	G995	M	UN 60	S4W1	*Calycophyllum candidissimum*	wood charcoal	11	0.7220
AV	G995	M	UN 60	S2W1	*Bixa* cf. *orellana*	wood charcoal	1	0.2250
AW	G995	M	UN 60	S1W2	*Psidium* sp.	wood charcoal	1	0.0450
AX	G995	M	UN 60	S1W2	*Cornus* sp.	wood charcoal	1	0.0870
AY	G995	M	UN 60	S2E1	*Cornus* sp.	wood charcoal	1	0.1840
AZ	G995	M	UN 60	S2E1	unidentifiable	wood charcoal	1	0.0190
BA	G995	M	UN 60	S2E1	*Cornus* sp.	wood charcoal	11	0.1920
BB	G995	M	UN 60	S1W2	unidentifiable	wood charcoal	1	0.0400
BC	G995	M	UN 60	S2E2	*Andira inermis*	wood charcoal	1	0.0170
BD	G995	M	UN 60	S2E1	unidentifiable	wood charcoal	1	0.0300
BE	G995	M	UN 60	S2E1	unidentifiable	wood charcoal	1	0.0300
BF	G995	M	UN 60	S4E0	*Clidemia* sp.	wood charcoal	1	1.3200
BG	G995	M	UN 60	S2E0	unidentifiable	wood charcoal	4	0.1280
BH	G995	M	UN 60	S2E0	*Cornus* sp.	wood charcoal	3	0.0710
BI	G995	M	UN 60	S2E1	*Psidium* sp.	wood charcoal	1	0.5520
BJ	G995	M	UN 60	S1E0	*Clidemia* sp.	wood charcoal	1	0.1210
BK	G995	M	UN 60	S2E1	*Casearia* sp.	wood charcoal	1	0.5340
BL	G995	M	UN 60	S2E2	*Aspidosperma* sp.	wood charcoal	28	0.4830
BM	G995	M	UN 60	S1W1	*Cornus* sp.	wood charcoal	1	0.0110
BN	G995	M	UN 60	S2E1	*Jacaranda* sp.	wood charcoal	1	0.0530
BO	G995	M	UN 60	S1E1	*Simarouba amara*	wood charcoal	2	0.2860

BP	G995	M	UN 60	S2E2	*Simarouba amara*	wood charcoal	1	0.0220
BQ	G995	M	F2	S3E1	unidentifiable	wood charcoal	1	0.0300
BR	G995	M	UN 60	S3W2	cf. *Crescentia alata*	wood charcoal	4	0.5220
BS	G995	M	UN 60	S1W1	*Psidium* sp.	wood charcoal	2	0.0820
BT	G995	M	UN 60	S1E1	*Persea* sp.	wood charcoal	6	0.2180
BU	G995	M	UN 60	S2E0	*Casearia* sp.	wood charcoal	8	0.2450
BV	G995	M	UN 61	S2E2	*Naucleopsis* sp.	wood charcoal	5	0.4760
				F1	geophyte	geophyte	2	0.0860
BW	G995	M	UN 60	S2W1	*Astronium graveolens*	wood charcoal	1	0.4370
BX	G995	M	UN 60	S2E2	*Platymiscium* sp.	wood charcoal	5	0.2820
BY	G995	M	UN 60	S2W1	*Spondias* sp.	wood charcoal	1	0.1950
BZ	G995	M	UN 61	S2E2	*Trichilia* cf. *pleeana*	wood charcoal	1	0.2020
				F2	unidentifiable	wood charcoal	1	0.0720
CA	G995	M	F2	S2E2	*Casearia* sp.	wood charcoal	1	0.0590
CB	G995	M	F3	S4W2	*Theobroma* sp.	wood charcoal	8	0.1000
CC	G995	M	UN 60	S4W1	*Platymiscium* sp.	wood charcoal	2	0.0420
CD	G995	M	UN 60	S4W1	*Platymiscium* sp.	wood charcoal	3	0.1620
CF	G995	M	UN 60	S4W1	*Spondias* sp.	wood charcoal	2	0.1110
CG	G995	M	UN 60	S4W1	unidentifiable	wood charcoal	3	0.0710
CH	G995	M	UN 60	S2W2	unidentifiable	wood charcoal	4	0.0720
CI	G995	M	UN 60	S1.5E2	*Weinmannia* sp.	wood charcoal	1	0.1370
CJ	G995	M	UN 60	S1.1W0.5	*Bellucia* sp.	wood charcoal	1	0.1000
CK	G995	M	UN 60	S2E2	unidentifiable	wood charcoal	2	0.0410
	G995	M	UN 60	S2E2	*Persea* sp.	wood charcoal	1	0.0100
CL	G995	M	UN 61	S2E2 F2	*Calycophyllum candidissimum*	wood charcoal	1	0.2430
CM	G995	M	F2	S2E3	*Nectandra/Ocotea*	wood charcoal	1	0.1830
CN	G995	M	F2A	S2E2	FABACEAE	wood charcoal	1	0.1380
CO	G995	M	UN 61	S2E2 F2A	*Dendropanax* sp.	wood charcoal	1	0.1440
CP	G995	M	F2A	S2E3	*Cornus* sp.	wood charcoal	6	0.0390
CQ	G995	M	F2A	S2E2	FABACEAE	wood charcoal	1	0.0120
CR	G995	M	UN 61	S2E2 F2B	*Calycophyllum candidissimum*	wood charcoal	4	0.0330
CS	G995	M	F2B	S2E2	*Morella* sp.	wood charcoal	1	0.1520
CT	G995	M	F2B	S2E2	*Clidemia* sp.	wood charcoal	1	0.1740
CU	G995	M	UN 60	S0.8E2	unidentifiable	wood charcoal	1	0.0350
					unidentifiable	wood charcoal	5	0.1740
					Cornus sp.	wood charcoal	2	0.1170
CV	G995	M	UN 60	S0.5E1.75	unidentifiable	wood charcoal	2	0.1060
CW	G995	M	UN 60	S0.3E2	*Persea* sp.	wood charcoal	1	0.1020
CX	G995	M	UN 60	S0.5E2	no botanical remains present		0	0.0000

CY	G995	M	Arbol	S6W1	unidentifiable	wood charcoal		
D	G995	M	Upper 50s	S2E0	*Palicourea* sp.	wood charcoal	1	0.0900
E	G995	M	Upper 50s	S2E0	geophyte	geophyte	3	0.1280
F	G995	M	Upper 50s	S3E1	unidentifiable	wood charcoal	7	0.1720
G	G995	M	Upper 50s	S4E1	*Clidemia* sp.	wood charcoal	1	0.0630
H	G995	M	Upper 50s	S1E3	geophyte	geophyte	1	0.0480
I	G995	M	Upper 50s	S1E2	*Clidemia* sp.	wood charcoal	1	0.0350
J	G995	M	Upper 50s	S1E2	unidentifiable	wood charcoal	1	0.0110
K	G995	M	Upper 50s	S1E3	unidentifiable	wood charcoal	3	0.0410
L	G995	M	Upper 50s	S3W1	geophyte	geophyte	1	0.0400
M	G995	M	UN 60	S3W1	unidentifiable	wood charcoal	1	0.0250
N	G995	M	UN 60	S2W1	MELASTOMATACEAE	wood charcoal	6	1.0910
O	G995	M	Upper 50s	S3W1	geophyte	geophyte	1	0.0560
P	G995	M	UN 60	S2W1	*Zanthoxylum* sp.	wood charcoal	1	0.0330
Q	G995	M	UN 60	S4W1	*Clidemia* sp.	wood charcoal	1	0.0680
R	G995	M	Upper 50s	S2E3	unidentifiable	wood charcoal	1	0.0030
S	G995	M	Upper 50s	S1E3	*Cornus* sp.	wood charcoal	1	0.0330
T	G995	M	Upper 50s	S1E2	unidentifiable	wood charcoal	1	0.0280
U	G995	M	UN 60	S1E3	unidentifiable	wood charcoal	1	0.0100
V	G995	M	UN 60	S4W1	*Casearia* sp.	wood charcoal	1	0.0780
W	G995	M	UN 60	S4E1	unidentifiable	wood charcoal	1	0.3440
X	G995	M	UN 60	S3E1	*Casearia* sp.	wood charcoal	2	0.4320
Y	G995	M	UN 60	S4W2	unidentifiable	wood charcoal	1	0.0480
Z	G995	M	UN 60	S2W2	*Clidemia* sp.	wood charcoal	2	0.1210

Appendix E:
Botanical Data G164 Sitio Bolívar - Raw Counts and Weights
<u>Description of column headings:</u>

Sample #	Sample ID number associated with each sample
Site	Archaeological site associated with the sample: G164 Sitio Bolívar
Type	Processing method: flotation (F) / screening or manual (S)
Depth	Excavation level (as described in Chapter 6)
Context	Operation F (F) Suboperation (1, 2, 3, 4, 5) Quadrant of suboperation (Cd.) Distance from Datum in meters: north (N) / south (S) / east (E) / west (W) Contexts may include a post hole (PH)
Vol	Volume as measured prior to processing in liters
Taxon	The most specific taxonomic rank associated with each item
Plant Part	Type of plant part recovered archaeologically
Qt	Quantity/Count of carbonized botanical remains
Wt (g)	Weight of total botanical remains measured in grams

Sample	Site	Type	Depth	Context	Vol	Taxon	Plant Part	Qt	Wt (g)
1001	G164	F	4	F1 S 3.0, W 1.0	6.0	*Acmella* sp.	achene	14	0.0010
						Acrocomia aculeata	endocarp	1	0.0070
						Cecropia sp.	seed	2	0.0002
						Cornus cf. *florida*	wood charcoal	3	0.0390
						Nectandra/Ocotea	wood charcoal	1	0.0040
						Terminalia cf. *buceras*	wood charcoal	2	0.0170
						ARECACEAE	wood charcoal	16	0.0950
						unidentifiable	wood charcoal	24	0.0400
						unidentifiable	testa	1	0.0002
1002	G164	F	4	F1 S 2.0, W 1.0	6.0	*Acmella* sp.	achene	7	0.0004
						Cecropia sp.	seed	5	0.0050
						Crescentia cujete	wood charcoal	1	0.0040
						Ouratea sp.	wood charcoal	1	0.0410
						Piper cf. *aduncum*	seed	32	0.0020
						Terminalia cf. *buceras*	wood charcoal	1	0.1710
						UNID A	seed	6	0.0008
						ARECACEAE	wood charcoal	7	0.0410
						unidentifiable	wood charcoal	13	0.0220
						unidentifiable	wood charcoal	5	0.0120
1003	G164	F	5A	F1 S 3.0, W 1.0	6.5	*Acmella* sp.	achene	41	0.0005
						Cecropia sp.	seed	71	0.0250
						Mollugo verticillata	seed	1	0.0001
						Piper cf. *aduncum*	seed	60	0.0004
						Terminalia cf. *buceras*	wood charcoal	1	0.0040
						UNID C	seed	1	0.0010
						UNID D	seed	1	0.0001
						Zanthoxylum sp.	wood charcoal	1	0.0100
						Zea mays	cupule	1	0.0004
						ARECACEAE	wood charcoal	5	0.0580
						ASTERACEAE	achene	1	0.0001
						FABACEAE	wood charcoal	1	0.0300
						unidentifiable	wood charcoal	6	0.0360
						unidentifiable	wood charcoal	1	0.0190
						unidentifiable	wood charcoal	17	0.0340
1004	G164	F	5A	F1 S 2.0, W 1.0	6.0	*Acmella* sp.	achene	75	0.0009
						cf. Symphonia globulifera	wood charcoal	2	0.0160
						Eugenia sp.	wood charcoal	2	0.0570
						Piper cf. *aduncum*	seed	2	0.0001
						UNID A	seed	8	0.0005
						UNID C	seed	1	0.0010
						unidentifiable	geophyte	3	0.0040
						ASTERACEAE	achene	18	0.0001
						unidentifiable	wood charcoal	18	0.0410

						unidentifiable	wood charcoal	32	0.1630
1005	G164	F	5A	F1 PH 1	1.0	*Acmella* sp.	achene	10	0.0002
						Cecropia sp.	seed	2	0.0006
						cf. *Heliocarpus* sp.	wood charcoal	2	0.0140
						unidentifiable	wood charcoal	2	0.0050
1006	G164	F	5A	F1 PH 2	0.5	*Cecropia* sp.	seed	7	0.0007
						Piper cf. *aduncum*	seed	1	0.0001
						unidentifiable	wood charcoal	5	0.0004
1007	G164	F	5C	F1 S 0.5, W 0.7	5.0	*Acmella* sp.	achene	116	0.0013
						Acrocomia aculeata	endocarp	1	0.0070
						Cecropia sp.	seed	6	0.0002
						Nectandra/Ocotea	wood charcoal	1	0.0180
						Piper cf. *aduncum*	seed	32	0.0001
						Terminalia cf. *buceras*	wood charcoal	3	0.0320
						UNID A	seed	2	0.0001
						UNID B	seed	1	0.0002
						Zea mays	cupule	4	0.0004
						ASTERACEAE	achene	1	0.0001
						POACEAE	seed	2	0.0001
						unidentifiable	wood charcoal	5	0.0010
						unidentifiable	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	5	0.0150
						unidentifiable	stem	1	0.0001
1008	G164	F	5C	F1 PH 3	2.5	*Acmella* sp.	achene	20	0.0002
						Cecropia sp.	seed	1	0.0001
						ARECACEAE	wood charcoal	1	0.0070
1009	G164	F	3	F2 Cd. SO	6.0	*Acmella* sp.	achene	4	0.0001
						Acrocomia aculeata	endocarp	1	0.0040
						Casearia sp.	wood charcoal	1	0.0060
						Cecropia sp.	seed	2	0.0002
						Persea sp.	wood charcoal	1	0.0060
						Piper cf. *aduncum*	seed	2	0.0001
						Terminalia cf. *buceras*	wood charcoal	1	0.0270
						UNID A	seed	10	0.0001
						UNID C	seed	1	0.0120
						ARECACEAE	wood charcoal	1	0.0030
						ASTERACEAE	achene	5	0.0001
						unidentifiable	wood charcoal	11	0.0080
						unidentifiable	wood charcoal	3	0.0160
1010	G164	F	3	F2 Cd. NO	5.0	*Piper* cf. *aduncum*	seed	2	0.0001
						UNID A	seed	3	0.0001
						unidentifiable	geophyte	3	0.0090
						FABACEAE	wood charcoal	1	0.0030

1011	G164	F	3	F2 Cd. NE	5.0	UNID A	seed	3	0.0250
						ARECACEAE	wood charcoal	2	0.0100
						unidentifiable	wood charcoal	3	0.0240
						unidentifiable	seed	2	0.0259
1012	G164	F	3	F2 Cd. SE	6.0	cf. *Passiflora* sp.	seed	1	0.0030
						Piper cf. *aduncum*	seed	1	0.0001
						Siparuna sp.	wood charcoal	1	0.0330
						UNID A	seed	4	0.0003
						unidentifiable	geophyte	6	0.0950
						ASTERACEAE	achene	2	0.0001
1013	G164	F	3	F2 S 1.9, W 1.7	1.0	*Acmella* sp.	achene	2	0.0001
						unidentifiable	wood charcoal	1	0.0002
1014	G164	F	4	F2 Cd. SO	6.0	UNID A	seed	2	0.0001
						unidentifiable	wood charcoal	9	0.0040
1015	G164	F	4	F2 Cd. NO	6.0	*Acmella* sp.	achene	2	0.0001
						Capparis sp.	wood charcoal	4	0.0210
						Casearia sp.	wood charcoal	1	0.0180
						UNID A	seed	2	0.0002
						Zea mays	kernel	1	0.0120
						unidentifiable	wood charcoal	4	0.0388
1016	G164	F	4	F2 Cd. NE	6.5	*Acmella* sp.	achene	1	0.0001
						UNID A	seed	19	0.0005
						ARECACEAE	wood charcoal	2	0.0090
						unidentifiable	wood charcoal	3	0.0026
						unidentifiable	wood charcoal	7	0.0860
						unidentifiable	root	1	0.0007
1017	G164	F	4	F2 Cd. SE	5.0	*Acmella* sp.	achene	7	0.0002
						Acrocomia aculeata	endocarp	1	0.0010
						Jacaranda sp.	wood charcoal	2	0.0500
						Palicourea sp.	wood charcoal	1	0.0110
						Persea sp.	wood charcoal	3	0.0260
						Terminalia cf. *buceras*	wood charcoal	5	0.1400
						UNID A	seed	8	0.0004
						UNID C	seed	1	0.0020
						ARECACEAE	wood charcoal	1	0.0070
						ASTERACEAE	achene	3	0.0001
						unidentifiable	wood charcoal	5	0.0246
						unidentifiable	wood charcoal	9	0.0530
1018	G164	F	5A	F2 S 0, W 1.5	5.0	*Acmella* sp.	achene	15	0.0006
						Psidium sp.	wood charcoal	1	0.0070
						Sapindus saponaria	wood charcoal	2	0.0100
						UNID A	seed	3	0.0001

						ARECACEAE	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	5	0.0094
						unidentifiable	seed	2	0.0001
1019	G164	F	5A	F2 S 0.0, W 1.0	6.5	*Acmella* sp.	achene	19	0.0008
						Nectandra/Ocotea	wood charcoal	3	0.0470
						Terminalia cf. *buceras*	wood charcoal	8	0.0690
						UNID A	seed	9	0.0017
						Zea mays	cupule	1	0.0018
						ARECACEAE	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	6	0.4030
						unidentifiable	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	4	0.0010
1020	G164	F	5A	F2 S 0.0, W 0.5	2.0	*Acmella* sp.	achene	10	0.0004
						Nectandra/Ocotea	wood charcoal	1	0.0110
						Phaseolus sp.	cotyledon	1	0.0100
						Piper cf. *aduncum*	seed	1	0.0001
						Terminalia cf. *buceras*	wood charcoal	7	0.0625
						UNID A	seed	9	0.0011
						UNID C	seed	1	0.0013
						ARECACEAE	wood charcoal	8	0.0665
						unidentifiable	wood charcoal	7	0.0625
						unidentifiable	wood charcoal	6	0.0460
						unidentifiable	amorphous lump	1	0.0010
						unidentifiable	seed	2	0.0040
1021	G164	F	5A	F2 S 0.0, W 0.0	2.0	*Acmella* sp.	achene	4	0.0002
						Capparis sp.	wood charcoal	26	0.1970
						UNID A	seed	5	0.0005
						ARECACEAE	wood charcoal	4	0.0780
						unidentifiable	wood charcoal	4	0.0231
						unidentifiable	wood charcoal	9	0.0480
1022	G164	F	5A	F2 S 0.5, W 1.5	6.0	*Acmella* sp.	achene	11	0.0002
						Acrocomia aculeata	endocarp	1	0.0290
						Attalea sp.	wood charcoal	2	0.0320
						Sapindus saponaria	wood charcoal	3	0.0380
						Spondias sp.	wood charcoal	2	0.0690
						Terminalia cf. *buceras*	wood charcoal	2	0.0230
						UNID A	seed	3	0.0005
						unidentifiable	geophyte	1	0.0126
						Zea mays	cupule	1	0.0020
						ARECACEAE	wood charcoal	1	0.0110
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	5	0.0282
						unidentifiable	wood charcoal	2	0.0050
						unidentifiable	testa	1	0.0025

1023	G164	F	5A	F2 S 0.5, W 1.0	5.0	*Acmella* sp.	achene	8	0.0001
						Diphysa robinioides	wood charcoal	6	0.1000
						Hamelia sp.	wood charcoal	1	0.0030
						UNID A	seed	1	0.0002
						Zanthoxylum sp.	wood charcoal	1	0.0100
						ARECACEAE	wood charcoal	2	0.0080
						unidentifiable	wood charcoal	7	0.0266
						unidentifiable	wood charcoal	3	0.0260
1024	G164	F	5A	F2 S 0.5, W 0.5	2.0	*Acmella* sp.	achene	36	0.0005
						Acrocomia aculeata	endocarp	1	0.0130
						Phaseolus sp.	cotyledon	1	0.0120
						Piper cf. *aduncum*	seed	3	0.0001
						Terminalia cf. *buceras*	wood charcoal	7	0.1620
						UNID A	seed	2	0.0001
						Zea mays	kernel	2	0.0360
						Zea mays	kernel	1	0.0210
						ARECACEAE	wood charcoal	9	0.1070
						unidentifiable	wood charcoal	28	0.0690
						unidentifiable	wood charcoal	23	0.1500
1025	G164	F	5A	F2 S 0.5, W 0.0	2.0	*Acmella* sp.	achene	26	0.0003
						Acrocomia aculeata	endocarp	1	0.0080
						UNID A	seed	2	0.0002
						FABACEAE	wood charcoal	2	0.0110
						SAPOTACEAE	wood charcoal	1	0.0100
						unidentifiable	wood charcoal	6	0.0120
						unidentifiable	wood charcoal	11	0.0450
1026	G164	F	5A	F2 S 1.0, W 1.5	4.0	*Acmella* sp.	achene	9	0.0001
						Capparis sp.	wood charcoal	2	0.0350
						Jacaranda cf. *caucana*	wood charcoal	2	0.0080
						Terminalia cf. *buceras*	wood charcoal	2	0.0180
						unidentifiable	geophyte	3	0.0370
						ARECACEAE	wood charcoal	17	0.1060
						RUBIACEAE	wood charcoal	3	0.0480
						unidentifiable	wood charcoal	6	0.0250
						unidentifiable	wood charcoal	11	0.0300
1027	G164	F	5A	F2 S 1.0, W 1.0	5.0	*Acmella* sp.	achene	25	0.0003
						cf. *Palicourea* sp.	wood charcoal	2	0.0040
						Cornus sp.	wood charcoal	2	0.0080
						Diphysa robinioides	wood charcoal	2	0.0230
						Piper cf. *aduncum*	seed	2	0.0001
						Pouteria sp.	wood charcoal	1	0.0090
						Terminalia cf. *buceras*	wood charcoal	6	0.0670
						UNID A	seed	3	0.0002
						unidentifiable	geophyte	1	0.0130

						Zea mays	cupule	1	0.0070
						ARECACEAE	wood charcoal	4	0.0310
						unidentifiable	wood charcoal	15	0.0660
						unidentifiable	wood charcoal	2	0.0180
						unidentifiable	wood charcoal	14	0.0320
						unidentifiable	seed	1	0.0060
1028	G164	F	5A	F2 S 1.0, W 0.5	5.0	*Acmella* sp.	achene	38	0.0005
						Jacaranda sp.	wood charcoal	1	0.0100
						Terminalia cf. *buceras*	wood charcoal	1	0.0100
						UNID A	seed	9	0.0002
						ARECACEAE	wood charcoal	14	0.0710
						unidentifiable	wood charcoal	7	0.0500
						unidentifiable	wood charcoal	12	0.0490
						unidentifiable	seed	1	0.0110
1029	G164	F	5A	F2 S 1.0, W 0.0	6.0	*Acmella* sp.	achene	81	0.0009
						Nectandra/Ocotea	wood charcoal	2	0.0280
						Piper cf. *aduncum*	seed	1	0.0001
						Terminalia cf. *buceras*	wood charcoal	1	0.0020
						UNID A	seed	5	0.0002
						Zanthoxylum sp.	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0080
1030	G164	F	5A	F2 S 1.5, W 1.5	5.0	*Acmella* sp.	achene	42	0.0005
						Cornus sp.	wood charcoal	17	0.7010
						Faramea sp.	wood charcoal	3	0.0270
						Jacaranda sp.	wood charcoal	2	0.0110
						Manilkara sp.	wood charcoal	3	0.0560
						Piper cf. *aduncum*	seed	2	0.0001
						Terminalia cf. *buceras*	wood charcoal	2	0.0130
						Terminalia cf. oblonga	wood charcoal	1	0.0120
						UNID A	seed	2	0.0001
						ANACARDIACEAE	wood charcoal	1	0.0150
						unidentifiable	wood charcoal	4	0.0140
						unidentifiable	wood charcoal	1	0.0100
						unidentifiable	wood charcoal	27	0.0920
1031	G164	F	5A	F2 S 1.5, W 1.0	6.0	*Acmella* sp.	achene	55	0.0004
						Inga sp.	wood charcoal	1	0.0060
						Persea sp.	wood charcoal	6	0.0630
						Pouteria sp.	wood charcoal	1	0.0080
						UNID A	seed	4	0.0004
						UNID C	seed	1	0.0010
						unidentifiable	geophyte	1	0.0070
						Zea mays	cupule	2	0.0090
						unidentifiable	wood charcoal	5	0.0170
						unidentifiable	wood charcoal	8	0.0300

1032	G164	F	5A	F2 S 1.5, W 0.5	6.0	*Acmella* sp.	achene	30	0.0003
						cf. *Hedyosmum* sp.	wood charcoal	1	0.0030
						Cornus sp.	wood charcoal	1	0.0100
						Piper cf. *aduncum*	seed	2	0.0001
						Terminalia cf. *buceras*	wood charcoal	3	0.0270
						UNID A	seed	1	0.0001
						UNID C	seed	1	0.0020
						unidentifiable	wood charcoal	2	0.0080
						unidentifiable	wood charcoal	3	0.0160
1033	G164	F	5A	F2 S 1.5, W 0.0	4.5	*Acmella* sp.	achene	17	0.0002
						Persea sp.	wood charcoal	1	0.0090
						Terminalia cf. *buceras*	wood charcoal	4	0.0520
						unidentifiable	wood charcoal	3	0.0010
1034	G164	F	5A	F2 S 0.5, W 0.7	1.5	*Acmella* sp.	achene	3	0.0001
				PH 5		*Piper* cf. *aduncum*	seed	1	0.0001
						unidentifiable	wood charcoal	1	0.0052
1035	G164	F	5B	F2 S 0.0, W 1.5	5.0	*Acmella* sp.	achene	32	0.0008
						cf. *Amphipterygium* sp.	wood charcoal	1	0.0520
						cf. *Otoba* sp.	wood charcoal	2	0.0170
						Nectandra/Ocotea	wood charcoal	1	0.0220
						Piper cf. *aduncum*	seed	4	0.0001
						Pourouma sp.	wood charcoal	1	0.0140
						Terminalia cf. *buceras*	wood charcoal	3	0.0360
						Trema sp.	wood charcoal	1	0.0080
						UNID A	seed	11	0.0006
						UNID C	seed	3	0.0022
						Zanthoxylum sp.	wood charcoal	5	0.5360
						ANNONACEAE	wood charcoal	2	0.0780
						ASTERACEAE	achene	3	0.0001
						unidentifiable	wood charcoal	21	0.0363
						unidentifiable	wood charcoal	38	0.2300
1036	G164	F	5B	F2 S 0.0, W 1.0	5.0	*Acmella* sp.	achene	44	0.0013
						Campnosperma panamense	wood charcoal	1	0.0130
						Sapindus saponaria	wood charcoal	1	0.0210
						Terminalia cf. *buceras*	wood charcoal	8	0.2470
						UNID A	seed	25	0.0011
						UNID C	seed	1	0.0010
						unidentifiable	geophyte	1	0.0250
						Zea mays	cupule	1	0.0012
						Zea mays	kernel	4	0.0993
						ARECACEAE	wood charcoal	1	0.0130
						unidentifiable	wood charcoal	39	0.1281
						unidentifiable	wood charcoal	1	0.0570
						unidentifiable	wood charcoal	34	0.2490

1037 A	G164	F	5B	F2 S 0.0, W 0.5	2.0	*Acmella* sp.	achene	11	0.0002
						Acrocomia aculeata	endocarp	1	0.0140
						Acrocomia aculeata	endocarp	5	0.2330
						Coutarea/Exostema	wood charcoal	1	0.0030
						Jacaranda sp.	wood charcoal	1	0.0030
						Terminalia cf. *buceras*	wood charcoal	23	0.4960
						unidentifiable	geophyte	1	0.0210
						Zea mays	cupule	2	0.0050
						Zea mays	kernel	1	0.0022
						Zea mays	kernel	1	0.0020
						ARECACEAE	wood charcoal	1	0.0270
						unidentifiable	wood charcoal	3	0.0010
						unidentifiable	wood charcoal	2	0.0090
						unidentifiable	wood charcoal	15	0.0310
						unidentifiable	seed	2	0.0036
1037 B	G164	F	5B	F2 S 0.0, W 0.5	2.5	*Acmella* sp.	achene	8	0.0001
						UNID A	seed	5	0.0002
						FABACEAE	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	2	0.0034
						unidentifiable	wood charcoal	12	0.0340
						unidentifiable	seed	1	0.0003
1038	G164	F	5B	F2 S 0.0, W 0.0	5.0	*Acmella* sp.	achene	17	0.0002
						Piper cf. *aduncum*	seed	1	0.0001
						UNID A	seed	4	0.0001
						unidentifiable	wood charcoal	7	0.0420
1039	G164	F	5B	F2 S 0.5, W 1.5	5.0	*Acmella* sp.	achene	23	0.0008
						Astronium graveolens	wood charcoal	1	0.0110
						Cassia sp.	wood charcoal	1	0.0110
						Piper cf. *aduncum*	seed	7	0.0002
						Terminalia cf. *buceras*	wood charcoal	2	0.1190
						UNID A	seed	22	0.0010
						Vochysia sp.	wood charcoal	1	0.0090
						Zanthoxylum sp.	wood charcoal	2	0.0110
						Zea mays	cupule	1	0.0080
						ARECACEAE	wood charcoal	1	0.0050
						ASTERACEAE	achene	1	0.0001
						CUCURBITACEAE	rind	1	0.0260
						SALICACEAE	wood charcoal	1	0.0120
						unidentifiable	wood charcoal	4	0.0272
						unidentifiable	wood charcoal	1	0.1950
						unidentifiable	wood charcoal	15	0.0520
1040	G164	F	5B	F2 S 0.5, W 1.0	5.5	*Acmella* sp.	achene	44	0.0017
						Acrocomia aculeata	endocarp	2	0.0300
						Anacardium sp.	wood charcoal	1	0.0150

						Aspidosperma sp.	wood charcoal	3	0.0600
						Bactris sp.	wood charcoal	3	0.0600
						Casearia sp.	wood charcoal	2	0.0210
						Coutarea/Exostema	wood charcoal	6	0.3020
						Jacaranda sp.	wood charcoal	1	0.0090
						Lacistema aggregatum	wood charcoal	2	0.0570
						Phaseolus sp.	cotyledon	4	0.0592
						Sebastiania sp.	wood charcoal	1	0.0130
						Terminalia cf. *buceras*	wood charcoal	6	0.1410
						Tetragastris panamensis	wood charcoal	1	0.0750
						UNID A	seed	10	0.0007
						Zea mays	cupule	1	0.0160
						ARECACEAE	wood charcoal	7	0.0920
						unidentifiable	wood charcoal	36	0.1000
1041	G164	F	5B	F2 S 0.5, W 0.5	5.0	*Acmella* sp.	achene	9	0.0001
						Jacaranda sp.	wood charcoal	1	0.0070
						Psidium sp.	wood charcoal	4	0.1250
						Terminalia cf. *buceras*	wood charcoal	2	0.0730
						UNID A	seed	7	0.0005
						ARECACEAE	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	13	0.0660
1042	G164	F	5B	F2 S 0.5, W 0.0	5.0	*Acmella* sp.	achene	54	0.0006
						Terminalia cf. *buceras*	wood charcoal	4	0.0428
						UNID A	seed	2	0.0002
						unidentifiable	wood charcoal	16	0.0530
1043	G164	F	5B	F2 S 1.0, W 1.5	5.0	*Acmella* sp.	achene	13	0.0001
						Acrocomia aculeata	endocarp	1	0.1220
						Terminalia cf. *buceras*	wood charcoal	9	0.2920
						Trema sp.	wood charcoal	4	0.0590
						Zea mays	cupule	2	0.0028
						Zea mays	kernel	2	0.0073
						ARECACEAE	wood charcoal	1	0.0110
						unidentifiable	wood charcoal	15	0.0699
						unidentifiable	wood charcoal	11	0.0380
1044	G164	F	5B	F2 S 1.0, W 1.0	5.0	*Acmella* sp.	achene	29	0.0004
						Acrocomia aculeata	endocarp	2	0.0400
						Acrocomia aculeata	endocarp	3	0.0370
						Inga sp.	wood charcoal	1	0.0270
						Terminalia cf. *buceras*	wood charcoal	2	0.0350
						UNID A	seed	3	0.0002
						Zea mays	cupule	4	0.0016
						unidentifiable	wood charcoal	4	0.0112
						unidentifiable	wood charcoal	11	0.0530
1045	G164	F	5B	F2 S 1.0, W 0.5	5.5	*Acmella* sp.	achene	56	0.0010

						Acrocomia aculeata	endocarp	1	0.0030
						Terminalia cf. *buceras*	wood charcoal	4	0.0500
						UNID A	seed	8	0.0003
						Zea mays	cupule	3	0.0228
						Zea mays	kernel	1	0.0020
						ASTERACEAE	achene	6	0.0002
						unidentifiable	wood charcoal	11	0.0167
						unidentifiable	wood charcoal	1	0.0230
						unidentifiable	wood charcoal	1	0.0190
						unidentifiable	wood charcoal	3	0.0070
1046	G164	F	5B	F2 S 1.0, W 0.0	5.0	*Acmella* sp.	achene	78	0.0023
						ASTERACEAE	achene	4	0.0001
						unidentifiable	wood charcoal	4	0.0112
						unidentifiable	wood charcoal	12	0.0230
1047	G164	F	5B	F2 S 1.5, W 1.5	5.0	*Acmella* sp.	achene	17	0.0002
						Acrocomia aculeata	endocarp	2	0.0380
						Annona sp.	wood charcoal	1	0.0210
						Phaseolus sp.	cotyledon	1	0.0010
						Terminalia cf. *buceras*	wood charcoal	2	0.0470
						UNID A	seed	5	0.0002
						Zea mays	kernel	1	0.0042
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	8	0.0288
						unidentifiable	wood charcoal	7	0.0280
1048	G164	F	5B	F2 S 1.5, W 1.0	4.5	*Acmella* sp.	achene	41	0.0012
						Swietenia sp.	wood charcoal	1	0.0060
						Terminalia cf. *buceras*	wood charcoal	3	0.0700
						UNID A	seed	5	0.0006
						unidentifiable	geophyte	1	0.0140
						unidentifiable	geophyte	1	0.0230
						Zea mays	cupules	3	0.0045
						ASTERACEAE	achene	9	0.0004
						unidentifiable	wood charcoal	9	0.0945
						unidentifiable	wood charcoal	3	0.0020
1049	G164	F	5B	F2 S 1.5, W 0.5	6.0	*Acmella* sp.	achene	35	0.0012
						Acrocomia aculeata	endocarp	2	0.0420
						Terminalia cf. *buceras*	wood charcoal	11	0.4780
						UNID A	seed	3	0.0001
						ARECACEAE	wood charcoal	3	0.0080
						FABACEAE	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	15	0.0560
1050	G164	F	5B	F2 S 1.5, W 0.0	4.0	*Acmella* sp.	achene	28	0.0006
						UNID A	seed	3	0.0002
						ASTERACEAE	achene	1	0.0001

1051	G164	F	3/4	F4 S 3.0, W 2.0	5.0	*Acmella* sp.	achene	14	0.0002
						Chenopodium sp.	seed	1	0.0001
						Piper cf. *aduncum*	seed	2	0.0001
						Sapindus saponaria	wood charcoal	1	0.0140
						Terminalia cf. *buceras*	wood charcoal	1	0.0040
						Theobroma sp.	wood charcoal	1	0.0070
						UNID A	seed	3	0.0004
						UNID C	seed	2	0.0020
						ASTERACEAE	achene	4	0.0002
						unidentifiable	wood charcoal	11	0.0520
1052	G164	F	3/4	F4 S 2.0, W 2.0	6.0	*Acmella* sp.	achene	16	0.0003
						Casearia sp.	wood charcoal	2	0.0120
						cf. *Ardisia* sp.	wood charcoal	1	0.0110
						Handroanthus sp.	wood charcoal	3	0.0270
						Sapindus saponaria	wood charcoal	3	0.0460
						Terminalia cf. *buceras*	wood charcoal	1	0.0050
						UNID A	seed	4	0.0002
						UNID C	seed	1	0.0020
						ARECACEAE	wood charcoal	4	0.0370
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	4	0.0250
						unidentifiable	wood charcoal	25	0.1160
1053	G164	F	3/4	F5 S 1.0, W 2.0	6.0	*Acmella* sp.	achene	5	0.0001
						Anacardium occidentale	wood charcoal	2	0.0070
						cf. *Psidium* sp.	wood charcoal	1	0.0080
						Piper cf. *aduncum*	seed	2	0.0001
						Terminalia cf. *buceras*	wood charcoal	1	0.0060
						Theobroma sp.	wood charcoal	1	0.0070
						UNID A	seed	6	0.0004
						UNID C	seed	2	0.0010
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	4	0.0160
1054	G164	F	3/4	F5 S 0.0, W 2.0	6.0	*Acmella* sp.	achene	24	0.0003
						Terminalia cf. *buceras*	wood charcoal	5	0.0940
						UNID A	seed	6	0.0002
						unidentifiable	wood charcoal	3	0.0010
						unidentifiable	wood charcoal	10	0.0610
1055	G164	F	3	F3 S 3.0, W 0.0	6.5	ARECACEAE	wood charcoal	3	0.0130
						ASTERACEAE	achene	2	0.0001
1056	G164	F	3	F3 S 2.0, W 0.0	7.0	UNID A	seed	2	0.0002
						Zea mays	kernel	1	0.0040
						ASTERACEAE	achene	7	0.0001
						unidentifiable	wood charcoal	3	0.0060

1057 A	G164	F	4A	F3 Cd. S	6.0	*Acmella* sp.	achene	1	0.0001
						Terminalia cf. *buceras*	wood charcoal	2	0.0450
						UNID A	seed	3	0.0002
						UNID C	seed	2	0.0020
						ARECACEAE	wood charcoal	3	0.0120
						unidentifiable	wood charcoal	2	0.0110
1057 B	G164	F	4B	F3 S 3.0, W 0.0	6.5	*Acmella* sp.	achene	16	0.0002
						UNID A	seed	1	0.0001
						UNID E	seed	3	0.0002
						ANACARDIACEAE	wood charcoal	1	0.0110
						ARECACEAE	wood charcoal	1	0.0020
						unidentifiable	wood charcoal	6	0.0300
						unidentifiable	seed	1	0.0001
1058 A	G164	F	4A	F3 Cd. N	7.0	*Terminalia* cf. *buceras*	wood charcoal	3	0.0100
						UNID A	seed	7	0.0009
						ARECACEAE	wood charcoal	3	0.0100
						ASTERACEAE	achene	3	0.0001
						unidentifiable	wood charcoal	1	0.0009
						unidentifiable	wood charcoal	3	0.0100
						unidentifiable	seed	1	0.0000
1058 B1	G164	F	4B	F3 S 2.0, W 0.0	3.0	*Acacia* sp.	wood charcoal	14	0.4140
						Acmella sp.	achene	10	0.0001
						Astronium graveolens	wood charcoal	1	0.0080
						cf. *Poulsenia armata*	wood charcoal	1	0.0030
						Inga sp.	wood charcoal	2	0.0610
						Terminalia cf. *buceras*	wood charcoal	2	0.0300
						UNID A	seed	3	0.0002
						UNID seed	seed	1	0.0030
						Zea mays	kernel	1	0.0240
						ARECACEAE	wood charcoal	2	0.0080
						unidentifiable	wood charcoal	10	0.0550
1058 B2	G164	F	4B	F3 S 2.0, W 0.0	3.0	*Acmella* sp.	achene	2	0.0001
						UNID A	seed	1	0.0002
						unidentifiable	wood charcoal	6	0.0200
1059	G164	F	5A	F5 S 0.0, W 2.5	6.0	*Acmella* sp.	achene	11	0.0001
						cf. Zea mays	kernel	1	0.0072
						Zanthoxylum sp.	wood charcoal	1	0.0050
						Zea mays	cupule	2	0.0030
						unidentifiable	wood charcoal	2	0.0054
						unidentifiable	wood charcoal	17	0.0490
1060	G164	F	5A	F5 S 0.0, W 2.0	5.5	*Acmella* sp.	achene	29	0.0012
						Acrocomia aculeata	endocarp	2	0.0280
						Capparis sp.	wood charcoal	2	0.0710

						Faramea sp.	wood charcoal	1	0.0030
						geophyte	geophyte	2	0.0530
						Hedyosmum sp.	wood charcoal	1	0.0170
						Jacaranda sp.	wood charcoal	4	0.0400
						Sapindus saponaria	wood charcoal	6	0.2450
						Terminalia cf. *buceras*	wood charcoal	3	0.0200
						UNID A	seed	7	0.0007
						UNID C	seed	3	0.0010
						Zea mays	kernel	1	0.0014
						unidentifiable	wood charcoal	2	0.0070
						unidentifiable	wood charcoal	6	0.0260
1061	G164	F	5A	F5 S 0.5, W 2.5	6.0	*Acmella* sp.	achene	12	0.0004
						Capparis sp.	wood charcoal	2	0.0720
						Jacaranda sp.	wood charcoal	1	0.0080
						Pouteria sp.	wood charcoal	1	0.0070
						Trema sp.	wood charcoal	1	0.0060
						UNID A	seed	6	0.0001
						UNID C	seed	1	0.0010
						Wimmeria sp.	wood charcoal	1	0.0060
						ARECACEAE	wood charcoal	2	0.0430
						CUCURBITACEAE	rind	1	0.1416
						unidentifiable	wood charcoal	2	0.0134
						unidentifiable	wood charcoal	7	0.0480
1062	G164	F	5A	F5 S 0.5, W 2.0	5.5	*Acmella* sp.	achene	18	0.0003
						Casearia sp.	wood charcoal	1	0.025
						Jacaranda sp.	wood charcoal	1	0.0080
						Terminalia cf. *buceras*	wood charcoal	3	0.0230
						UNID A	seed	4	0.0001
						Zea mays	cupule	1	0.0100
						ASTERACEAE	achene	2	0.0001
						unidentifiable	wood charcoal	13	0.0970
						unidentifiable	wood charcoal	1	0.0180
						unidentifiable	plant material	1	0.0015
1063	G164	F	5A	F5 S 1.0, W 2.5	6.0	*Acmella* sp.	achene	14	0.0004
						Acrocomia aculeata	endocarp	1	0.0110
						Cinnamomum sp.	wood charcoal	1	0.0340
						Garcinia sp.	wood charcoal	1	0.0560
						Jacaranda sp.	wood charcoal	4	0.0900
						Nectandra/Ocotea	wood charcoal	1	0.0090
						Sapindus saponaria	wood charcoal	2	0.0160
						Terminalia cf. *buceras*	wood charcoal	1	0.0200
						UNID A	seed	6	0.0007
						UNID C	seed	1	0.0027
						ARECACEAE	wood charcoal	3	0.0580
						ASTERACEAE	achene	2	0.0001
						unidentifiable	wood charcoal	6	0.0140

						unidentifiable	wood charcoal	1	0.0310
						unidentifiable	wood charcoal	18	0.0560
						unidentifiable	plant material	2	0.0460
1064	G164	F	5A	F5 S 1.0, W 2.0	5.0	*Acmella* sp.	achene	6	0.0001
						Acrocomia aculeata	endocarp	4	0.0362
						Jacaranda sp.	wood charcoal	3	0.0530
						Nectandra/Ocotea	wood charcoal	1	0.0330
						Simarouba amara	wood charcoal	2	0.0280
						Swietenia sp.	wood charcoal	1	0.0490
						Tabebuia sp.	wood charcoal	1	0.0420
						Terminalia cf. *buceras*	wood charcoal	2	0.0640
						UNID A	seed	6	0.0010
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	1	0.0190
						unidentifiable	wood charcoal	7	0.0560
						unidentifiable	nutshell	1	0.0059
1065	G164	F	5A	F5 S 1.5, W 2.5	5.5	*Acmella* sp.	achene	8	0.0003
						Genipa americana	wood charcoal	1	0.0520
						Hedyosmum sp.	wood charcoal	2	0.0330
						Jacaranda sp.	wood charcoal	2	0.1120
						Pouteria sp.	wood charcoal	1	0.0100
						Theobroma sp.	wood charcoal	1	0.0180
						UNID A	seed	3	0.0021
						UNID C	seed	1	0.0020
						UNID C	seed	1	0.0040
						Zea mays	kernel	1	0.0039
						ASTERACEAE	achene	2	0.0001
						FABACEAE	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	4	0.0120
						unidentifiable	wood charcoal	42	0.0990
1066	G164	F	5A	F5 S 1.5, W 2.0	5.0	*Acmella* sp.	achene	22	0.0005
						Acrocomia aculeata	endocarp	1	0.0150
						cf. *Schefflera* sp.	wood charcoal	1	0.0140
						UNID A	seed	7	0.0005
						ARECACEAE	wood charcoal	1	0.0100
						FABACEAE	wood charcoal	1	0.0070
						unidentifiable	wood charcoal	17	0.0410
						unidentifiable	plant material	2	0.0160
						unidentifiable	seed	3	0.0283
1067	G164	F	5A	F4 S 2.0, W 2.5	5.5	*Acmella* sp.	achene	6	0.0001
						Sapindus saponaria	wood charcoal	6	0.0770
						Terminalia cf. *buceras*	wood charcoal	2	0.0420
						UNID A	seed	5	0.0001
						Zea mays	cupule	2	0.0035
						ARECACEAE	wood charcoal	1	0.0090

						unidentifiable	wood charcoal	3	0.0140
1068	G164	F	5A	F4 S 2.0, W 2.0	6.0	*Acmella* sp.	achene	15	0.0004
						Acrocomia aculeata	endocarp	1	0.0200
						Aspidosperma sp.	wood charcoal	3	0.0170
						Diphysa robinioides	wood charcoal	2	0.0310
						Terminalia cf. *buceras*	wood charcoal	2	0.0210
						UNID A	seed	4	0.0005
						UNID C	seed	2	0.0020
						ARECACEAE	wood charcoal	2	0.0280
						ASTERACEAE	achene	4	0.0001
						unidentifiable	wood charcoal	3	0.0226
						unidentifiable	wood charcoal	1	0.0140
						unidentifiable	wood charcoal	17	0.0610
						unidentifiable	seed	1	0.0145
1069	G164	F	5A	F4 S 2.5, W 2.5	6.5	*Acmella* sp.	achene	89	0.0014
						Hedyosmum sp.	wood charcoal	2	0.0120
						Manilkara sp.	wood charcoal	1	0.0030
						Sapindus saponaria	wood charcoal	1	0.0100
						Swietenia sp.	wood charcoal	2	0.0070
						Terminalia cf. *buceras*	wood charcoal	5	0.0520
						Tetragastris panamensis	wood charcoal	1	0.0190
						UNID A	seed	16	0.0048
						UNID C	seed	3	0.0061
						unidentifiable	geophyte	2	0.0190
						Zea mays	kernel	5	0.0266
						ARECACEAE	wood charcoal	5	0.0120
						FABACEAE	wood charcoal	3	0.0070
						unidentifiable	wood charcoal	14	0.1339
						unidentifiable	wood charcoal	2	0.0180
						unidentifiable	wood charcoal	14	0.0570
1070	G164	F	5A	F4 S 2.5, W 2.0	6.0	*Acmella* sp.	achene	8	0.0002
						Sapindus saponaria	wood charcoal	1	0.0050
						UNID A	seed	4	0.0002
						Zea mays	kernel	1	0.0283
						ARECACEAE	wood charcoal	1	0.0030
						BURSERACEAE	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	4	0.0122
						unidentifiable	wood charcoal	14	0.0540
1071	G164	F	5A	F4 S 3.0, W 2.5	6.0	*Acmella* sp.	achene	37	0.0005
						Acrocomia aculeata	endocarp	2	0.0472
						Meliosma sp.	wood charcoal	2	0.0410
						Palicourea sp.	wood charcoal	1	0.0170
						UNID A	seed	7	0.0002
						unidentifiable	geophyte	3	0.0259

						unidentifiable	geophyte	1	0.0120
						ASTERACEAE	achene	2	0.0001
						unidentifiable	wood charcoal	4	0.0168
						unidentifiable	wood charcoal	10	0.0310
1072	G164	F	5A	F4 S 3.0, W 2.0	6.0	*Acmella* sp.	achene	13	0.0003
						Faramea sp.	wood charcoal	1	0.0270
						Terminalia cf. *buceras*	wood charcoal	1	0.0090
						UNID A	seed	1	0.0001
						UNID C	seed	1	0.0028
						ARECACEAE	wood charcoal	1	0.0050
						ASTERACEAE	achene	2	0.0002
						unidentifiable	wood charcoal	8	0.0380
						unidentifiable	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	45	0.1900
1073	G164	F	5A	F4 S 3.5, W 2.5	6.0	*Acmella* sp.	achene	37	0.0005
						cf. *Fimbristylis* sp.	seed	1	0.0001
						Coccoloba sp.	wood charcoal	1	0.0070
						Nectandra/Ocotea	wood charcoal	1	0.0050
						Sideroxylon sp.	wood charcoal	2	0.0390
						UNID A	seed	4	0.0002
						Zea mays	cupule	1	0.0090
						ARECACEAE	wood charcoal	1	0.0030
						ASTERACEAE	achene	6	0.0017
						unidentifiable	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	25	0.1670
1074	G164	F	5A	F4 S 3.5, W 2.0	5.5	*Acmella* sp.	achene	65	0.0009
						Astronium graveolens	wood charcoal	1	0.0300
						Terminalia cf. *buceras*	wood charcoal	4	0.0690
						UNID A	seed	3	0.0003
						UNID C	seed	2	0.0019
						ARECACEAE	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	13	0.0130
1075	G164	F	5A	F3 S 2.0, W 0.5	5.5	*Acmella* sp.	achene	9	0.0002
						Acrocomia aculeata	endocarp	1	0.0230
						Faramea sp.	wood charcoal	1	0.0374
						UNID A	seed	3	0.0001
						UNID C	seed	2	0.0006
						ASTERACEAE	achene	3	0.0002
						unidentifiable	wood charcoal	11	0.0550
1076	G164	F	5A	F3 S 2.0, W 0.0	5.5	*Acmella* sp.	achene	21	0.0003
						cf. *Swartzia* sp.	wood charcoal	1	0.0070
						Terminalia cf. *buceras*	wood charcoal	5	0.0900
						Zea mays	cupule	1	0.0024
						ARECACEAE	wood charcoal	3	0.0220

						ASTERACEAE	achene	2	0.0001
						unidentifiable	wood charcoal	6	0.0047
						unidentifiable	wood charcoal	6	0.0260
1077	G164	F	5A	F3 S 2.5, W 0.5	6.0	*Acmella* sp.	achene	13	0.0001
						Acrocomia aculeata	endocarp	4	0.0487
						Pouteria sp.	wood charcoal	1	0.0210
						UNID A	seed	2	0.0001
						UNID C	seed	1	0.0020
						Zea mays	cupule	1	0.0040
						ARECACEAE	wood charcoal	3	0.0560
						SIMAROUBACEAE	wood charcoal	1	0.0260
						unidentifiable	wood charcoal	7	0.0300
						unidentifiable	plant material	3	0.0042
1078	G164	F	5A	F3 S 2.5, W 0.0	5.5	*Acmella* sp.	achene	24	0.0004
						UNID A	seed	3	0.0002
						Zea mays	cupule	2	0.0032
						Zea mays	cupule	2	0.0050
						Zea mays	kernel	1	0.0148
						LAURACEAE	wood charcoal	1	0.0110
						FABACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	6	0.0213
						unidentifiable	wood charcoal	1	0.0410
						unidentifiable	wood charcoal	2	0.0170
						unidentifiable	wood charcoal	13	0.0940
1079	G164	F	5A	F3 S 3.0, W 0.5	6.0	*Acmella* sp.	achene	13	0.0002
						UNID A	seed	6	0.0002
						UNID C	seed	1	0.0010
						UNID C	seed	1	0.0001
						unidentifiable	geophyte	1	0.0203
						unidentifiable	wood charcoal	8	0.0300
1080	G164	F	5A	F3 S 3.0, W 0.0	6.0	*Acmella* sp.	achene	20	0.0003
						cf. *Mosquitoxylum jamaicense*	wood charcoal	1	0.0080
						Faramea sp.	wood charcoal	3	0.0120
						Heliocarpus sp.	wood charcoal	1	0.0060
						Nectandra/Ocotea	wood charcoal	2	0.0610
						Portulaca cf. *oleracea*	seed	1	0.0001
						Terminalia cf. *buceras*	wood charcoal	4	0.0560
						UNID A	seed	3	0.0003
						UNID F	seed	2	0.0003
						unidentifiable	geophyte	1	0.0080
						ARECACEAE	wood charcoal	5	0.0430
						unidentifiable	wood charcoal	5	0.0170
						unidentifiable	wood charcoal	10	0.0290
						unidentifiable	wood charcoal	1	0.0100

1081	G164	F	5A	F3 S 3.5, W 0.5	7.0	*Acmella* sp.	achene	31	0.0004
						Acrocomia aculeata	endocarp	1	0.0130
						Bixa cf. *orellana*	wood charcoal	1	0.0050
						Faramea sp.	wood charcoal	1	0.0060
						Terminalia sp.	wood charcoal	2	0.0410
						Trema sp.	wood charcoal	3	0.0190
						UNID A	seed	1	0.0001
						ASTERACEAE	achene	3	0.0001
1082	G164	F	5A	F3 S 3.5, W 0.0	6.0	*Acmella* sp.	achene	34	0.0004
						Astronium graveolens	wood charcoal	1	0.0320
						cf. *Garcinia* sp.	wood charcoal	3	0.0880
						Hymenaea sp.	wood charcoal	1	0.0100
						Phaseolus sp.	cotyledon	1	0.0060
						UNID A	seed	3	0.0004
						ARECACEAE	wood charcoal	3	0.1200
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	1	0.0230
						unidentifiable	wood charcoal	3	0.0050
1083	G164	F	5B	F3 S 0.0, W 2.5	5.0	*Acmella* sp.	achene	9	0.0001
						Acrocomia aculeata	endocarp	1	0.1100
						Casearia sp.	wood charcoal	2	0.0310
						cf. *Buddleja* sp.	wood charcoal	2	0.0180
						Pouteria sp.	wood charcoal	1	0.0030
						Sapindus saponaria	wood charcoal	1	0.0160
						Terminalia cf. *buceras*	wood charcoal	1	0.0070
						UNID C	seed	1	0.0040
						UNID C	seed	1	0.0020
						unidentifiable	geophyte	1	0.0720
						ARECACEAE	wood charcoal	3	0.0680
						unidentifiable	wood charcoal	4	0.0360
						unidentifiable	wood charcoal	1	0.0250
						unidentifiable	wood charcoal	15	0.0490
1084	G164	F	5B	F5 S 0.0, W 2.0	5.0	*Acmella* sp.	achene	31	0.0003
						Ardisia sp.	wood charcoal	2	0.0180
						Jacaranda cf. *caucana*	wood charcoal	2	0.0190
						Jacaranda sp.	wood charcoal	3	0.1010
						Terminalia cf. *buceras*	wood charcoal	8	0.1050
						UNID C	seed	1	0.0010
						UNID G	seed	1	0.0140
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	2	0.0230
						unidentifiable	wood charcoal	7	0.0010
1085	G164	F	5B	F5 S 0.5, W 2.5	5.0	*Acmella* sp.	achene	49	0.0006
						Acrocomia aculeata	endocarp	1	0.0010

						Bourreria sp.	wood charcoal	1	0.0220
						Persea sp.	wood charcoal	1	0.0190
						Sebastiania sp.	wood charcoal	1	0.0060
						Terminalia cf. *buceras*	wood charcoal	5	0.0680
						UNID A	seed	2	0.0002
						ARECACEAE	wood charcoal	1	0.0090
						FABACEAE	cotyledon	1	0.0113
						FABACEAE	wood charcoal	1	0.0030
						SALICACEAE	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	7	0.0970
						unidentifiable	wood charcoal	9	0.0430
1086	G164	F	5B	F5 S 0.5, W 2.0	5.0	*Acmella* sp.	achene	43	0.0006
						Acrocomia aculeata	endocarp	1	0.0150
						Parkinsonia aculeata	wood charcoal	1	0.0040
						Portulaca cf. *oleracea*	seed	1	0.0001
						Terminalia cf. *buceras*	wood charcoal	2	0.0160
						UNID A	seed	5	0.0006
						FABACEAE	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	3	0.0080
						unidentifiable	wood charcoal	9	0.0250
1087	G164	F	5B	F5 S 1.0, W 2.5	4.0	*Acmella* sp.	achene	55	0.0007
						cf. *Trophis* sp.	wood charcoal	1	0.0130
						Terminalia cf. *buceras*	wood charcoal	1	0.0650
						UNID A	seed	3	0.0002
						UNID C	seed	2	0.0020
						unidentifiable	plant tissue	1	0.0060
						Vochysia sp.	wood charcoal	1	0.0020
						Zanthoxylum sp.	wood charcoal	1	0.0180
						unidentifiable	wood charcoal	1	0.0070
						unidentifiable	wood charcoal	3	0.0190
1088	G164	F	5B	F5 S 1.0, W 2.0	5.0	*Acmella* sp.	achene	79	0.0011
						Beilschmiedia sp.	wood charcoal	2	0.0380
						Casearia sp.	wood charcoal	3	0.0520
						cf. Zea mays	kernel	1	0.0320
						Pouteria sp.	wood charcoal	9	0.1500
						Simaba cf. *cedron*	wood charcoal	1	0.0320
						Terminalia cf. *buceras*	wood charcoal	3	0.0660
						UNID A	seed	2	0.0002
						ASTERACEAE	achene	1	0.0001
						unidentifiable	wood charcoal	4	0.0510
						unidentifiable	wood charcoal	1	0.0170
						unidentifiable	wood charcoal	2	0.0460
1089	G164	F	5B	F5 S 1.5, W 2.5	4.5	*Acmella* sp.	achene	20	0.0002
						Acrocomia aculeata	endocarp	2	0.0200
						Jacaranda sp.	wood charcoal	1	0.0110

						Terminalia cf. *buceras*	wood charcoal	3	0.0290
						UNID A	seed	6	0.0007
						UNID C	seed	1	0.0020
						UNID C	seed	1	0.0030
						ARECACEAE	wood charcoal	4	0.0480
						unidentifiable	wood charcoal	16	0.0490
1090	G164	F	5B	F5 S 1.5, W 2.0	5.0	*Acmella* sp.	achene	6	0.0002
						Acrocomia aculeata	endocarp	1	0.0760
						Piper cf. *aduncum*	seed	14	0.0005
						UNID A	seed	4	0.0003
						Zanthoxylum sp.	wood charcoal	2	0.0190
						Zea mays	kernel	2	0.0462
						ARECACEAE	wood charcoal	25	0.1990
						unidentifiable	wood charcoal	21	0.0730
						unidentifiable	seed	1	0.0090
						unidentifiable	bone	1	0.0144
1091	G164	F	5B	F5 S 2.0, W 2.5	5.5	*Acmella* sp.	achene	3	0.0001
						Acrocomia aculeata	endocarp	3	0.1020
						Cecropia cf. obtusifolia	wood charcoal	21	0.0810
						Peltogyne sp.	wood charcoal	3	0.0320
						Piper cf. *aduncum*	seed	1	0.0001
						UNID A	seed	7	0.0002
						unidentifiable	geophyte	2	0.0050
						unidentifiable	geophyte	1	0.0510
						ARECACEAE	wood charcoal	12	0.0860
						unidentifiable	wood charcoal	9	0.1041
						unidentifiable	wood charcoal	29	0.0900
						unidentifiable	nutshell	1	0.0637
						unidentifiable	seed	1	0.0002
1092	G164	F	5B	F5 S 2.0, W 2.0	5.5	*Acmella* sp.	achene	12	0.0012
						Piper cf. *aduncum*	seed	1	0.0001
						Terminalia cf. *buceras*	wood charcoal	9	0.1450
						Trema sp.	wood charcoal	4	0.0360
						UNID A	seed	3	0.0001
						UNID C	seed	1	0.0015
						Zanthoxylum sp.	wood charcoal	1	0.0410
						Zea mays	kernel	2	0.0269
						ANACARDIACEAE	wood charcoal	1	0.0080
						ARECACEAE	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	14	0.0600
						unidentifiable	wood charcoal	1	0.0020
1093	G164	F	5B	F4 S 2.5, W 2.5	5.5	*Acmella* sp.	achene	37	0.0006
						Acrocomia aculeata	endocarp	1	0.0340
						Garcinia sp.	wood charcoal	1	0.0270
						Piper cf. *aduncum*	seed	16	0.0005

						Terminalia cf. *buceras*	wood charcoal	2	0.0920
						UNID A	seed	4	0.0006
						UNID C	seed	2	0.0067
						Zea mays	cupule	2	0.0042
						Zea mays	kernel	5	0.0388
						Zea mays	kernel	4	0.0100
						FABACEAE	wood charcoal	2	0.0100
						URTICACEAE	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	4	0.0070
1094	G164	F	5B	F4 S 2.5, W 2.0	6.0	*Acmella* sp.	achene	15	0.0003
						Astronium graveolens	wood charcoal	1	0.0420
						Bixa cf. *orellana*	wood charcoal	1	0.0070
						Cornus sp.	wood charcoal	1	0.1100
						Piper cf. *aduncum*	seed	2	0.0001
						Sapindus saponaria	wood charcoal	1	0.0070
						UNID A	seed	2	0.0004
						UNID C	seed	1	0.0030
						ARECACEAE	wood charcoal	4	0.0250
						unidentifiable	wood charcoal	4	0.0200
						unidentifiable	wood charcoal	8	0.0480
1095	G164	F	5B	F4 S 3.0, W 2.5	5.0	*Acmella* sp.	achene	28	0.0006
						Cecropia sp.	seed	1	0.0003
						Piper cf. *aduncum*	seed	4	0.0003
						UNID A	seed	2	0.0010
						UNID C	seed	2	0.0030
						Zea mays	cupule	1	0.0010
						unidentifiable	wood charcoal	2	0.0230
						unidentifiable	wood charcoal	1	0.0850
						unidentifiable	wood charcoal	1	0.0250
						unidentifiable	wood charcoal	1	0.0200
						unidentifiable	wood charcoal	5	0.0180
						unidentifiable	wood charcoal	1	0.0050
1096	G164	F	5B	F4 S 3.0, W 2.0	4.5	*Acmella* sp.	achene	16	0.0006
						Jacaranda sp.	wood charcoal	2	0.0150
						UNID A	seed	3	0.0003
						ARECACEAE	wood charcoal	1	0.0040
						ASTERACEAE	achene	1	0.0001
						MELIACEAE	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	5	0.0100
						unidentifiable	wood charcoal	13	0.0600
1097	G164	F	5B	F4 S 3.5, W 2.5	5.5	*Acmella* sp.	achene	22	0.0004
						Piper cf. *aduncum*	seed	1	0.0001
						Ryania speciosa	wood charcoal	1	0.0270
						Terminalia cf. *buceras*	wood charcoal	2	0.0690
						Trichilia sp.	wood charcoal	1	0.0110

						UNID A	seed	1	0.0002
						Zanthoxylum sp.	wood charcoal	2	0.0350
						ARECACEAE	wood charcoal	2	0.0380
						unidentifiable	wood charcoal	6	0.0560
						unidentifiable	wood charcoal	1	0.0060
						unidentifiable	wood charcoal	27	0.0740
1098	G164	F	5B	F4 S 3.5, W 2.0	5.0	*Acmella* sp.	achene	3	0.0001
						Pouteria sp.	wood charcoal	8	0.3600
						Trichilia sp.	wood charcoal	13	0.2870
						UNID A	seed	3	0.0083
						ARECACEAE	wood charcoal	2	0.0240
						unidentifiable	wood charcoal	7	0.0210
1099	G164	F	5B	F1 S 2.0, W 1.5	5.0	*Acmella* sp.	achene	26	0.0002
						Acrocomia aculeata	endocarp	1	0.0840
						Astronium graveolens	wood charcoal	5	0.1700
						Cinnamomum sp.	wood charcoal	3	0.0810
						Terminalia cf. *buceras*	wood charcoal	1	0.0140
						UNID C	seed	2	0.0030
						unidentifiable	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	11	0.0780
1100	G164	F	5B	F1 S 2.5, W 1.0	5.0	*Acmella* sp.	achene	50	0.0009
						Acrocomia aculeata	endocarp	1	0.0090
						Bellucia sp.	wood charcoal	1	0.0260
						Genipa americana	wood charcoal	1	0.0130
						Piper cf. *aduncum*	seed	2	0.0001
						UNID A	seed	1	0.0001
						Zea mays	cupule	1	0.0010
						ARECACEAE	wood charcoal	1	0.0180
						CELASTRACEAE	wood charcoal	1	0.0220
						unidentifiable	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	5	0.0610
1101	G164	F	5B	F1 S 3.0, W 1.0	5.0	*Acmella* sp.	achene	9	0.0003
						Pouteria sp.	wood charcoal	1	0.0090
						Terminalia cf. *buceras*	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	2	0.0130
						unidentifiable	wood charcoal	1	0.0040
1103	G164	F	5B	F3 S 2.0, W 0.5	5.0	*Acmella* sp.	achene	11	0.0002
						Jacaranda sp.	wood charcoal	3	0.0960
						Prioria copaifera	wood charcoal	1	0.0340
						Zea mays	cupule	1	0.0200
						Zea mays	cupule	1	0.0030
						CELASTRACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	1	0.0160

						unidentifiable	wood charcoal	2	0.0050
1104	G164	F	5B	F3 S 2.0, W 0.0	5.0	*Acmella* sp.	achene	14	0.0002
						Cecropia sp.	wood charcoal	1	0.0260
						Cecropia sp.	seed	1	0.0006
						Piper cf. *aduncum*	seed	3	0.0001
						Terminalia cf. *buceras*	wood charcoal	2	0.0930
						Zea mays	cupule	4	0.0290
						unidentifiable	wood charcoal	5	0.0280
1105	G164	F	5B	F3 S 2.5, W 0.5	5.0	*Acmella* sp.	achene	14	0.0002
						Trema sp.	wood charcoal	1	0.0769
						unidentifiable	wood charcoal	8	0.0140
1106	G164	F	5B	F3 S 2.5, W 0.0	5.0	*Acmella* sp.	achene	32	0.0004
						Acrocomia aculeata	endocarp	1	0.1850
						Nectandra/Ocotea	wood charcoal	2	0.0470
						Terminalia cf. *buceras*	wood charcoal	2	0.1010
						UNID C	seed	1	0.0020
						ANNONACEAE	wood charcoal	1	0.0040
						unidentifiable	wood charcoal	8	0.0300
1107	G164	F	5B	F3 S 3.0, W 0.5	5.0	*Acmella* sp.	achene	3	0.0001
						ARECACEAE	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	6	0.0050
						unidentifiable	wood charcoal	8	0.0300
1108	G164	F	5B	F3 S 3.0, W 0.0	5.5	*Acmella* sp.	achene	11	0.0002
						Brosimum sp.	wood charcoal	1	0.0090
						Diphysa robinioides	wood charcoal	1	0.0220
						Manilkara sp.	wood charcoal	1	0.0080
						UNID A	seed	2	0.0004
						ARECACEAE	wood charcoal	1	0.0070
						RUBIACEAE	wood charcoal	1	0.0230
						unidentifiable	wood charcoal	4	0.0140
1109	G164	F	5B	F3 S 3.5, W 0.5	5.0	*Acmella* sp.	achene	17	0.0002
						Nicotiana sp.	seed	1	0.0001
						Sapindus saponaria	wood charcoal	1	0.0580
						Simarouba amara	wood charcoal	1	0.0050
						UNID A	seed	1	0.0002
						UNID C	seed	2	0.0030
						ASTERACEAE	achene	1	0.0001
						SAPOTACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	8	0.0360
1110	G164	F	5B	F3 S 3.5, W 0.0	5.0	*Acmella* sp.	achene	19	0.0003
						UNID A	seed	2	0.0002
						UNID C	seed	1	0.0030
						ARECACEAE	wood charcoal	8	0.0280

						ASTERACEAE	achene	1	0.0001
1111	G164	F	5B	F3 S 2.7, W 0.7	1.0	*Acmella* sp.	achene	13	0.0002
						UNID A	seed	3	0.0003
						UNID C	seed	1	0.0010
						UNID C	seed	1	0.0020
						unidentifiable	wood charcoal	1	0.0090
1112	G164	F	5B	F3 PH 8	1.0	*Acmella* sp.	achene	2	0.0001
						Aspidosperma cf. *megalocarpon*	wood charcoal	5	0.065
1113	G164	F	5C	F5 S 0.0, W 2.0	5.5	*Acmella* sp.	achene	103	0.0013
						Acrocomia aculeata	endocarp	1	0.0560
						Prioria copaifera	wood charcoal	1	0.0120
						Terminalia cf. *buceras*	wood charcoal	11	0.8230
						UNID A	seed	5	0.0004
						Zea mays	kernel	1	0.0010
						ASTERACEAE	achene	1	0.0001
						RUBIACEAE	wood charcoal	1	0.0080
						unidentifiable	wood charcoal	5	0.0440
						unidentifiable	wood charcoal	1	0.0240
						unidentifiable	wood charcoal	1	0.0050
						unidentifiable	wood charcoal	11	0.0580
1114	G164	F	5C	F2 S 0.0, W 1.0	4.5	*Acmella* sp.	achene	24	0.0003
						Croton sp.	wood charcoal	1	0.0130
						Ficus sp.	wood charcoal	1	0.0750
						UNID A	seed	8	0.0006
						UNID C	seed	1	0.0020
						Zea mays	cupule	1	0.0044
						ARECACEAE	wood charcoal	2	0.0130
						unidentifiable	wood charcoal	5	0.0290
						unidentifiable	wood charcoal	19	0.0860
1115	G164	F	5C	F2 S 0.0, W 0.0	5.0	*Acmella* sp.	achene	13	0.0002
						Clidemia sp.	wood charcoal	1	0.0050
						Terminalia cf. *buceras*	wood charcoal	1	0.0130
						UNID A	seed	4	0.0004
						UNID C	seed	2	0.0030
						ARECACEAE	wood charcoal	1	0.0070
						FABACEAE	wood charcoal	1	0.0150
						unidentifiable	wood charcoal	8	0.0410
1116	G164	F	5C	F5 S 1.0, W 2.0	5.5	*Acmella* sp.	achene	48	0.0006
						Psidium sp.	wood charcoal	1	0.0420
						Terminalia cf. *buceras*	wood charcoal	6	0.0650
						UNID A	seed	2	0.0002
						UNID C	seed	1	0.0020
						ARECACEAE	wood charcoal	1	0.0080

						LAURACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	5	0.0130
						unidentifiable	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	6	0.0190
						unidentifiable	wood charcoal	1	0.0030
1117	G164	F	5C	F2 S 1.0, W 1.0	6.0	*Acmella* sp.	achene	59	0.0009
						Nectandra/Ocotea	wood charcoal	1	0.0200
						UNID A	seed	4	0.0003
						unidentifiable	wood charcoal	1	0.0200
1118	G164	F	5C	F2 S 1.0, W 0.0	5.5	*Acmella* sp.	achene	31	0.0003
						UNID C	seed	1	0.0020
1119	G164	F	5C	F4 S 2.0, W 2.0	6.0	*Acmella* sp.	achene	55	0.0007
						Terminalia cf. *buceras*	wood charcoal	2	0.0340
						UNID C	seed	1	0.0020
						Zea mays	kernel	1	0.0120
						unidentifiable	wood charcoal	2	0.0340
						unidentifiable	wood charcoal	11	0.0270
1120	G164	F	5C	F1 S 2.0, W 1.0	6.0	*Acmella* sp.	achene	40	0.0005
						Nicotiana sp.	seed	1	0.0001
						Piper cf. *aduncum*	seed	1	0.0001
						Pouteria sp.	wood charcoal	1	0.0260
						Sapindus saponaria	wood charcoal	4	0.0150
						Terminalia cf. *buceras*	wood charcoal	1	0.0110
						UNID A	seed	2	0.0002
						ARECACEAE	wood charcoal	3	0.0390
						ASTERACEAE	achene	1	0.0001
						FABACEAE	wood charcoal	7	0.1380
						URTICACEAE	wood charcoal	1	0.0030
						unidentifiable	wood charcoal	2	0.0290
						unidentifiable	wood charcoal	27	0.1290
1121	G164	F	6	F3 S 2.0, W 0.0	5.0	*Acmella sp.*	achene	92	0.0012
						Zea mays	kernel	1	0.0080
						unidentifiable	wood charcoal	4	0.0130
1122	G164	F	5C	F4 S 3.0, W 2.0	5.5	*Acmella* sp.	achene	67	0.0008
						Sapindus saponaria	wood charcoal	1	0.0060
						Terminalia cf. *buceras*	wood charcoal	3	0.0430
						UNID A	seed	2	0.0002
						UNID C	seed	2	0.0030
						Zanthoxylum sp.	wood charcoal	1	0.0380
						unidentifiable	wood charcoal	7	0.0450
						unidentifiable	plant material	1	0.0050
1123	G164	F	5C	F1 S 3.0, W 1.0	6.0	*Acmella* sp.	achene	121	0.0008
						Mollugo verticillata	seed	1	0.0001

						UNID A	seed	3	0.0002
						UNID C	seed	1	0.0020
						unidentifiable	geophyte	1	0.0160
						CUCURBITACEAE	rind	1	0.0040
						unidentifiable	wood charcoal	2	0.0080
1124	G164	F	6	F3 S 3.0, W 0.0	5.0	*Acmella sp.*	achene	84	0.0011
						Campnosperma panamense	wood charcoal	1	0.0100
						Zea mays	cupule	1	0.0060
						ARECACEAE	wood charcoal	3	0.0150
						unidentifiable	wood charcoal	7	0.0320
1125	G164	F	5B	F4 S 2.7, W 2.7	2.0	*Acmella* sp.	achene	109	0.0040
						UNID A	seed	2	0.0002
1126	G164	F	5C	F2 S 0.35, W 0.33	1.0	*Acmella* sp.	achene	7	0.0001
						Terminalia cf. *buceras*	wood charcoal	1	0.0170
						UNID A	seed	1	0.0001
						ARECACEAE	wood charcoal	1	0.0090
						unidentifiable	wood charcoal	3	0.0090
1128	G164	F	5C	F2 S 1.23, W 1.81	3.0	*Acmella* sp.	achene	129	0.0019
				PH 11		*Nectandra/Ocotea*	wood charcoal	6	0.1350
						Nicotiana sp.	seed	1	0.0001
						UNID A	seed	1	0.0001
						UNID C	seed	1	0.0020
						unidentifiable	wood charcoal	14	0.0570
						unidentifiable	plant material	3	0.0150
A	G164	S	4	F1 S		*Persea* sp.	wood charcoal	20	0.9760
						Samanea saman	wood charcoal	2	0.1840
						Terminalia cf. *buceras*	wood charcoal	7	0.3660
B	G164	S	4	F1 N		*Ardisia* sp.	wood charcoal	4	0.0770
						cf. *Buddleja* sp.	wood charcoal	1	0.0050
						Persea sp.	wood charcoal	6	0.3590
						Terminalia cf. *buceras*	wood charcoal	10	0.4320
						ARECACEAE	wood charcoal	1	0.0270
C	G164	S	5C	F1		*Acrocomia aculeata*	endocarp	1	0.0380
						Bixa cf. orellana	wood charcoal	1	0.0840
						Hura crepitans	wood charcoal	2	0.1030
						Terminalia cf. *buceras*	wood charcoal	5	0.3230
						Zanthoxylum sp.	wood charcoal	3	0.0540
						ARECACEAE	wood charcoal	15	0.7330
D	G164	S	5C	F1 S 3.0, W 1.5		*Acrocomia aculeata*	endocarp	2	0.1090
						Aspidosperma sp.	wood charcoal	2	0.0780
						ARECACEAE	wood charcoal	2	0.0840
						unidentifiable	wood charcoal	2	0.0630

E	G164	S	5C	F1 S 2.2, W 1.7	unidentifiable	wood charcoal	8	0.2210
F	G164	S		F1	ARECACEAE	wood charcoal	1	0.0140
					URTICACEAE	wood charcoal	1	0.0210
G	G164	S	5C	F1 NW	*Acrocomia aculeata*	endocarp	1	0.0190
					Astronium graveolens	wood charcoal	2	0.0440
					Trichilia sp.	wood charcoal	1	0.0690
					ARECACEAE	wood charcoal	1	0.0280
					unidentifiable	wood charcoal	1	0.0070
H	G164	S	5	F1 S 3.5, W 1.3	*Swietenia* sp.	wood charcoal	15	0.3930
					ARECACEAE	wood charcoal	1	0.0170
I	G164	S	2	F2 SE	*Parkinsonia aculeata*	wood charcoal	6	0.1430
					Terminalia cf. *buceras*	wood charcoal	5	0.2820
J	G164	S	3	F2 NE	*Terminalia* cf. *buceras*	wood charcoal	3	0.0320
					Trichilia sp.	wood charcoal	1	0.0490
					ARECACEAE	wood charcoal	2	0.0160
					BIGNONIACEAE	wood charcoal	1	0.0090
K	G164	S	3	F2 NW	*Acrocomia aculeata*	endocarp	3	0.0450
					Handroanthus sp.	wood charcoal	1	0.0130
					Pouteria sp.	wood charcoal	1	0.0920
					Terminalia cf. *buceras*	wood charcoal	2	0.0150
					ARECACEAE	wood charcoal	1	0.0130
L	G164	S	3	F2 SE	*Terminalia* cf. *buceras*	wood charcoal	1	0.0120
M	G164	S	3	F2 SW	LAURACEAE	wood charcoal	1	0.0050
					unidentifiable	wood charcoal	1	0.0190
N	G164	S	4	F2 SW	*Acrocomia aculeata*	endocarp	1	0.0130
					Bixa cf. *orellana*	wood charcoal	1	0.0160
					Jacaranda sp.	wood charcoal	4	0.1540
					Sapindus saponaria	wood charcoal	4	0.2200
					Terminalia cf. *buceras*	wood charcoal	10	0.3860
					Zea mays	cob fragment	1	0.0390
					ARECACEAE	wood charcoal	2	0.0377
					LAURACEAE	wood charcoal	1	0.0530
O	G164	S	4	F2 SE	*Acrocomia aculeata*	endocarp	7	0.5000
					Clidemia sp.	wood charcoal	1	0.1290
					Inga sp.	wood charcoal	2	0.0510
					Jacaranda sp.	wood charcoal	19	0.9250
					Psidium sp.	wood charcoal	1	0.0480
					Spondias sp.	wood charcoal	2	0.0740
					Terminalia cf. *buceras*	wood charcoal	5	2.2940
					ARECACEAE	wood charcoal	2	0.0500

					SIMAROUBACEAE	wood charcoal	2	0.0560
P	G164	S	4	F2 NW	*Hedyosmum* sp.	wood charcoal	1	0.0600
Q	G164	S	4	F2 NE	*Acrocomia aculeata*	endocarp	5	0.3580
					Aspidosperma sp.	wood charcoal	5	0.3400
					Garcinia sp.	wood charcoal	2	0.0580
					Jacaranda sp.	wood charcoal	1	0.0540
					Terminalia cf. *buceras*	wood charcoal	4	0.3090
					Trichilia sp.	wood charcoal	1	0.0620
					UNID H	seed	2	0.0470
					ANNONACEAE	wood charcoal	4	0.1370
					ARECACEAE	wood charcoal	7	0.2830
					unidentifiable	wood charcoal	11	0.4170
					unidentifiable	wood charcoal	1	0.0360
					unidentifiable	wood charcoal	2	0.0230
R	G164	S	5A	F2 NW	*Acrocomia aculeata*	endocarp	5	0.8920
					Garcinia sp.	wood charcoal	1	0.0230
					Hedyosmum sp.	wood charcoal	3	0.1850
					Jacaranda sp.	wood charcoal	1	0.0580
					Persea sp.	wood charcoal	1	0.0330
					Psidium sp.	wood charcoal	1	0.0200
					Sapindus saponaria	wood charcoal	3	0.0850
					Spondias cf. *mombin*	wood charcoal	4	0.2490
					Terminalia cf. *buceras*	wood charcoal	4	0.4670
					ARECACEAE	wood charcoal	3	0.2210
					FABACEAE	wood charcoal	1	0.0130
S	G164	S	5A	F2 NW	*Bellucia* sp.	wood charcoal	2	0.0260
					Pouteria sp.	wood charcoal	1	0.0120
					Sapindus saponaria	wood charcoal	1	0.0180
					Terminalia cf. *buceras*	wood charcoal	1	0.1790
					unidentifiable	wood charcoal	9	0.4000
T	G164	S	5A	F2 SW	*Acrocomia aculeata*	endocarp	7	0.3580
					Bourreria sp.	wood charcoal	3	0.1690
					Lacmellea sp.	wood charcoal	2	0.0380
					Terminalia cf. *buceras*	wood charcoal	9	0.3900
					Tibouchina sp.	wood charcoal	3	0.0810
					Zanthoxylum sp.	wood charcoal	4	0.2710
					ARECACEAE	wood charcoal	4	0.1460
U	G164	S	5A	F2 SW	*Acrocomia aculeata*	endocarp	2	0.3530
					Anacardium sp.	wood charcoal	2	0.0630
					Annona sp.	wood charcoal	4	0.2250
					Terminalia cf. *buceras*	wood charcoal	1	0.0390
					Trichilia sp.	wood charcoal	2	0.0280
					ARECACEAE	wood charcoal	3	0.1190

V	G164	S	5B	F2 SW	*Acrocomia aculeata*	endocarp	2	0.0200
					Terminalia cf. *buceras*	wood charcoal	4	0.0780
W	G164	S	5A	F2 SE	*Acrocomia aculeata*	endocarp	4	0.1300
					Persea sp.	wood charcoal	4	0.1350
					Terminalia cf. *buceras*	wood charcoal	1	0.0700
					ARECACEAE	wood charcoal	2	0.0300
					unidentifiable	wood charcoal	2	0.0450
X	G164	S	5B	F2 SE	*Acrocomia aculeata*	endocarp	2	0.0930
					Cabralea sp.	wood charcoal	5	0.1300
					Manilkara sp.	wood charcoal	4	0.0730
					Pouteria sp.	wood charcoal	3	0.1650
					Sebastiania sp.	wood charcoal	1	0.0060
					Terminalia cf. *buceras*	wood charcoal	17	0.6140
Y	G164	S	5B	F2 NE	*Acrocomia aculeata*	endocarp	2	0.1680
					Terminalia cf. *buceras*	wood charcoal	2	0.0580
					Zea mays	cupule	1	0.0070
					ARECACEAE	wood charcoal	2	0.0590
Z	G164	S	5B	F2 NW	*Acrocomia aculeata*	endocarp	4	0.8960
					Annona sp.	wood charcoal	3	0.1790
					Astronium graveolens	wood charcoal	1	0.0240
					Bixa cf. *orellana*	wood charcoal	3	0.0300
					Garcinia sp.	wood charcoal	3	0.3000
					Pouteria sp.	wood charcoal	1	0.0470
					Psidium sp.	wood charcoal	5	0.1850
					Zea mays	kernel	2	0.0200
					ARECACEAE	wood charcoal	1	0.1680
					unidentifiable	wood charcoal	1	0.0460
AA	G164	S	5B	F2 NW	unidentifiable	wood charcoal	31	1.6410
AB	G164	S	5B	F2	*Acrocomia aculeata*	endocarp	2	0.0190
					Calliandra sp.	wood charcoal	1	0.0550
					Viburnum sp.	wood charcoal	1	0.0110
AC-2	G164	S	5B	F2 S 0.82, W 0.77	no botanical remains			
AD	G164	S	5B	F2 SW	*Acrocomia aculeata*	endocarp	1	0.0250
					Cabralea sp.	wood charcoal	2	0.0780
					Terminalia cf. *buceras*	wood charcoal	1	0.0200
					ARECACEAE	wood charcoal	2	0.0310
AE	G164	S	5B	F2 NW	*Bourreria* sp.	wood charcoal	3	0.0580
					Sapindus saponaria	wood charcoal	5	0.1160
					Terminalia cf. *buceras*	wood charcoal	6	0.1900
					ARECACEAE	wood charcoal	2	0.1000
					unidentifiable	wood charcoal	7	0.1700

AF	G164	S	5B	F2 S 0.74, W 2.0	*Bourreria* sp.	wood charcoal	3	0.0590
					Terminalia cf. *buceras*	wood charcoal	4	0.4850
AG-1	G164	S	3/4	F4 S	*Acrocomia aculeata*	endocarp	3	0.3420
					cf. *Cosmibuena* sp.	wood charcoal	1	0.0280
					Pouteria sp.	wood charcoal	1	0.0200
					Zea mays	cupule	1	0.0220
					ARECACEAE	wood charcoal	1	0.0520
					CELASTRACEAE	wood charcoal	2	0.0610
					unidentifiable	wood charcoal	3	0.2200
					unidentifiable	wood charcoal	4	0.1350
					unidentifiable	wood charcoal	1	0.0110
AG-2	G164	S	5C	F2 S 1.23, W 0.36	*Terminalia* cf. *buceras*	wood charcoal	3	0.1332
AH	G164	S	3/4	F4 N	*Acrocomia aculeata*	endocarp	3	0.0550
					Bixa cf. orellana	wood charcoal	1	0.0350
					Casearia sp.	wood charcoal	1	0.0150
					Garcinia sp.	wood charcoal	5	0.2870
					Nectandra/Ocotea	wood charcoal	1	0.0450
					Swietenia sp.	wood charcoal	1	0.0350
					Terminalia cf. *buceras*	wood charcoal	6	0.2640
AI	G164	S	3/4	F5 S	*Acrocomia aculeata*	endocarp	1	0.0110
					ARECACEAE	wood charcoal	3	0.0710
					SIMAROUBACEAE	wood charcoal	1	0.0620
					unidentifiable	wood charcoal	1	0.0100
AJ	G164	S	3/4	F5 N	*Garcinia* sp.	wood charcoal	1	0.0663
					CELASTRACEAE	wood charcoal	1	0.0447
					unidentifiable	wood charcoal	1	0.0213
AK	G164	S	5A	F5 N	*Acrocomia aculeata*	endocarp	1	0.0475
					Nectandra/Ocotea	wood charcoal	1	0.0204
					Terminalia cf. *buceras*	wood charcoal	5	0.1603
					ARECACEAE	wood charcoal	6	0.0269
					unidentifiable	wood charcoal	2	0.0110
AL	G164	S	4A	F3 N	*Terminalia* cf. *buceras*	wood charcoal	2	0.0874
AM	G164	S	5A	F5 S	*Jacaranda* sp.	wood charcoal	1	0.0600
					Theobroma sp.	wood charcoal	1	0.0609
					MELIACEAE	wood charcoal	1	0.1403
					unidentifiable	wood charcoal	4	0.0968
AM	G164	S	5A	F5 S	unidentifiable	wood charcoal	3	0.2520
AN	G164	S	4B	F3 N	*Acrocomia aculeata*	endocarp	2	0.0410
					Astronium graveolens	wood charcoal	4	0.0520

					Terminalia cf. *buceras*	wood charcoal	8	0.9400
					unidentifiable	wood charcoal	1	0.0560
AO	G164	S	4B	F3 S	*Acrocomia aculeata*	endocarp	2	0.0170
					Terminalia cf. *buceras*	wood charcoal	3	0.0860
					unidentifiable	wood charcoal	2	0.1030
AQ	G164	S	5A	F3 S	*Acrocomia aculeata*	endocarp	7	0.1390
					Annona sp.	wood charcoal	2	0.0120
					Manilkara sp.	wood charcoal	6	0.1680
					Terminalia cf. *buceras*	wood charcoal	9	0.5110
					Trema sp.	wood charcoal	1	0.0310
					unidentifiable	geophyte	2	0.0120
					ARECACEAE	wood charcoal	2	0.0960
					unidentifiable	wood charcoal	23	0.0710
AR	G164	S	5A	F4 N	*Bixa* cf. *orellana*	wood charcoal	1	0.0150
					Coutarea/Exostema	wood charcoal	8	1.4700
					Hedyosmum sp.	wood charcoal	2	0.0320
					Jacaranda sp.	wood charcoal	1	0.0530
					Terminalia cf. *buceras*	wood charcoal	2	0.0580
					ARECACEAE	wood charcoal	1	0.0540
AS	G164	S	5A	F3 N	*Acrocomia aculeata*	endocarp	1	0.1890
					Acrocomia aculeata	endocarp	1	0.0220
					Buddleja sp.	wood charcoal	1	0.0050
					Garcinia sp.	wood charcoal	11	0.3610
					Palicourea sp.	wood charcoal	1	0.0180
					Persea sp.	wood charcoal	3	0.2750
					Terminalia cf. *buceras*	wood charcoal	12	1.3240
					ARECACEAE	wood charcoal	3	0.2070
AT	G164	S	5A	F4 S 3.0, W 2.0	*Acrocomia aculeata*	endocarp	2	0.0580
					unidentifiable	geophyte	5	0.1600
					FABACEAE	wood charcoal	2	0.0470
					SAPOTACEAE	wood charcoal	1	0.0340
AU	G164	S	5B	F5 N	*Acrocomia aculeata*	endocarp	4	0.4880
					Bixa cf. *orellana*	wood charcoal	3	0.1090
					Bourreria sp.	wood charcoal	2	0.0470
					Bunchosia sp.	wood charcoal	1	0.0270
					Cassia sp.	wood charcoal	1	0.0120
					Jacaranda sp.	wood charcoal	3	0.1150
					Manilkara sp.	wood charcoal	1	0.0060
					Sapindus saponaria	wood charcoal	1	0.0110
					ARECACEAE	wood charcoal	4	0.1790
					unidentifiable	wood charcoal	8	0.2610
					unidentifiable	wood charcoal	1	0.0320
AV	G164	S	5B	F3 N	*Acrocomia aculeata*	endocarp	1	0.0390

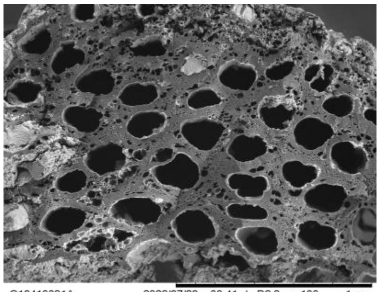
					Nectandra/Ocotea	wood charcoal	1	0.0160
					Sapindus saponaria	wood charcoal	2	0.0440
					Swietenia sp.	wood charcoal	6	0.1170
					Terminalia cf. *buceras*	wood charcoal	3	0.0480
					unidentifiable	geophyte	3	0.1770
					unidentifiable	wood charcoal	1	0.1160
AW	G164	S	5B	F5 S	*Acrocomia aculeata*	endocarp	2	0.0580
					Diphysa robinioides	wood charcoal	2	0.0570
					Garcinia sp.	wood charcoal	1	0.0290
					Inga sp.	wood charcoal	1	0.0480
					Terminalia cf. *buceras*	wood charcoal	4	0.1500
					ARECACEAE	wood charcoal	14	0.3550
					unidentifiable	wood charcoal	1	0.0380
AX	G164	S	5B	F3 S	*Faramea* sp.	wood charcoal	1	0.1680
					Nectandra/Ocotea	wood charcoal	3	0.0400
					Pouteria sp.	wood charcoal	2	0.0830
					Terminalia cf. *buceras*	wood charcoal	9	0.2570
					unidentifiable	wood charcoal	4	0.0830
					unidentifiable	wood charcoal	2	0.0740
AY	G164	S	5B	F5 S 1.30, W 2.47	unidentifiable	plant material	2	0.0320
AZ	G164	S	5B	F3 S 2.78, W 0.49	ARECACEAE	wood charcoal	18	0.3640
BA	G164	S	5B	F3 N	*Acrocomia aculeata*	endocarp	3	0.2570
					Bourreria sp.	wood charcoal	1	0.0530
					cf. *Protium* sp.	wood charcoal	1	0.0670
					Swietenia sp.	wood charcoal	5	0.1780
					Terminalia cf. *buceras*	wood charcoal	12	0.6840
					Zea mays	cob fragment	3	0.1280
					ARECACEAE	wood charcoal	1	0.0120
					unidentifiable	wood charcoal	1	0.0160
					unidentifiable	wood charcoal	1	0.0180
BB	G164	S	5B	F3 S 3.67, E 0.92	*Acrocomia aculeata*	endocarp	1	0.4940
BC	G164	S	5B	F4 N	*Cecropia* sp.	wood charcoal	1	0.0210
					Trema sp.	wood charcoal	1	0.0170
					ARECACEAE	wood charcoal	15	0.5830
					MELASTOMATACEAE	wood charcoal	3	0.1390
BD-1	G164	S	5B	F1 S 2.0, W 1.0	ARECACEAE	wood charcoal	2	0.0670
BD-2	G164	S	5B	F3 S 3.0, W 0.0	*Psychotria* sp.	wood charcoal	1	0.0150
					Tabernaemontana sp.	wood charcoal	3	0.1040
					ARECACEAE	wood charcoal	7	0.1090
					MALVACEAE	wood charcoal	1	0.0730

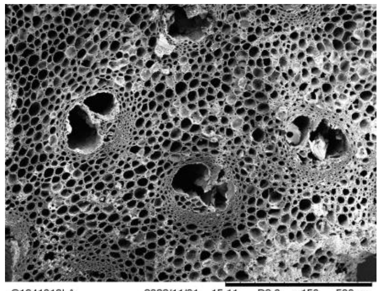
BE	G164	S	5B	F4 S	*Acrocomia aculeata*	endocarp	1	0.0500
					Terminalia cf. *buceras*	wood charcoal	1	0.0150
BF	G164	S	5B	F2NW	*Terminalia* cf. *buceras*	wood charcoal	3	0.0330
BG	G164	S	5B	F2 S 0.5, W 1.0	*Psidium* sp.	wood charcoal	6	0.1260
					Terminalia cf. *buceras*	wood charcoal	2	0.0620
					unidentifiable	wood charcoal	1	0.0150
BH	G164	S	5B	F3 N	unidentifiable	wood charcoal	2	0.0050
BI	G164	S	5B	F4 S 2.0, W2.5	ARECACEAE	wood charcoal	2	0.1430
					unidentifiable	wood charcoal	5	0.0820
BJ	G164	S	5B	F5 S	unidentifiable	geophyte	25	0.2680
BK	G164	S	5B	F5 N	*Tabebuia* sp.	wood charcoal	4	0.1760
BL	G164	S	5B	F2S 0.3, W 1.5	*Acrocomia aculeata*	endocarp	2	0.1600
					Psidium sp.	wood charcoal	1	0.0560
					Terminalia cf. *buceras*	wood charcoal	1	0.0410
BM	G164	S	5C	F5 S0.60, W 2.19	*Acrocomia aculeata*	endocarp	1	0.2364
BN	G164	S	5C	F2 NE	*Couratari* cf. *scottmorii*	wood charcoal	2	0.0290
					Nectandra/Ocotea	wood charcoal	13	0.4250
					ARECACEAE	wood charcoal	2	0.0470
					FABACEAE	wood charcoal	1	0.0300
BO	G164	S	5C	F5 N	*Acrocomia aculeata*	endocarp	4	0.3550
					Bixa cf. orellana	wood charcoal	1	0.0450
					Genipa americana	wood charcoal	1	0.3090
					Maytenus sp.	wood charcoal	4	0.2710
					Terminalia cf. *amazonia*	wood charcoal	1	0.0190
					Terminalia cf. *buceras*	wood charcoal	13	0.8010
					Tibouchina sp.	wood charcoal	5	0.1360
					unidentifiable	wood charcoal	1	0.0490
BP	G164	S	5C	F2 NW	*Acrocomia aculeata*	endocarp	6	0.1350
					Sapindus saponaria	wood charcoal	5	0.1360
					Terminalia cf. *buceras*	wood charcoal	7	0.1920
					ARECACEAE	wood charcoal	1	0.0330
					unidentifiable	wood charcoal	2	0.0370
					unidentifiable	wood charcoal	2	0.0190
BQ	G164	S	6	F3 N	*Terminalia* cf. *buceras*	wood charcoal	11	0.4120
BR	G164	S	6	F3 S	*Acrocomia aculeata*	endocarp	1	0.0110
					Capparis sp.	wood charcoal	2	0.0740
					Inga sp.	wood charcoal	1	0.0170
					Terminalia cf. *buceras*	wood charcoal	6	0.0520

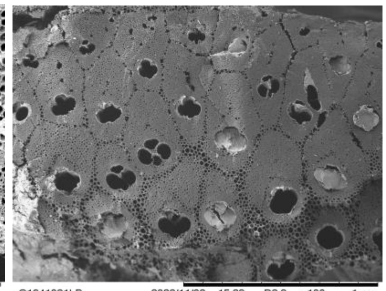
BS	G164	S	5C	F5 S 1.8, W 2.8	no botanical remains			
BU	G164	S	5C	F2 SW	*Terminalia* cf. *oblonga*	wood charcoal	4	0.1250
					Trophis sp.	wood charcoal	3	0.1170
BV	G164	S	5C	F2 SE	*Acrocomia aculeata*	endocarp	1	0.0350
					Terminalia cf. *buceras*	wood charcoal	7	0.3500
					ARECACEAE	wood charcoal	2	0.0810
					FABACEAE	wood charcoal	1	0.0080
BW	G164	S	5C	F1 N	*Manilkara* sp.	wood charcoal	2	0.0580
					Swietenia sp.	wood charcoal	1	0.0550
					Terminalia cf. *buceras*	wood charcoal	3	0.1040
					Zea mays	cupule	1	0.0100
					unidentifiable	wood charcoal	1	0.0350
BX	G164	S	5C	F4 N	no botanical remains			
BY	G164	S	5C	F1 S	*Inga* sp.	wood charcoal	8	0.2960
					Manilkara sp.	wood charcoal	3	0.0820
					ARECACEAE	wood charcoal	1	0.0360
BZ	G164	S	5C	F4 S	*Acrocomia aculeata*	endocarp	2	0.2290
CA	G164	S	5C	F2 NE	*Sapindus saponaria*	wood charcoal	4	0.0570
CB	G164	S	5C	F2 NW	*Acrocomia aculeata*	endocarp	1	0.1540
					Jacaranda sp.	wood charcoal	2	0.0680
					Terminalia cf. *buceras*	wood charcoal	8	0.2760
					FABACEAE	wood charcoal	1	0.0120
CC	G164	S	5C	F5 S 0.5, W 2.0	*Persea* sp.	wood charcoal	16	0.1920
CE	G164	S	5C	F2 NW	*Acrocomia aculeata*	endocarp	2	0.4270
					Sapindus saponaria	wood charcoal	8	0.5990
CF	G164	S	5C	F2 N	*Sapindus saponaria*	wood charcoal	3	0.0390
					unidentifiable	wood charcoal	5	0.1360
CG	G164	S	5C	F5 S	*Terminalia* cf. *buceras*	wood charcoal	3	0.0920
CH	G164	S	5C	F1 N	no botanical remains			

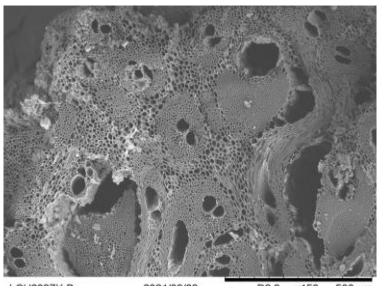
Appendix F: G995 La Chiripa Identified Wood Taxa from the 2018 Excavations Scanning Electron Micrographs and Context Maps

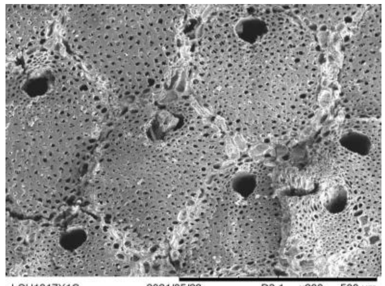
Scientific Name: ARECACEAE **Common Name:** palm Transverse Views

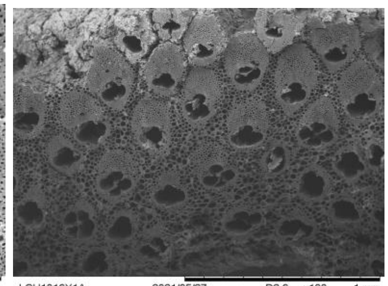

G16410031A 2022/07/28 00:41 L D2.3 x100 1 mm


G1641018LA 2022/11/01 15:11 D3.0 x150 500 um


G1641021LB 2022/11/02 15:23 D2.3 x100 1 mm


LCH2037X-B 2021/03/03 D2.8 x150 500 um


LCH1017X1C 2021/05/28 D3.1 x200 500 um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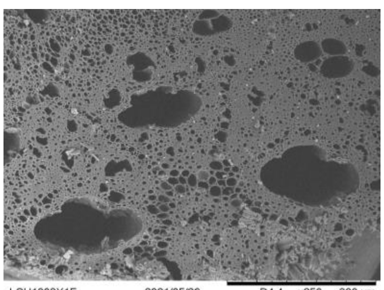
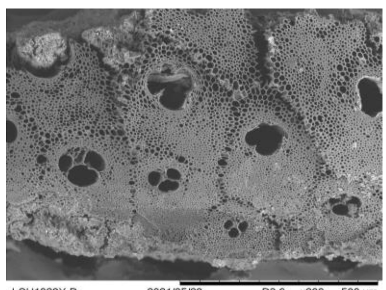
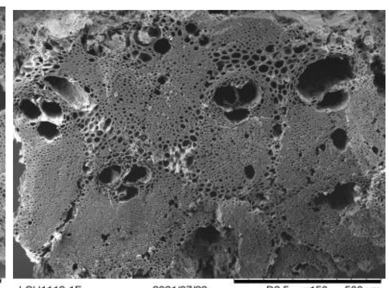

LCH1003X1E 2021/05/26 D4.4 x250 300 um


LCH1028X-D 2021/05/28 D3.6 x200 500 um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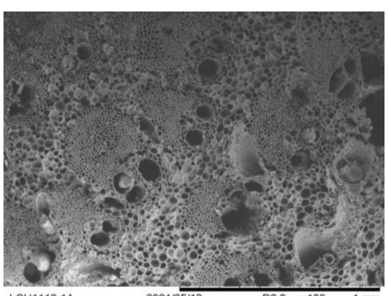
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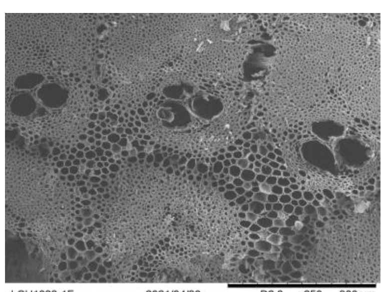
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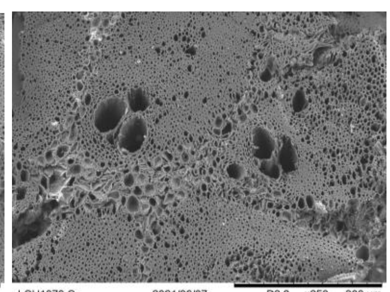
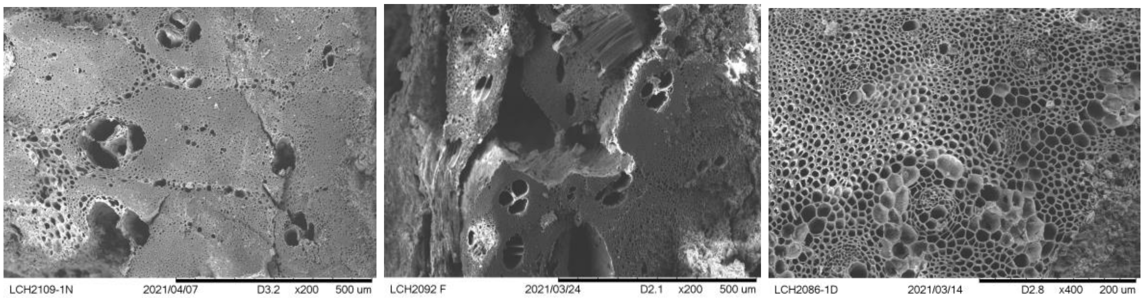
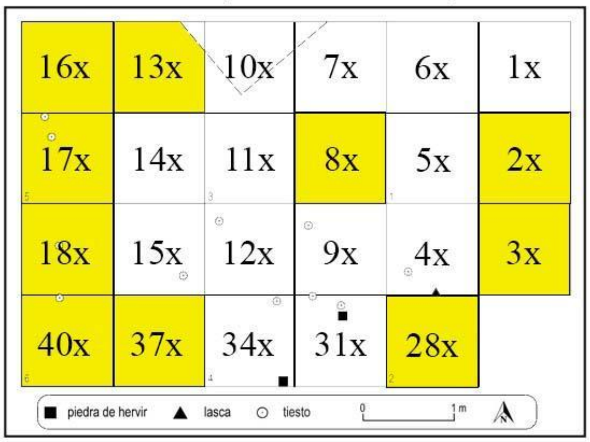

LCH1070 C 2021/06/07 D3.9 x250 300 um

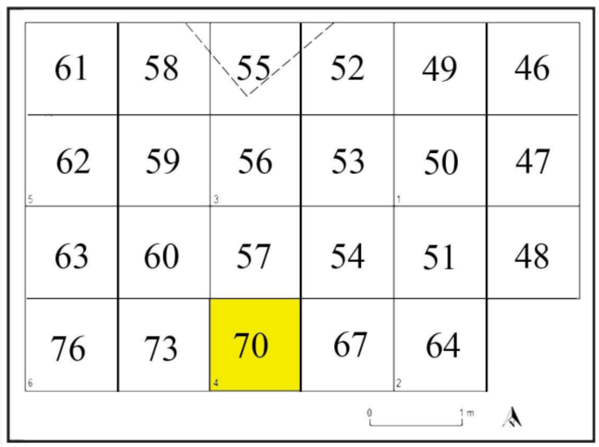


Maps of ARECACEAE wood charcoal

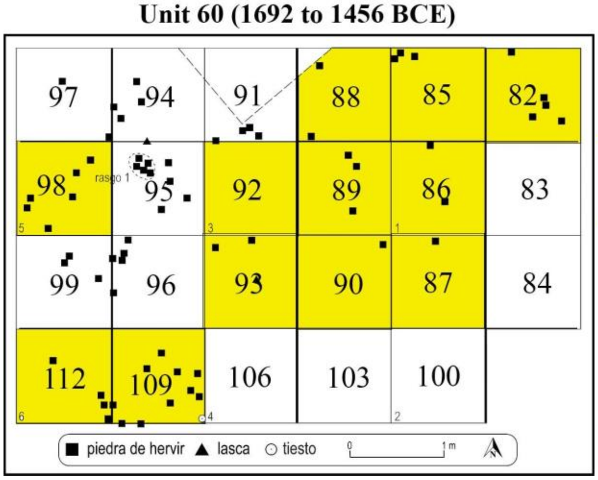
Unit 54 (500 BCE to 100 CE)



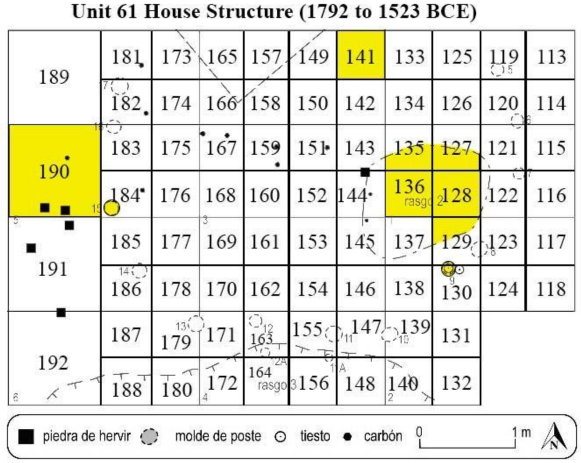
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

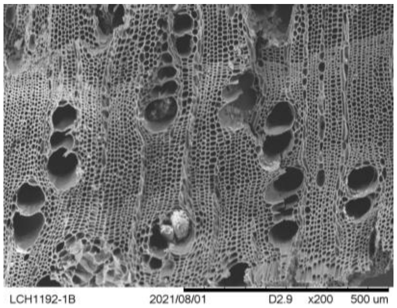


Unit 61 House Structure (1792 to 1523 BCE)

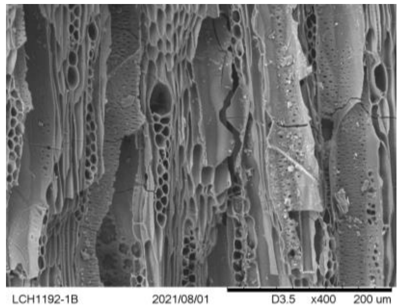


Scientific Name: ACANTHACEAE *Avicennia* sp.
Common Name: mangle salado, mangle negro, mangle prieto, black mangrove

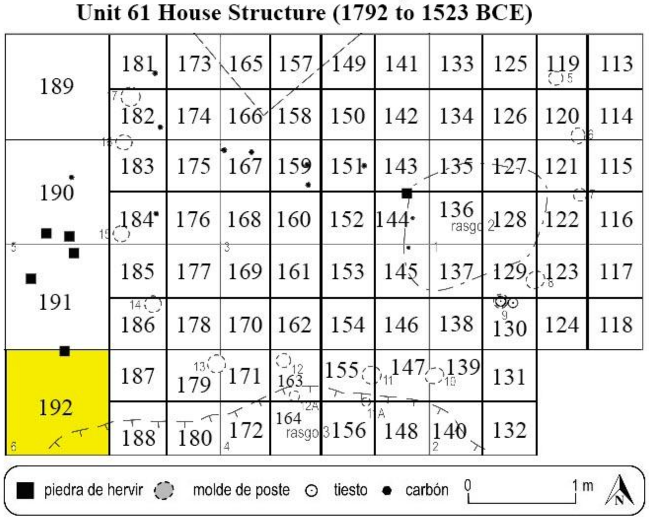
Transverse View



Tangential View

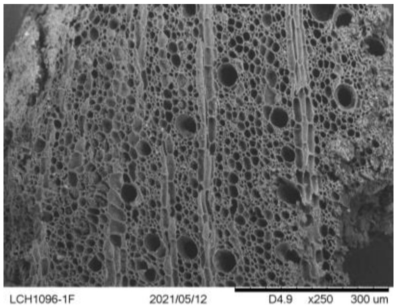


Unit 61 House Structure (1792 to 1523 BCE)

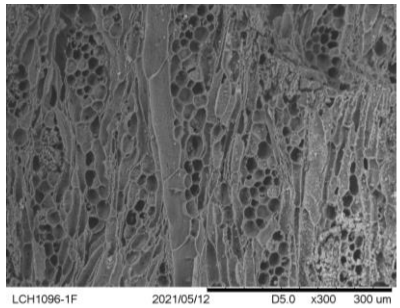


Scientific Name: ADOXACEAE *Viburnum* sp.
Common Name: viburnum

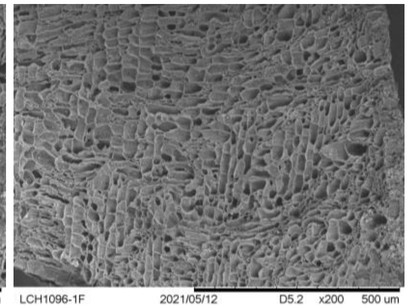
Transverse View



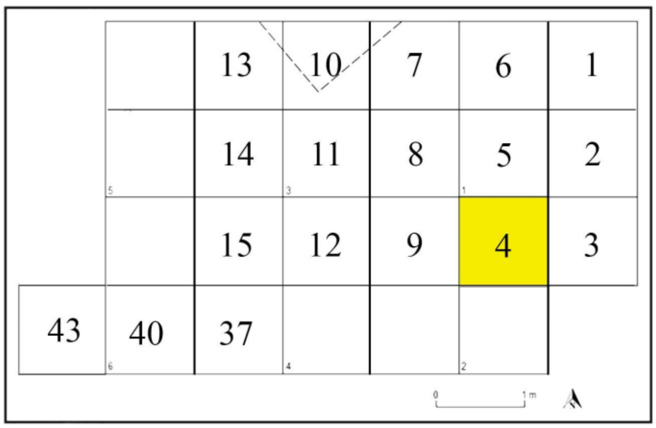
Tangential View



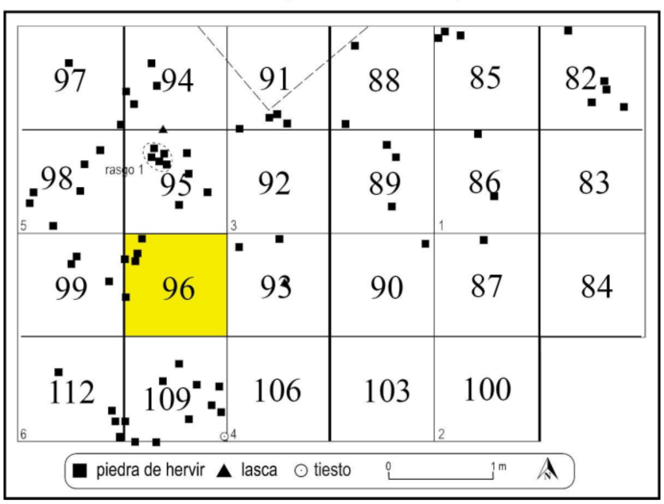
Radial View



AR 16-15 **(100 BCE to 100 CE)**

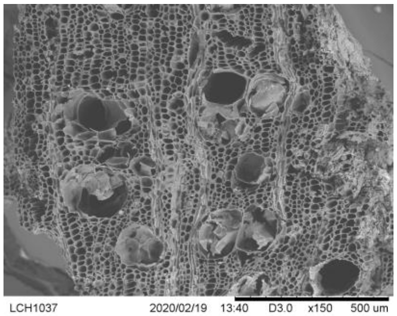


Unit 60 **(1692 to 1456 BCE)**



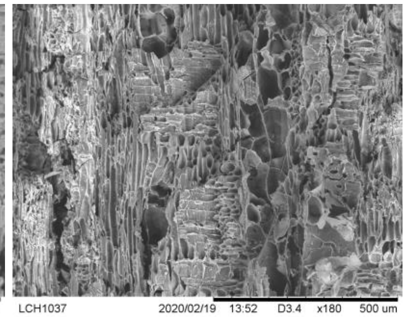
Scientific Name: ANACARDIACEAE *Amphipterygium* sp.
Common Name: cuachalalate

Transverse View

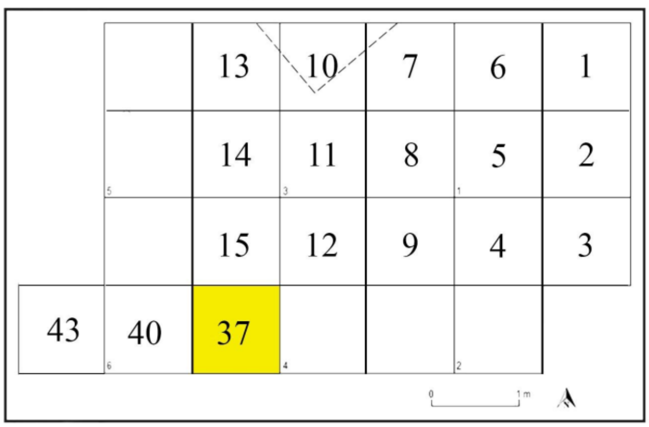


Tangential View

Radial View

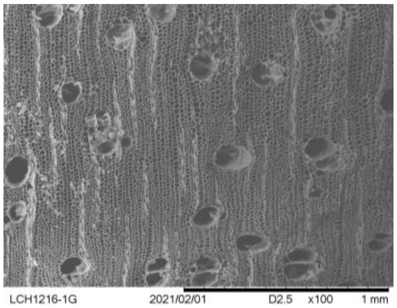


AR 16-15 (100 BCE to 100 CE)

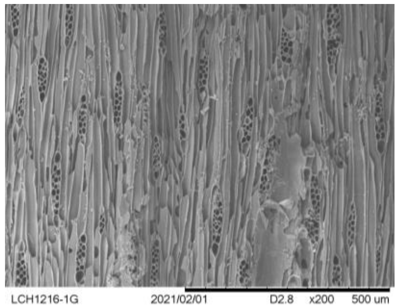


Scientific Name: ANACARDIACEAE *Anacardium excelsum* (Bertero & Balb. ex Kunth) Skeels
Common Name: wild cashew, espave

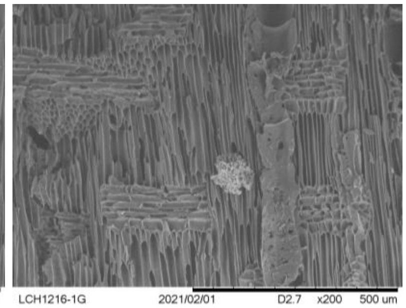
Transverse View



Tangential View

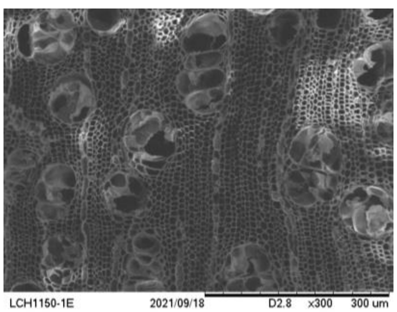


Radial View

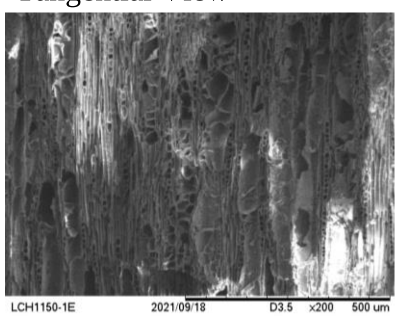


Scientific Name: ANACARDIACEAE *Anacardium occidentale* L.
Common Name: cashew, marañón

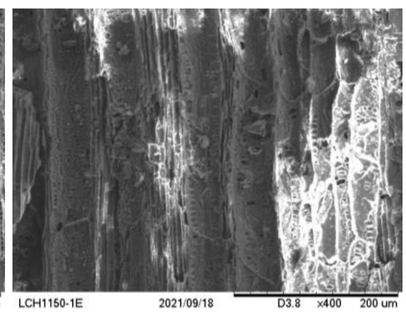
Transverse View



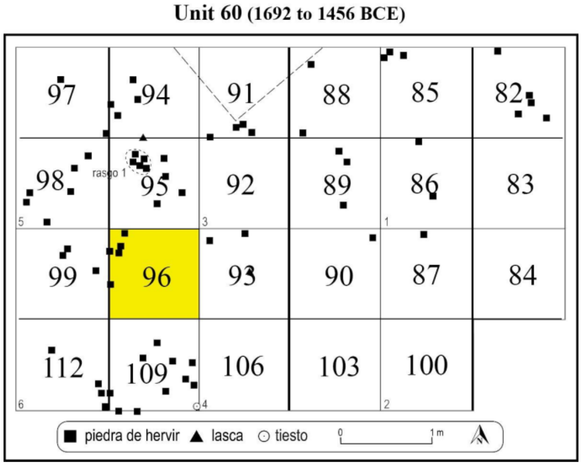
Tangential View



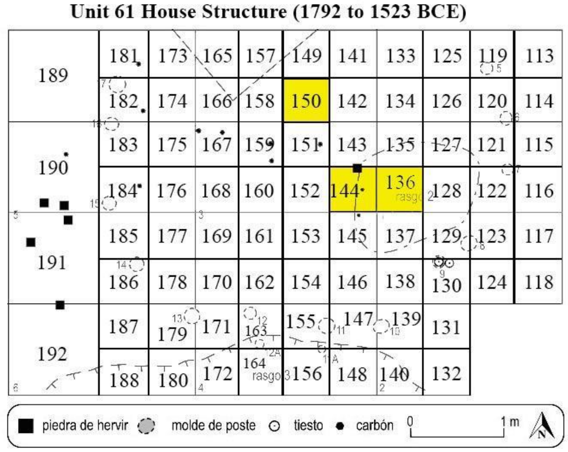
Radial View



Unit 60 **(1692 to 1456 BCE)**



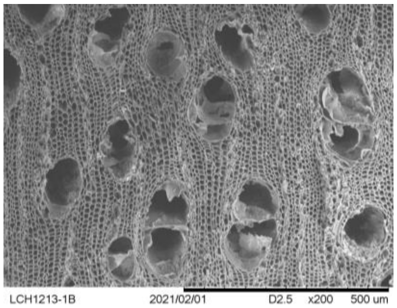
Unit 61 House Structure (1792 to 1523 BCE)



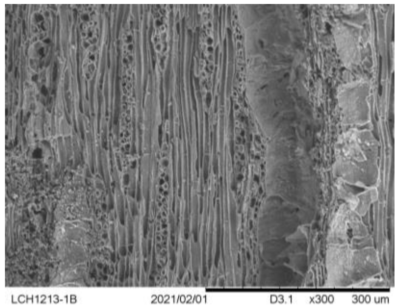
*Maps of *Anacardium* spp. combined.

Scientific Name: ANACARDIACEAE *Astronium graveolens* Jacq.
Common Name: zorro, ron-ron, tigrillo, tolerante, cucaracho

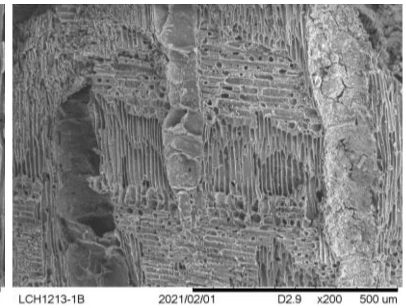
Transverse View



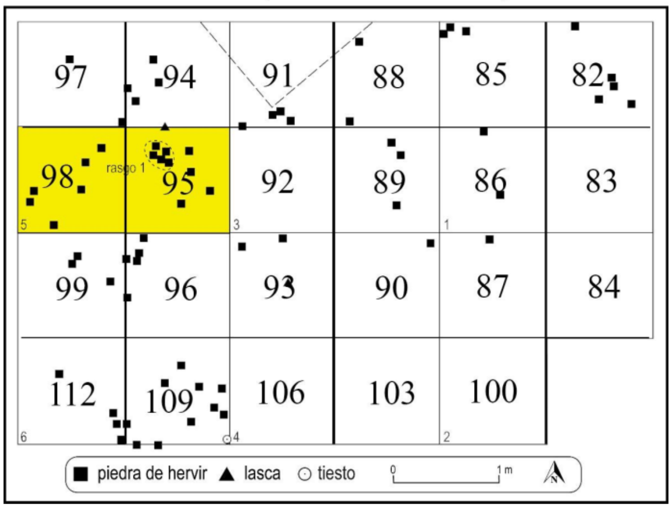
Tangential View



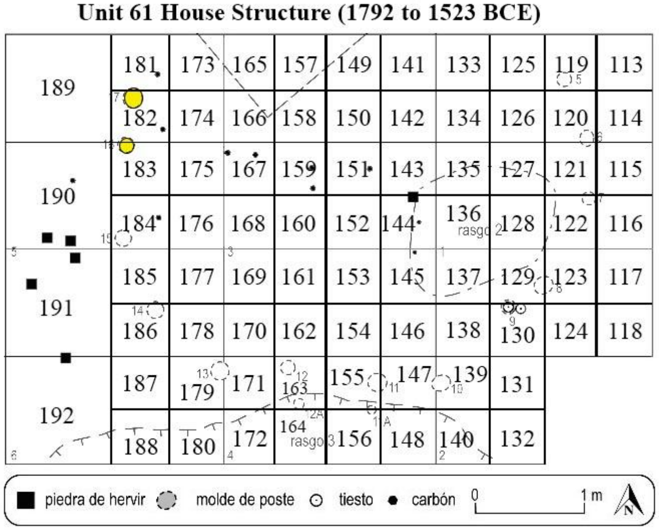
Radial View



Unit 60 (1692 to 1456 BCE)

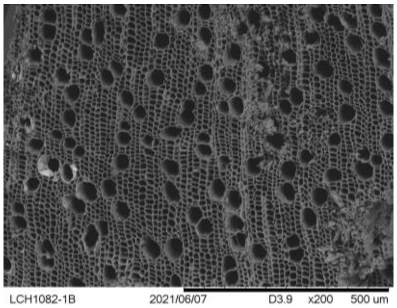


Unit 61 House Structure (1792 to 1523 BCE)

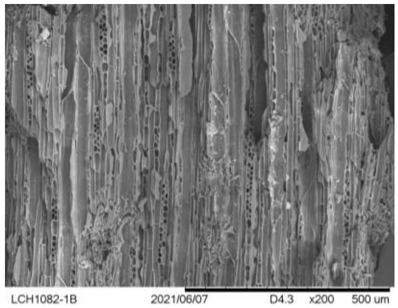


Scientific Name: ANACARDIACEAE *Campnosperma panamense* Standl.
Common Name: orey

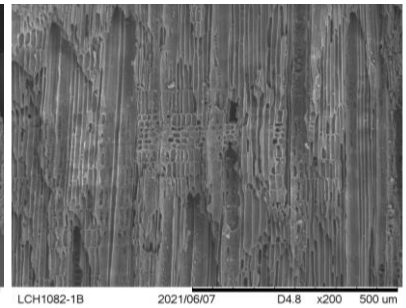
Transverse View



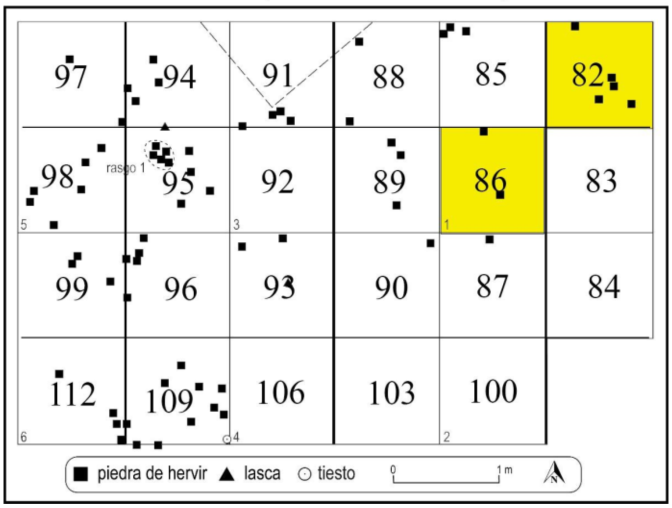
Tangential View



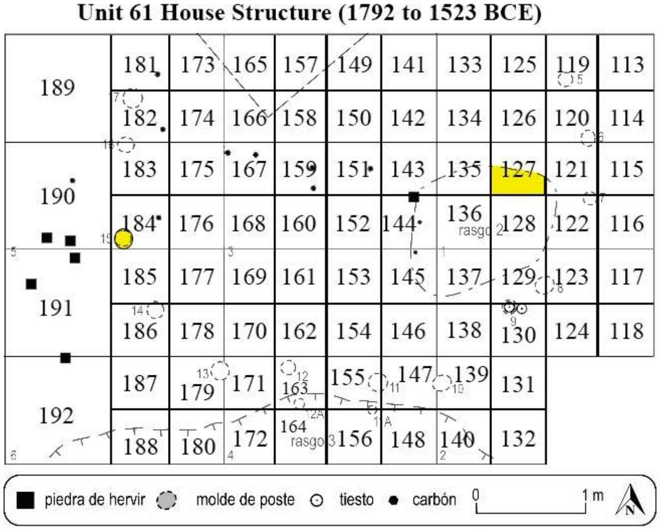
Radial View



Unit 60 (1692 to 1456 BCE)

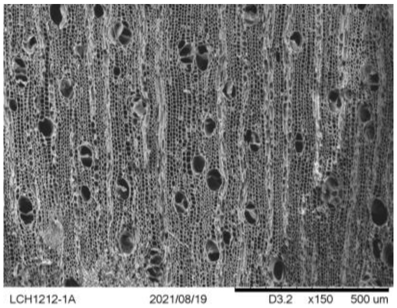


Unit 61 House Structure (1792 to 1523 BCE)

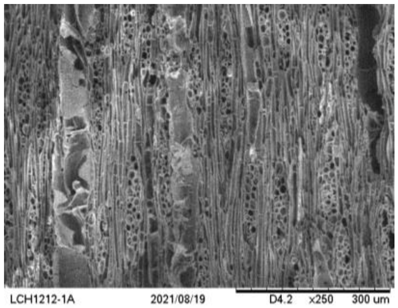


Scientific Name: ANACARDIACEAE *Schinus terebinthifolius* Raddi
Common Name: pepper tree

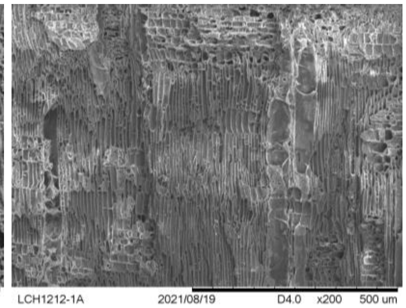
Transverse View



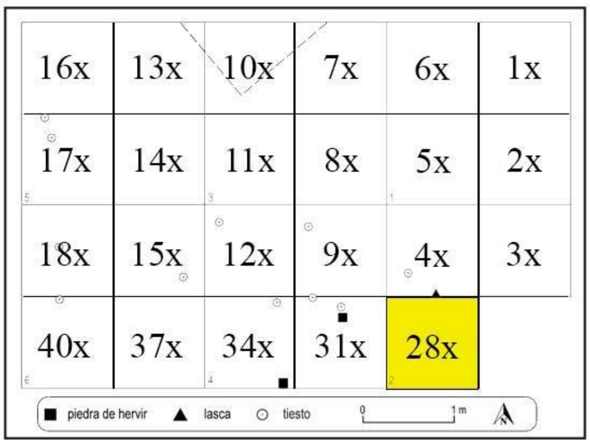
Tangential View



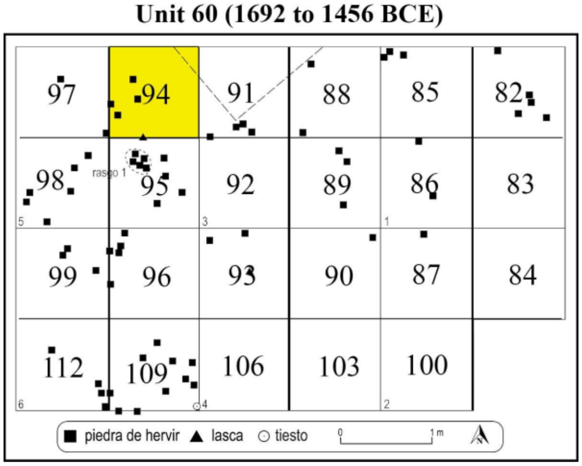
Radial View



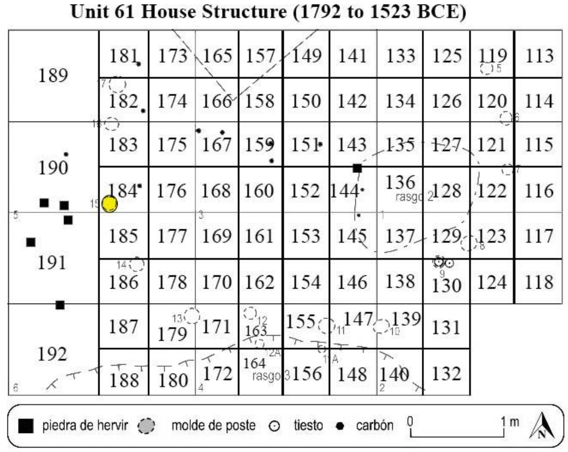
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

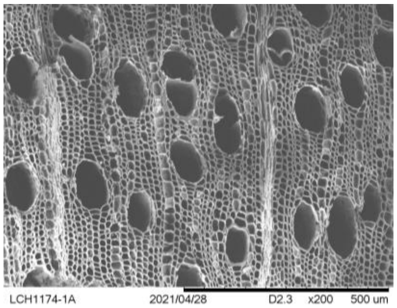


Unit 61 House Structure (1792 to 1523 BCE)

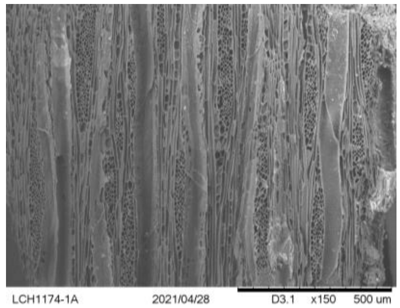


Scientific Name: ANACARDIACEAE *Spondias* cf. *mombin* L.
Common Name: jobo, mope, hogplum

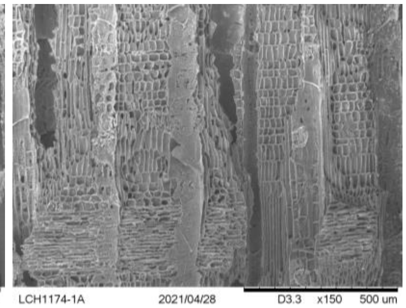
Transverse View



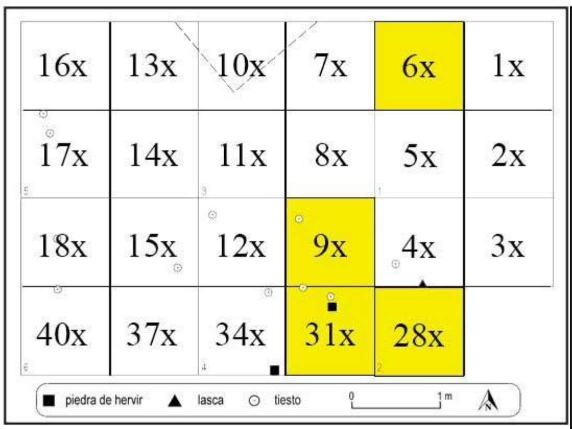
Tangential View



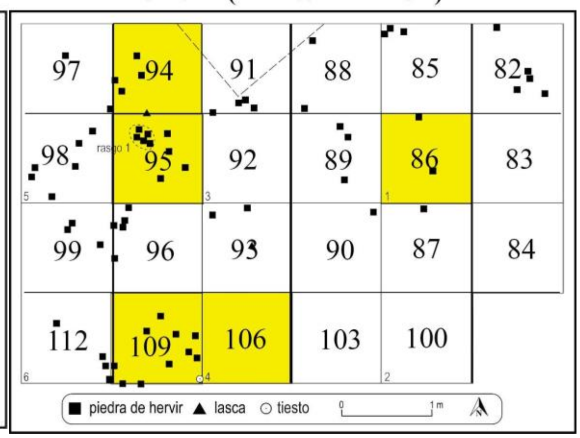
Radial View



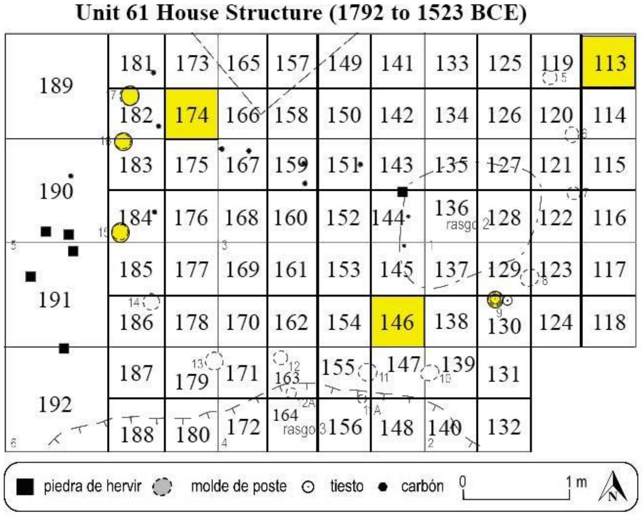
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

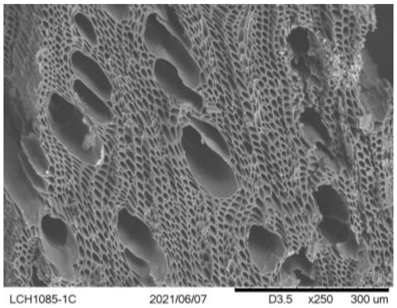


Unit 61 House Structure (1792 to 1523 BCE)

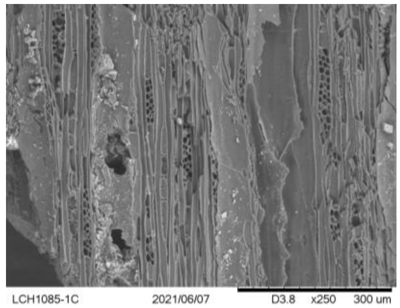


Scientific Name: ANACARDIACEAE *Tapirira* sp.
Common Name: caobilla

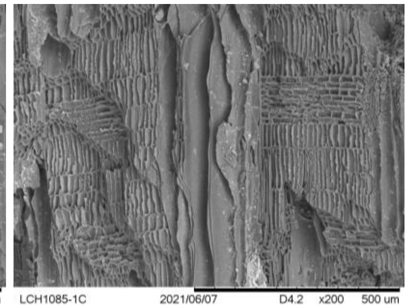
Transverse View



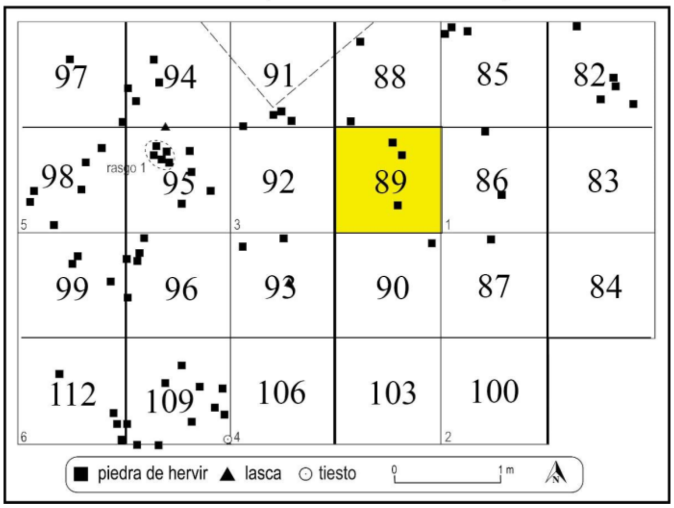
Tangential View



Radial View

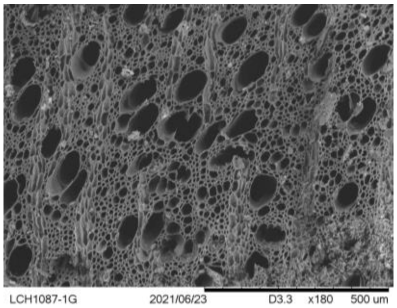


Unit 60 (1692 to 1456 BCE)

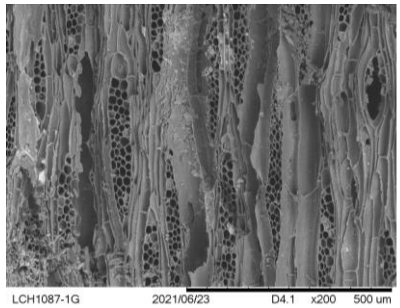


Scientific Name: ANNONACEAE *Annona* sp.
Common Name: guanabana, cherimoya, pond apple, anon

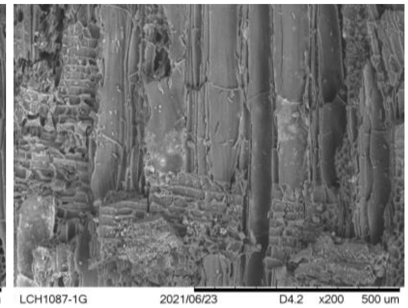
Transverse View



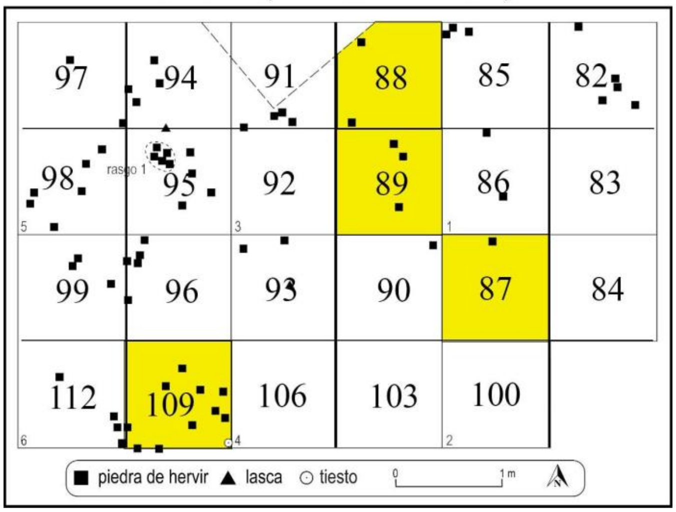
Tangential View



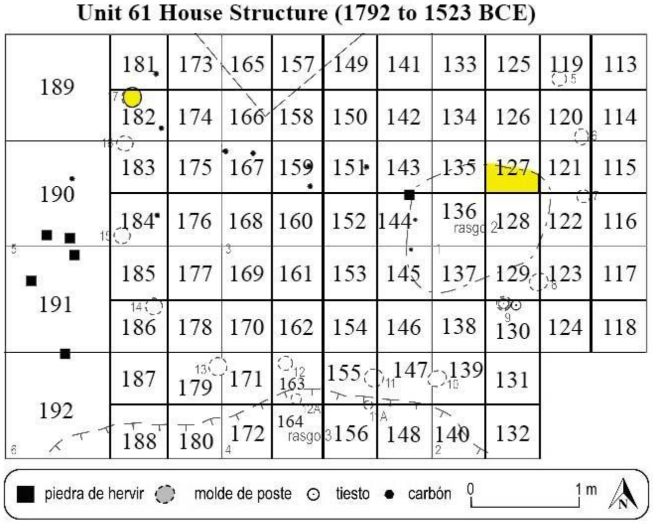
Radial View



Unit 60 (1692 to 1456 BCE)



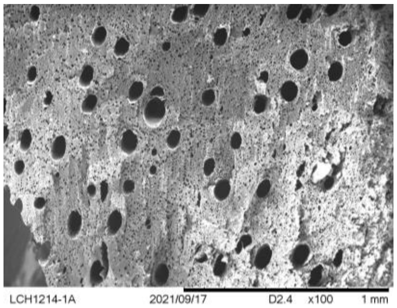
Unit 61 House Structure (1792 to 1523 BCE)



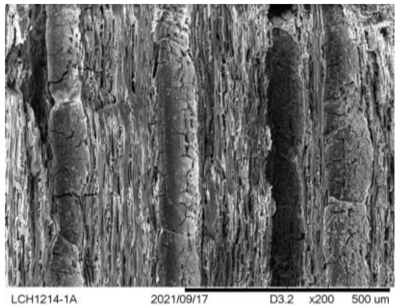
*Maps combine all Annonaceae

Scientific Name: APOCYNACEAE *Aspidosperma* cf. *excelsum* Benth.
Common Name: remo caspi

Transverse View



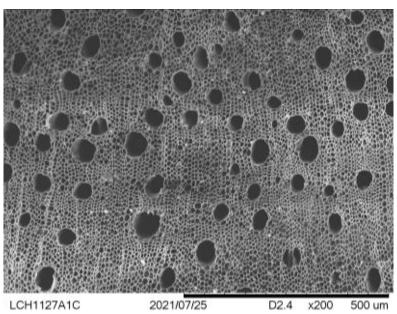
Tangential View



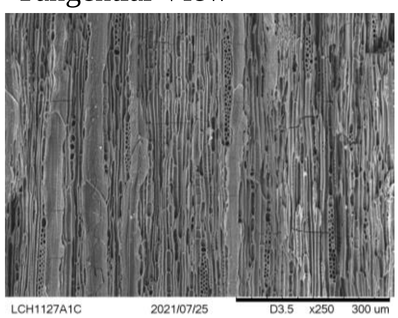
Radial View

Scientific Name: APOCYNACEAE *Aspidosperma* cf. *megalocarpon* Müll. Arg.
Common Name: aracanga, alcarreto, volador

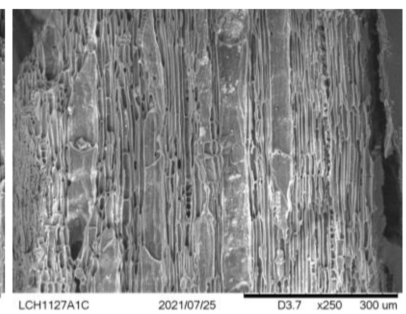
Transverse View



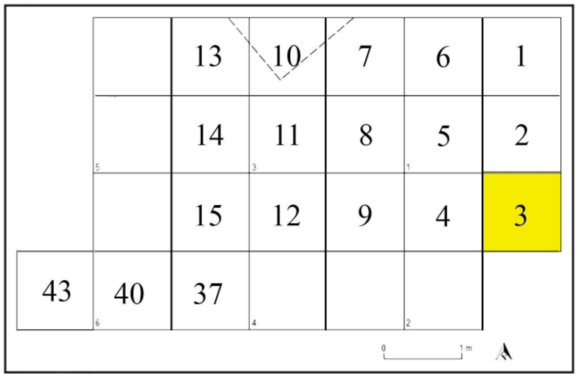
Tangential View



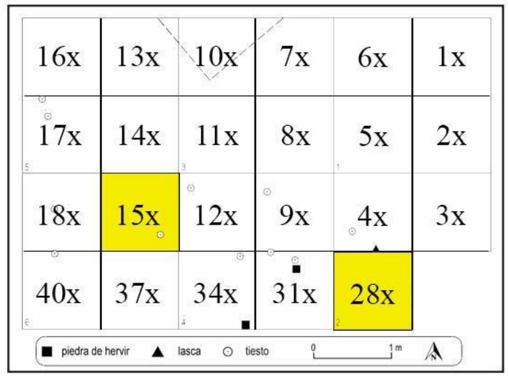
Radial View



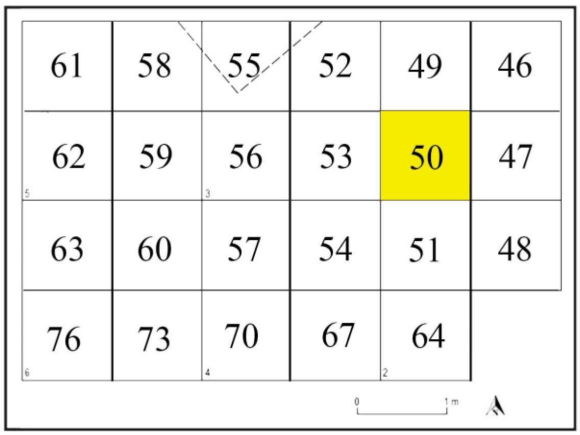
AR 16-15 (100 BCE to 100 CE)



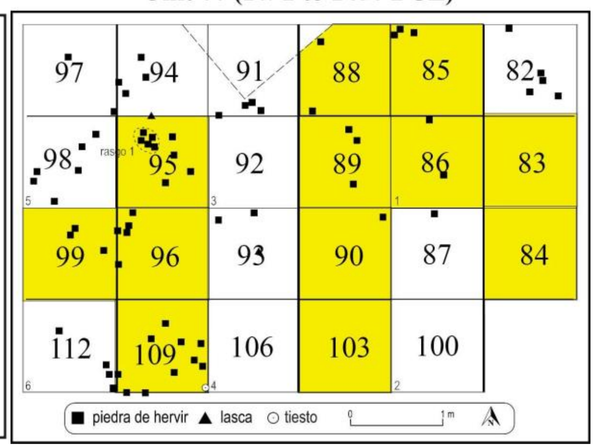
Unit 54 (500 BCE to 100 CE)



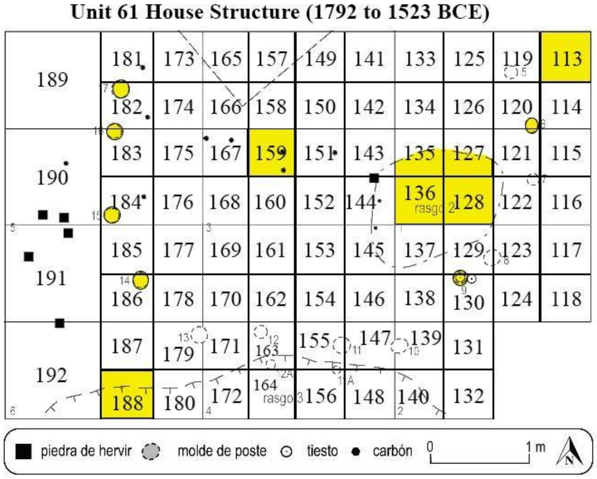
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)



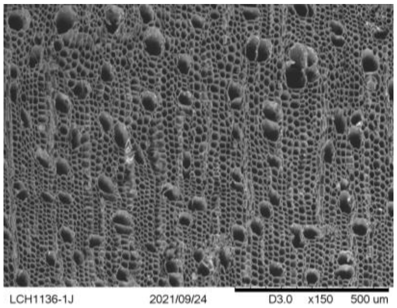
Unit 61 House Structure (1792 to 1523 BCE)



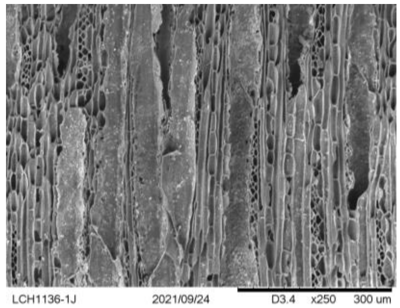
* Maps of *Aspidosperma* spp. combined

Scientific Name: APOCYNACEAE *Tabernaemontana* sp.
Common Name: milkwood

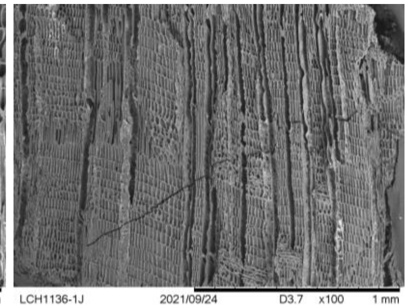
Transverse View



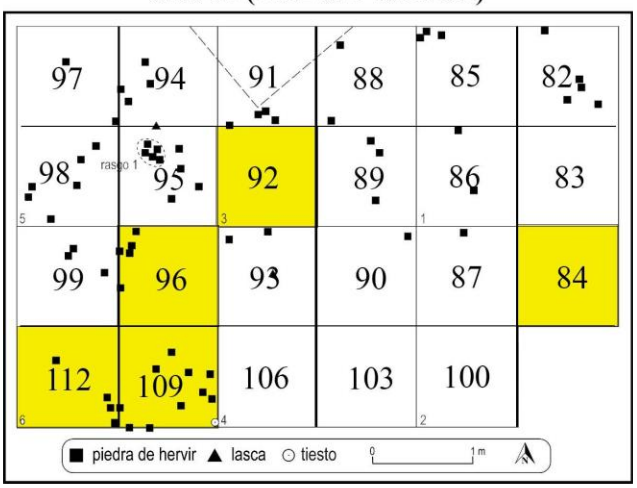
Tangential View



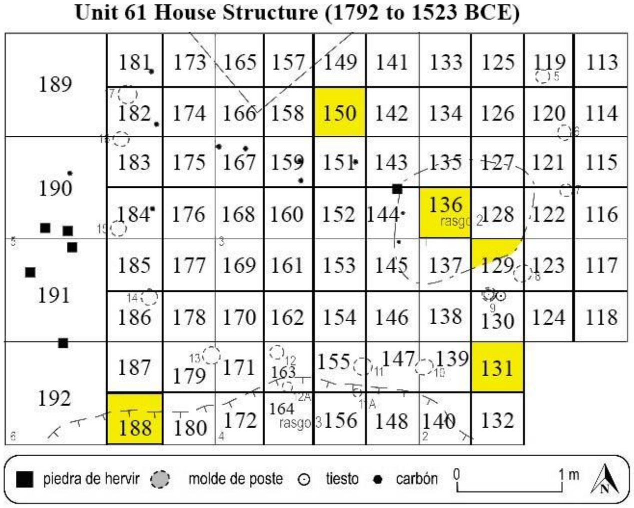
Radial View



Unit 60 (1692 to 1456 BCE)

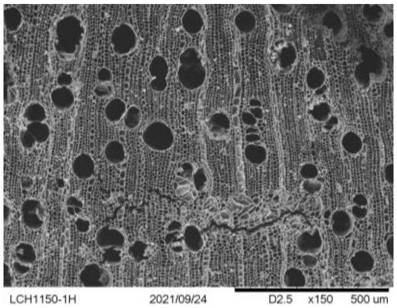


Unit 61 House Structure (1792 to 1523 BCE)

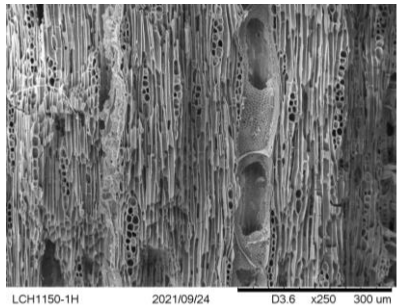


Scientific Name: APOCYNACEAE *Thevetia* sp.
Common Name: yellow oleander

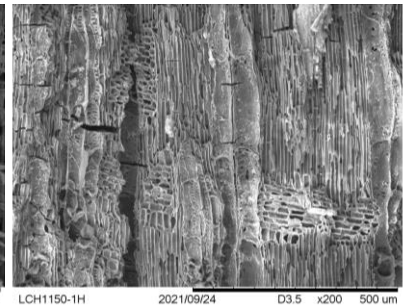
Transverse View



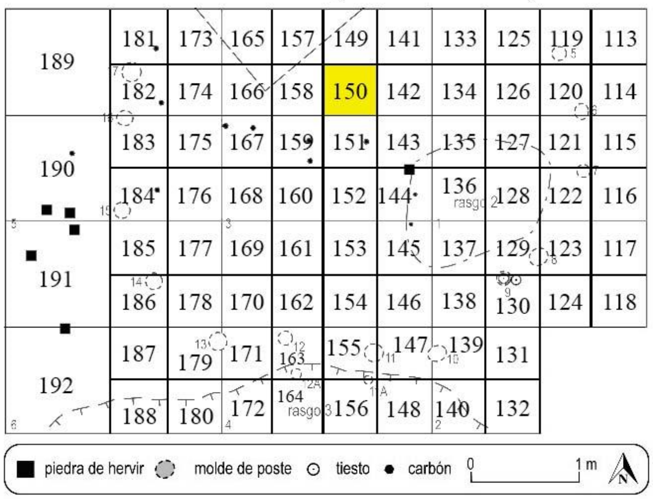
Tangential View



Radial View

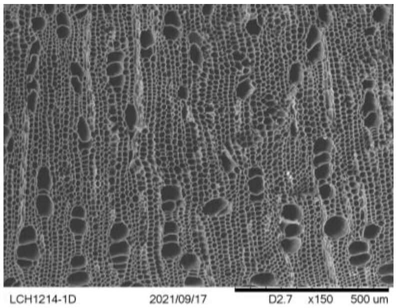


Unit 61 House Structure (1792 to 1523 BCE)

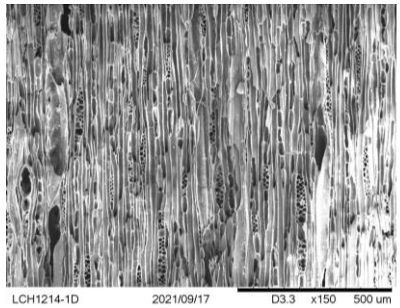


Scientific Name: ARALIACEAE *Dendropanax* sp.
Common Name: vaquero

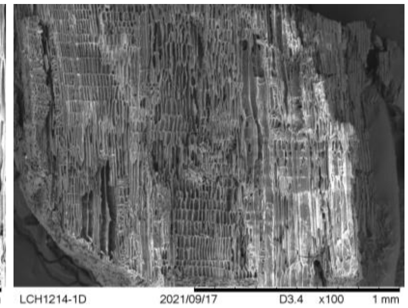
Transverse View



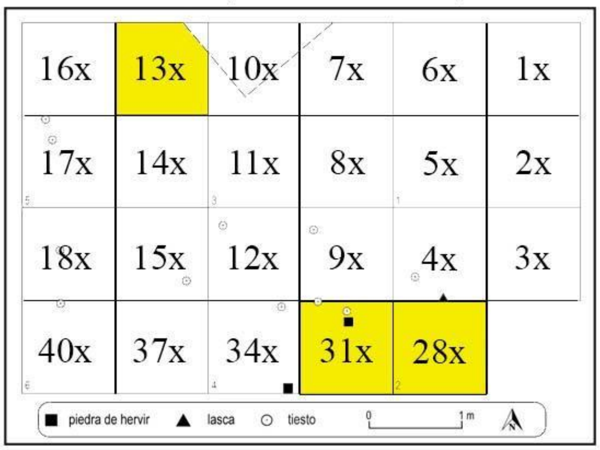
Tangential View



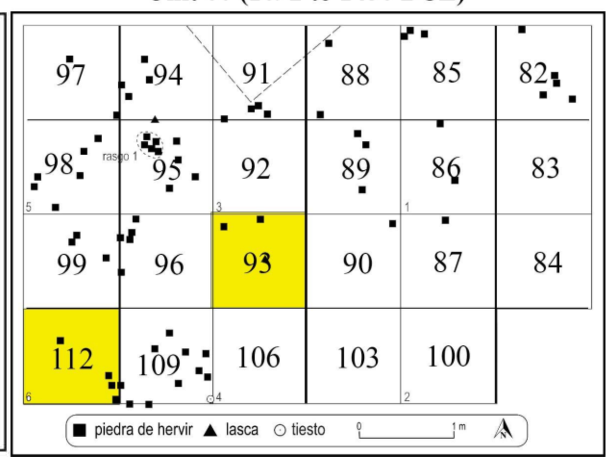
Radial View



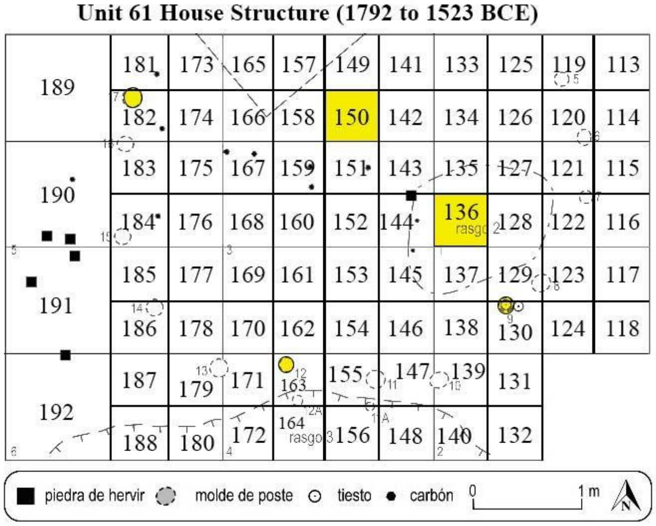
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

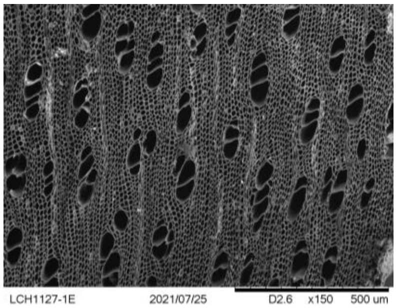


Unit 61 House Structure (1792 to 1523 BCE)

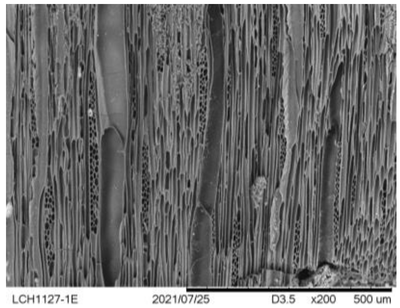


Scientific Name: ARALIACEAE *Schefflera* sp.
Common Name: mangabé

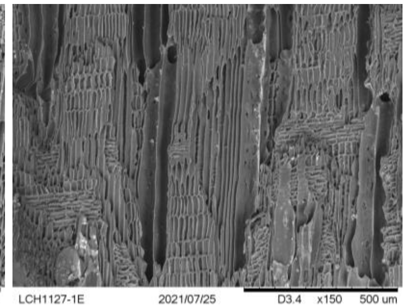
Transverse View



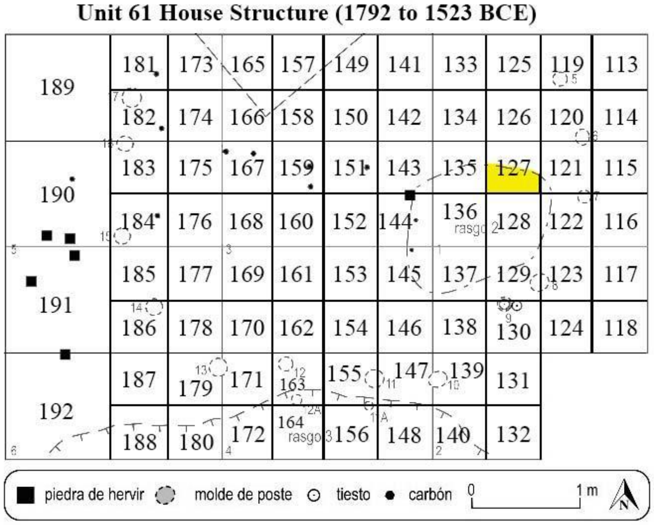
Tangential View



Radial View

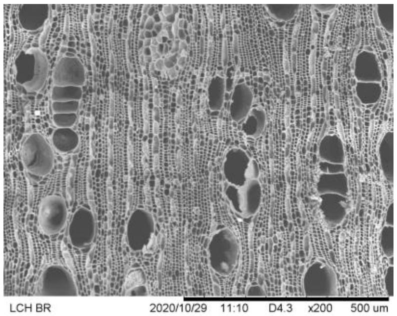


Unit 61 House Structure (1792 to 1523 BCE)

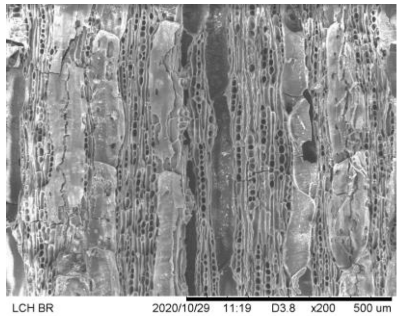


Scientific Name: BIGNONIACEAE cf. *Crescentia alata* Kunth.
Common Name: calabash, jícaro

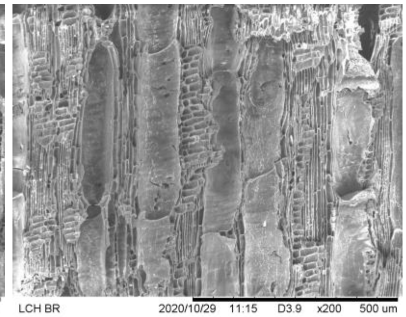
Transverse View



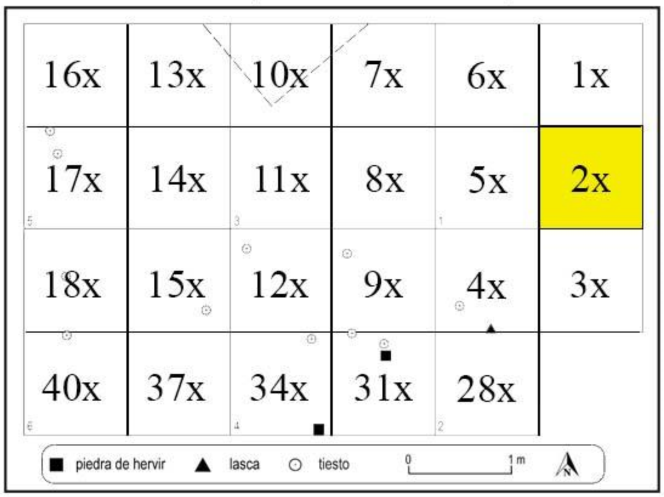
Tangential View



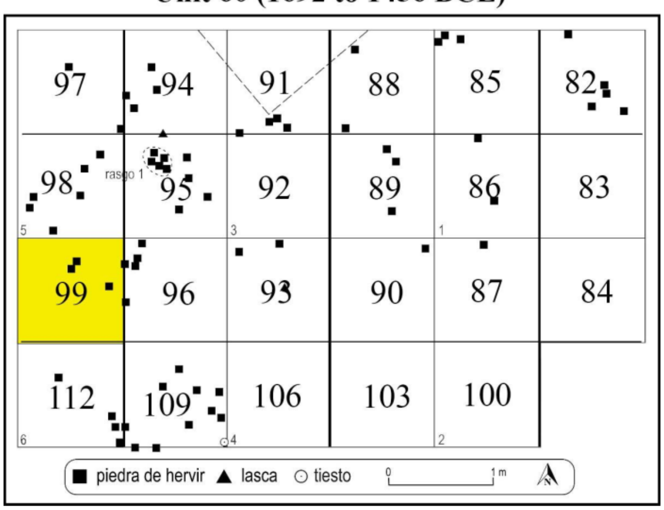
Radial View



Unit 54 (500 BCE to 100 CE)

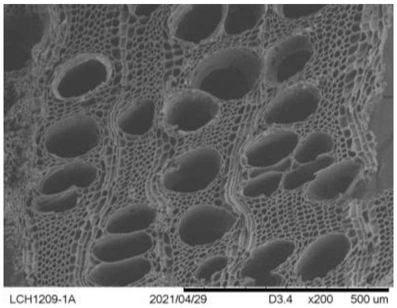


Unit 60 (1692 to 1456 BCE)

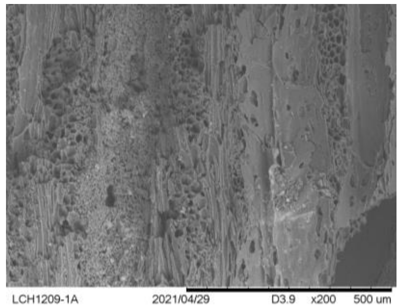


Scientific Name: BIGNONIACEAE *Handroanthus* sp.
Common Name: poui, pau d'arco, or ipê

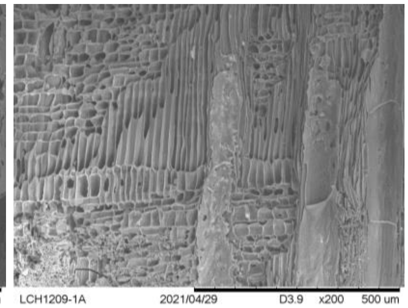
Transverse View



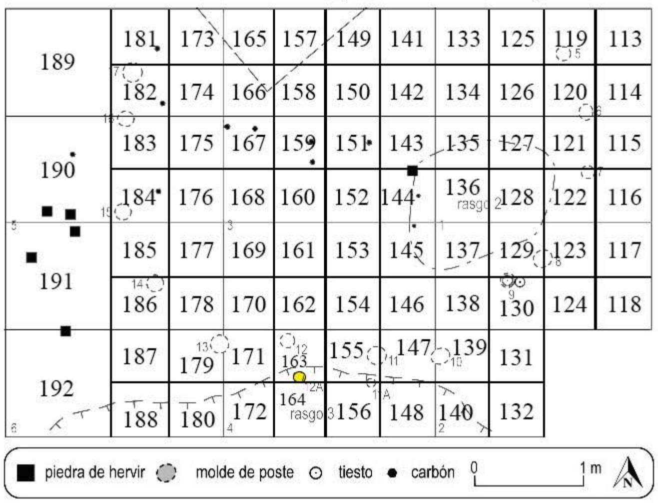
Tangential View



Radial View

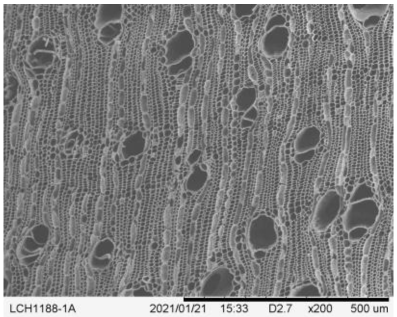


Unit 61 House Structure (1792 to 1523 BCE)

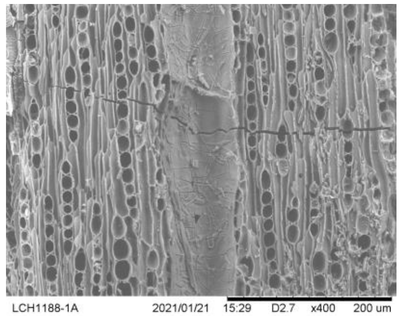


Scientific Name: BIGNONIACEAE *Jacaranda* spp.
Common Name: blue flamboyant, jacaranda, nazareno, guabanday, chingala, gobaja

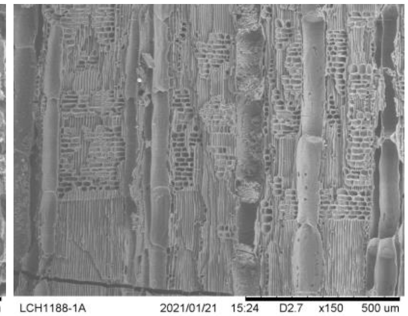
Transverse View



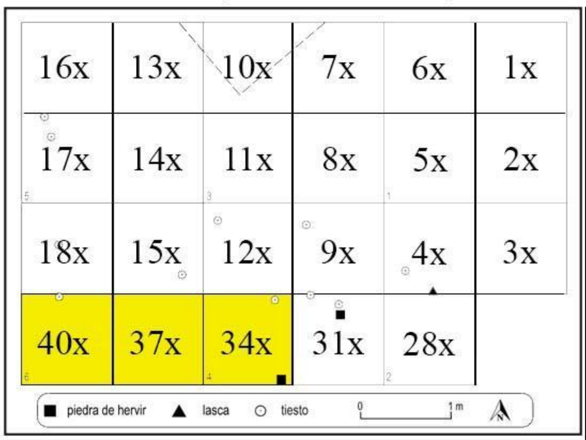
Tangential View



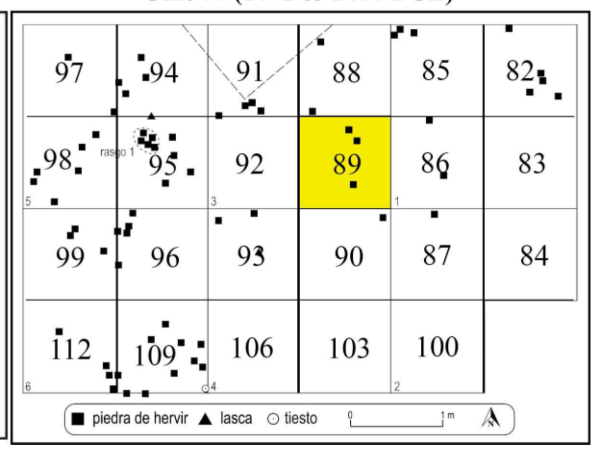
Radial View



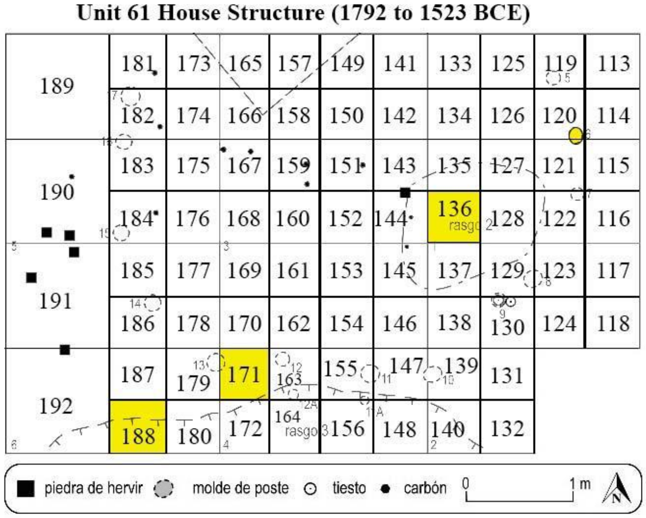
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)



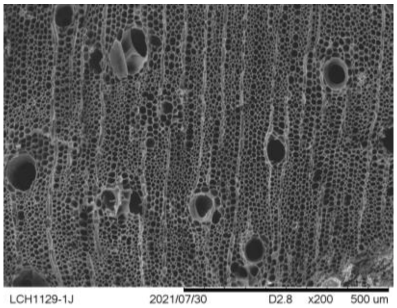
Unit 61 House Structure (1792 to 1523 BCE)



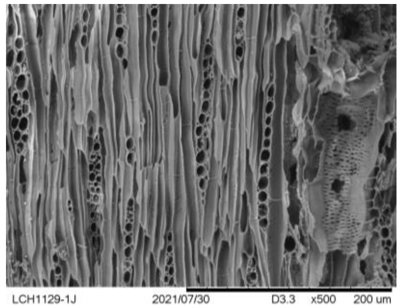
* All *Jacaranda* spp. combined in maps

Scientific Name: BIGNONIACEAE *Parmentiera* sp.
Common Name: arbol de vela

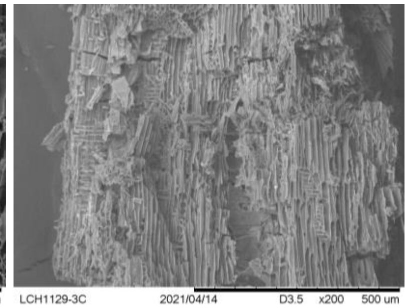
Transverse View



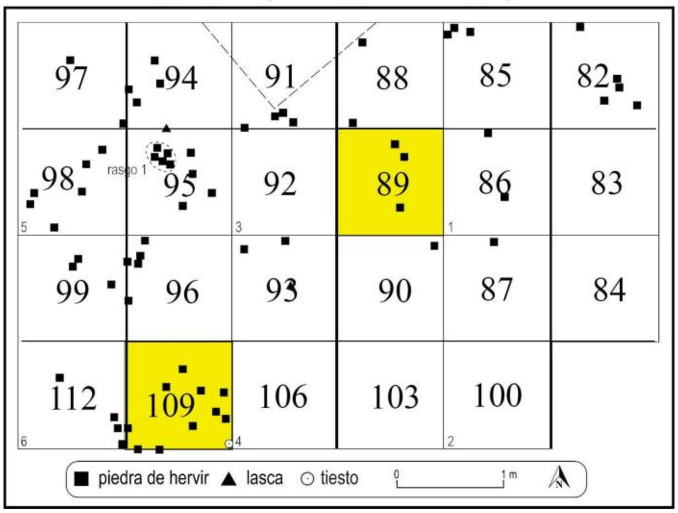
Tangential View



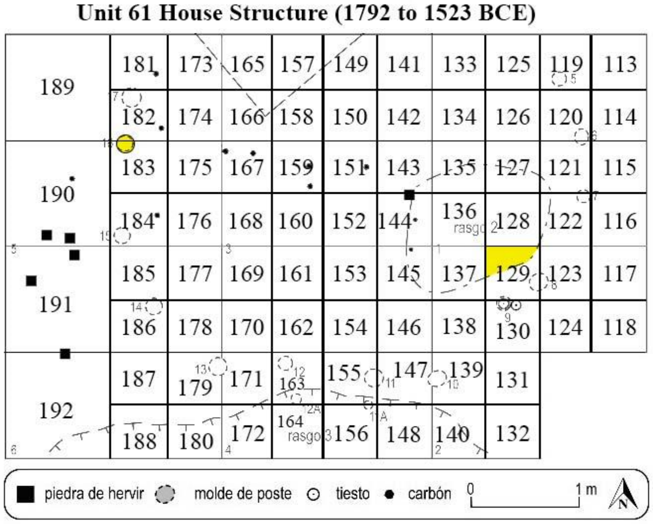
Radial View



Unit 60 (1692 to 1456 BCE)

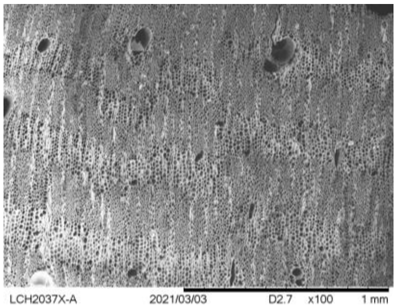


Unit 61 House Structure (1792 to 1523 BCE)

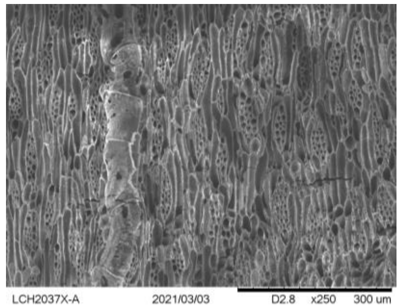


Scientific Name: BIGNONIACEAE *Tabebuia* sp.
Common Name: roble de sabana

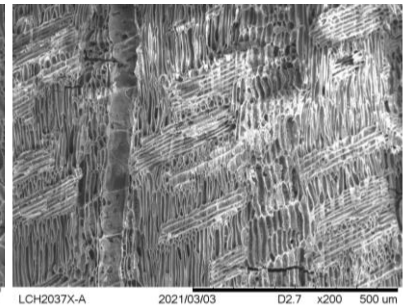
Transverse View



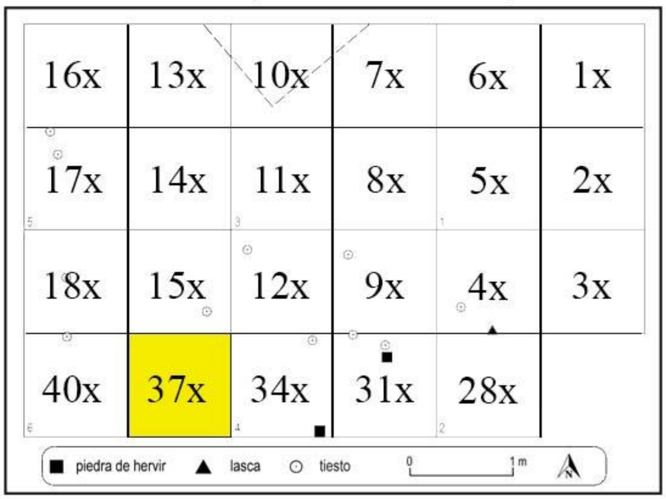
Tangential View



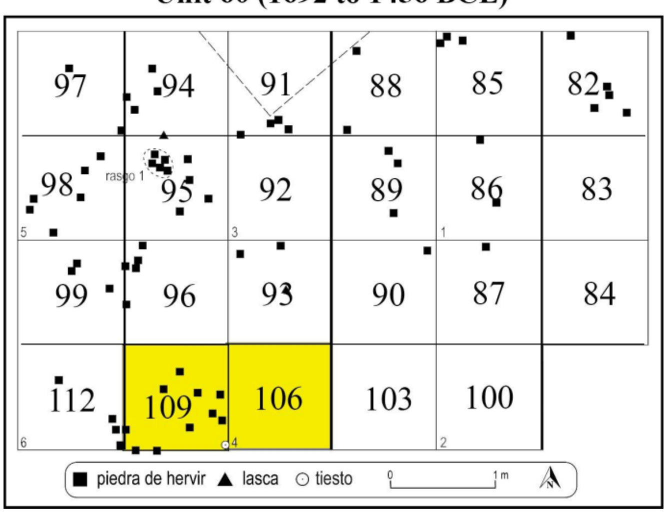
Radial View



Unit 54 (500 BCE to 100 CE)

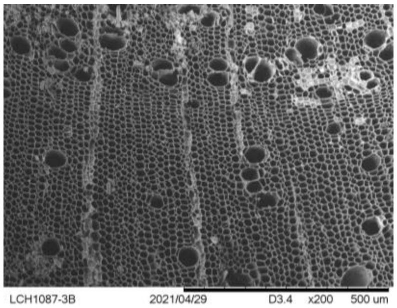


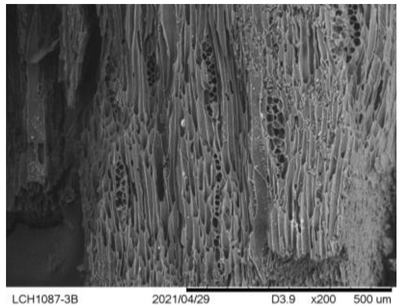
Unit 60 (1692 to 1456 BCE)



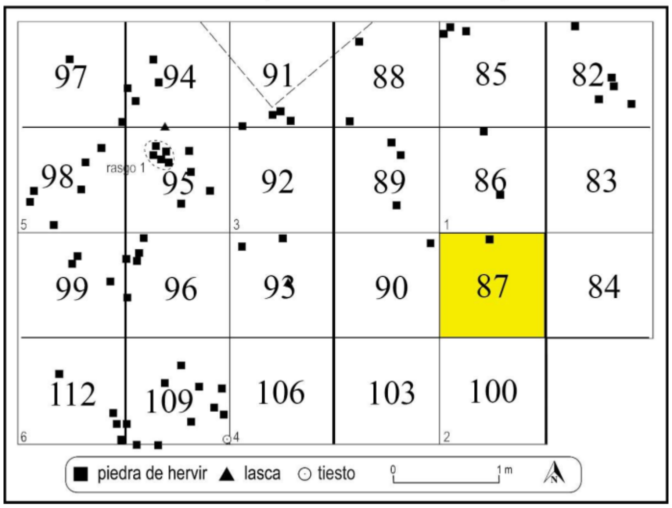
Scientific Name: BIGNONIACEAE *Tecoma stans* (L.) Juss. ex Kunth
Common Name: el vainillo

Transverse View | Tangential View



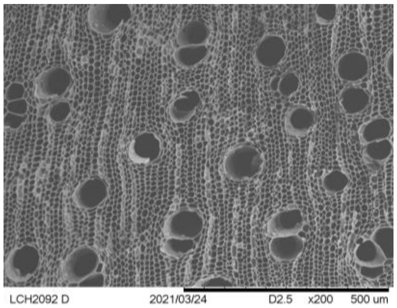


Unit 60 (1692 to 1456 BCE)

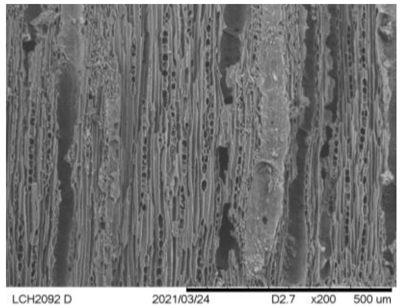


Scientific Name: BIXACEAE *Bixa* cf. *orellana* L.
Common Name: achiote, annatto

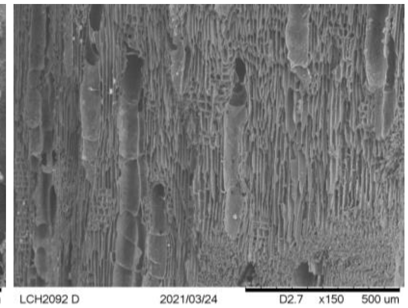
Transverse View



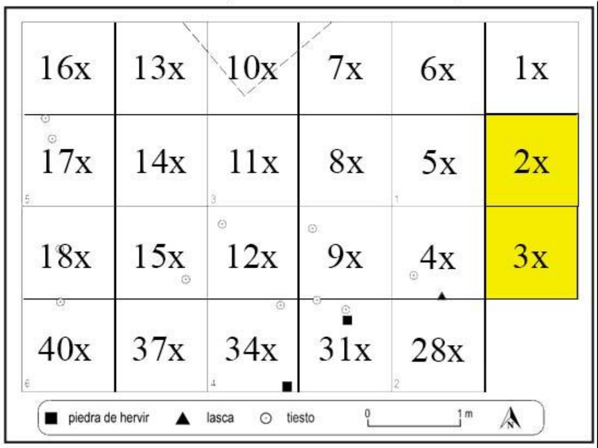
Tangential View



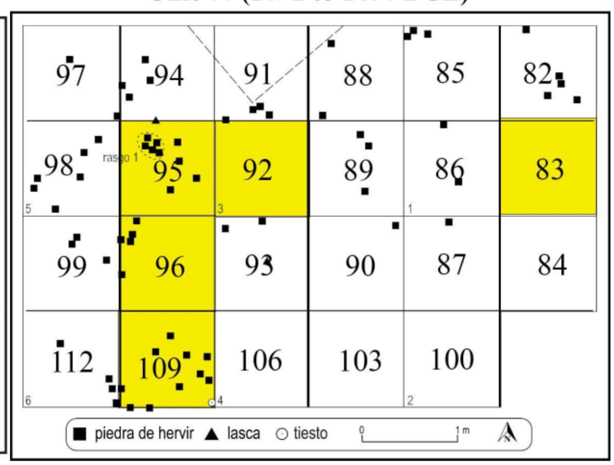
Radial View



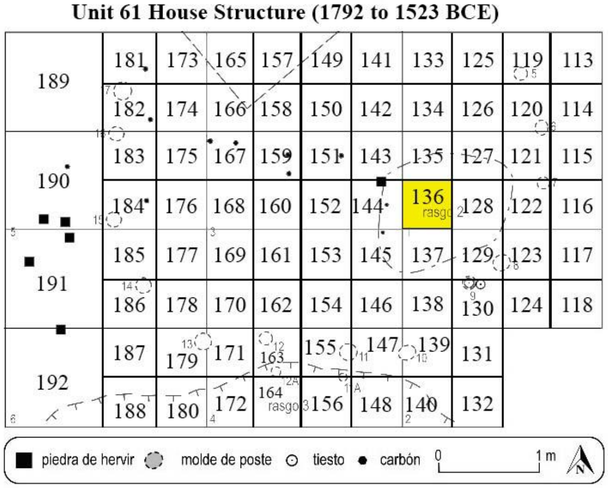
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

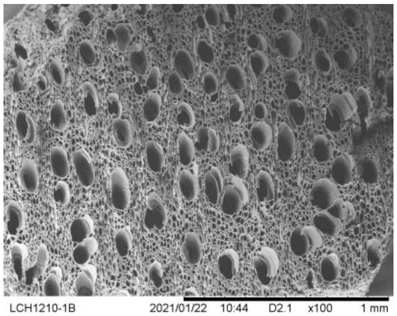


Unit 61 House Structure (1792 to 1523 BCE)

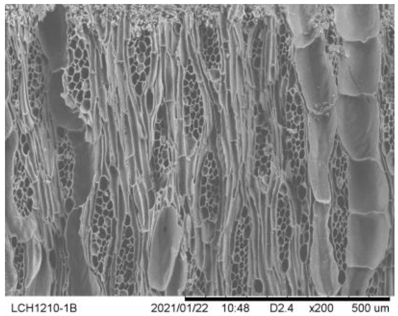


Scientific Name: BORAGINACEAE *Bourreria* sp.
Common Name: canalú

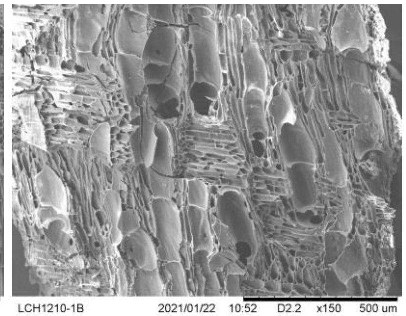
Transverse View



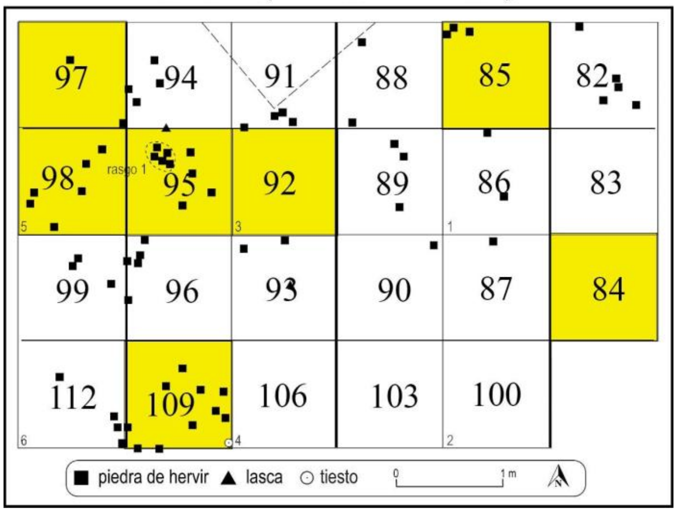
Tangential View



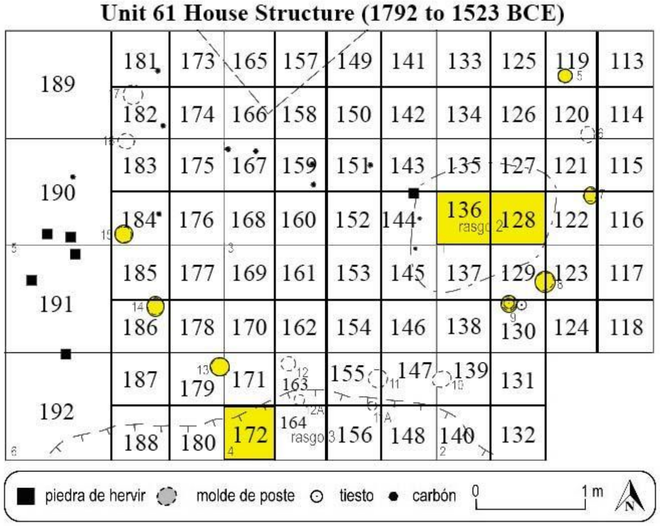
Radial View



Unit 60 (1692 to 1456 BCE)

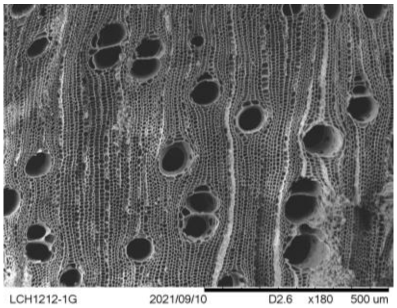


Unit 61 House Structure (1792 to 1523 BCE)

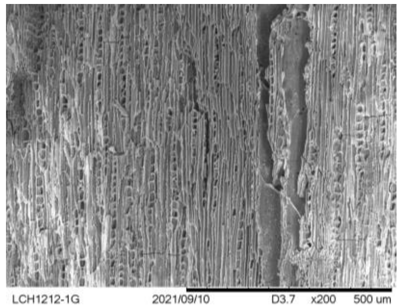


Scientific Name: BURSERACEAE *Tetragastris panamensis* (Engl.) Kuntze
Common Name: anime, cuatro estómagos, chutra, kerosin

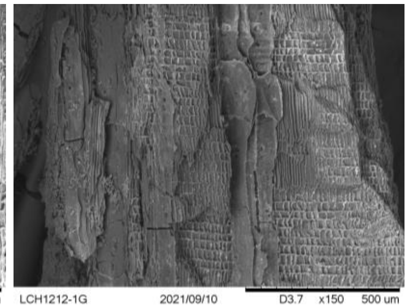
Transverse View



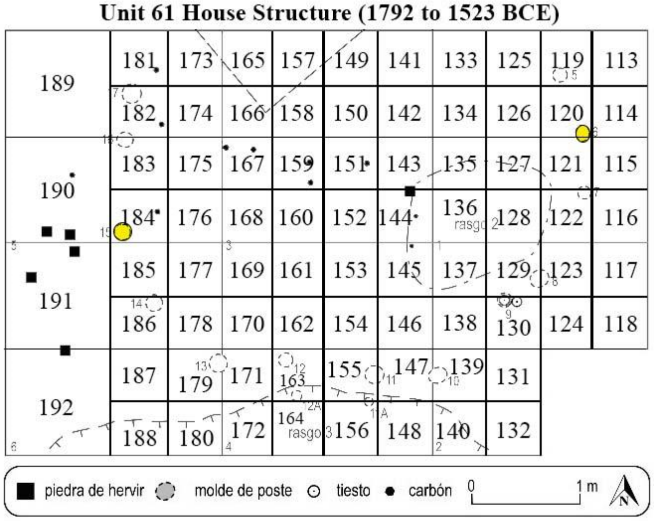
Tangential View



Radial View

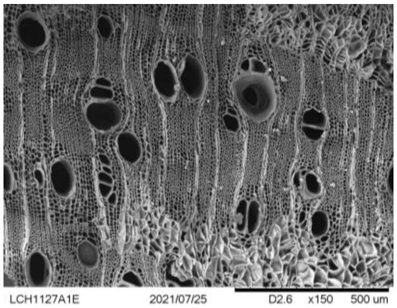


Unit 61 House Structure (1792 to 1523 BCE)

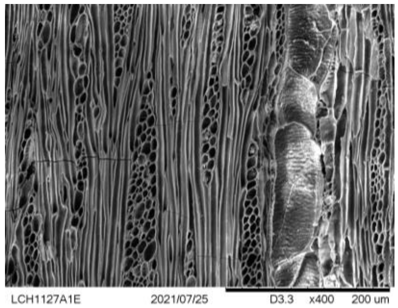


Scientific Name: CANNABACEAE *Celtis* sp.
Common Name: hackberry

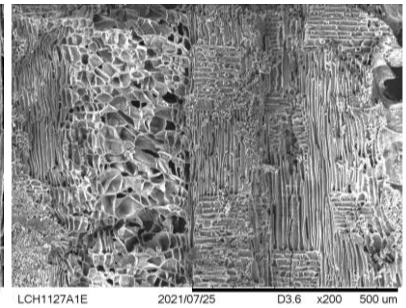
Transverse View



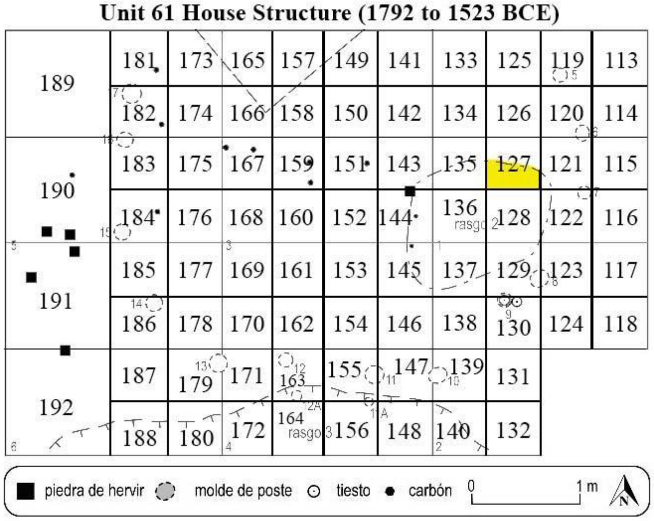
Tangential View



Radial View

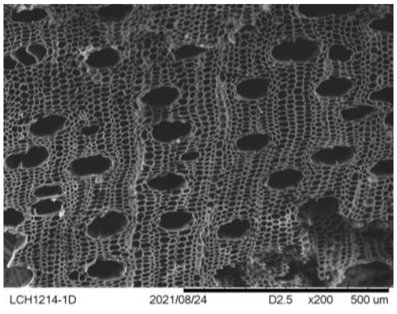


Unit 61 House Structure (1792 to 1523 BCE)

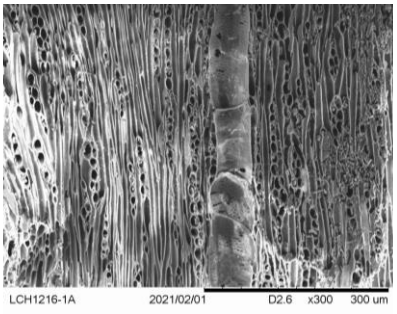


Scientific Name: CANNABACEAE *Trema* sp.
Common Name: jordancillo, capulin

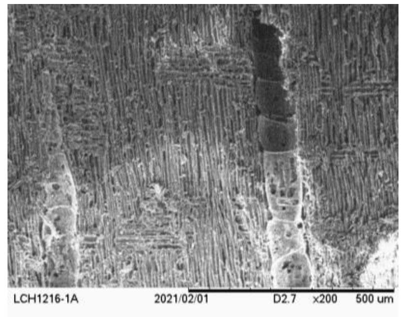
Transverse View



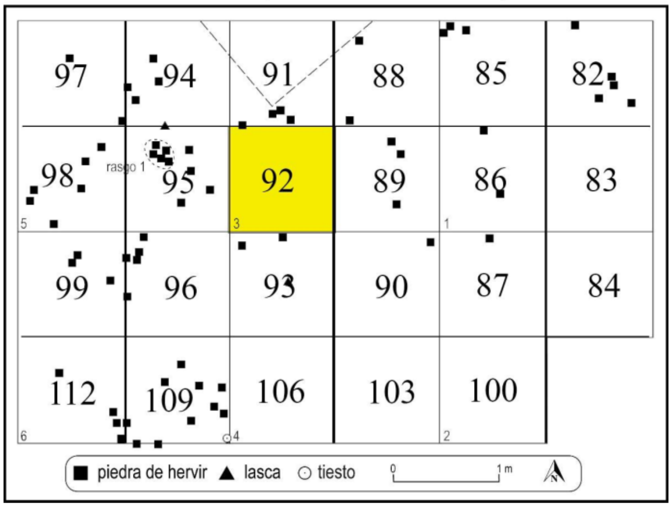
Tangential View



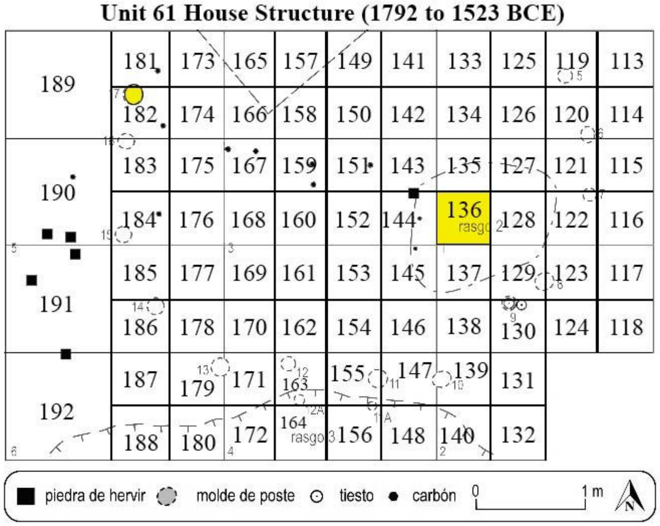
Radial View



Unit 60 (1692 to 1456 BCE)

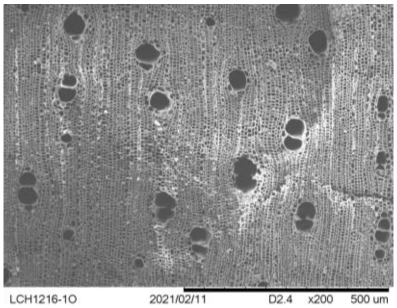


Unit 61 House Structure (1792 to 1523 BCE)

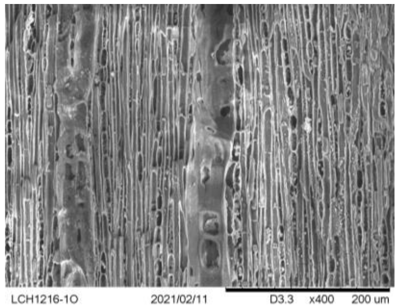


Scientific Name: CAPPARACEAE *Capparis* sp.
Common Name: caper bush, carne de venado, garrotillo

Transverse View

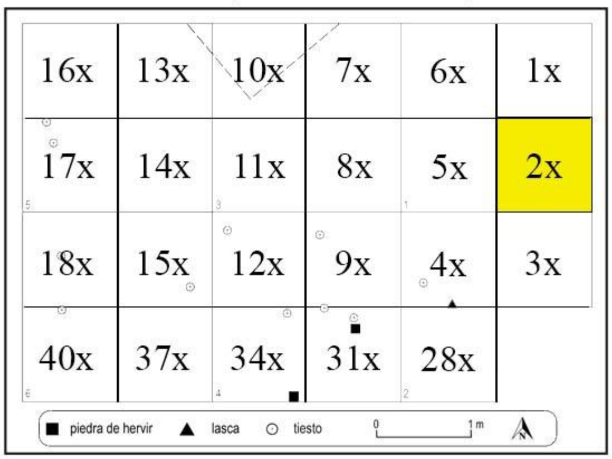


Tangential View

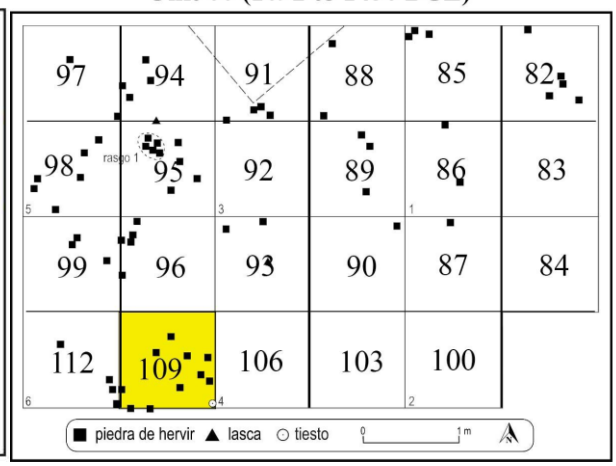


Radial View

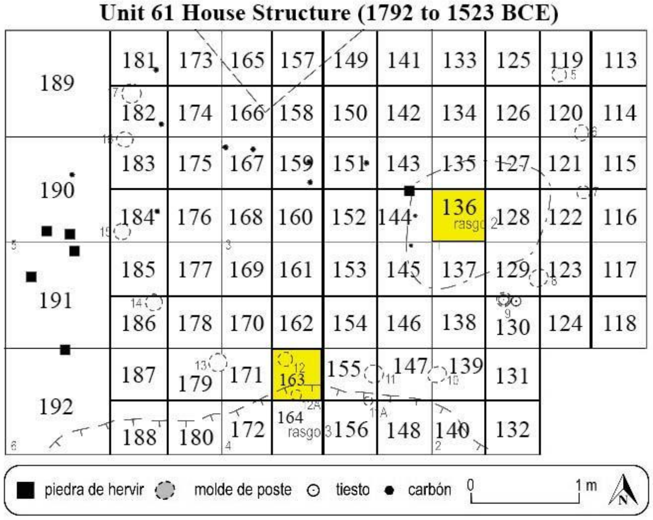
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

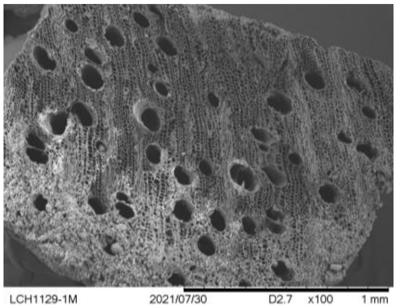


Unit 61 House Structure (1792 to 1523 BCE)

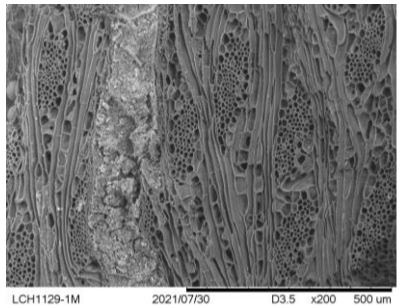


Scientific Name: CAPPARACEAE *Crateva* sp.
Common Name: guaco, palo de guaco, perguetano, mongo

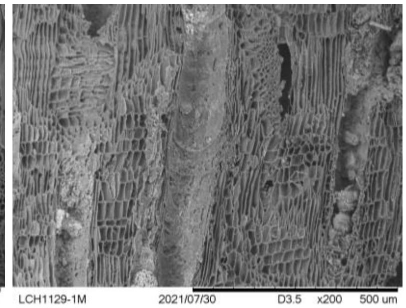
Transverse View



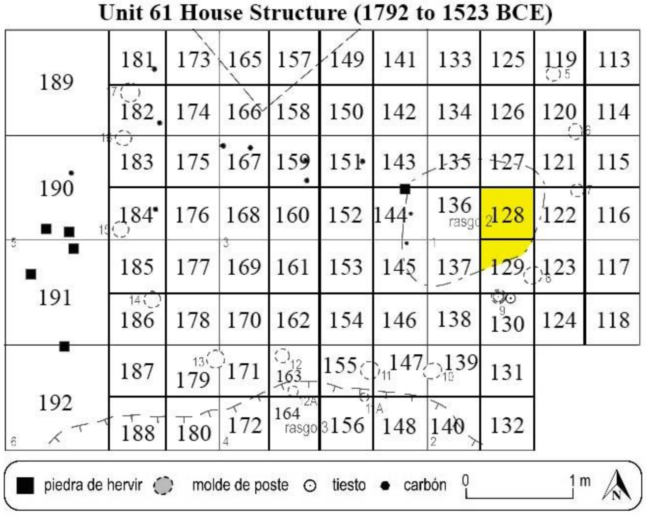
Tangential View



Radial View

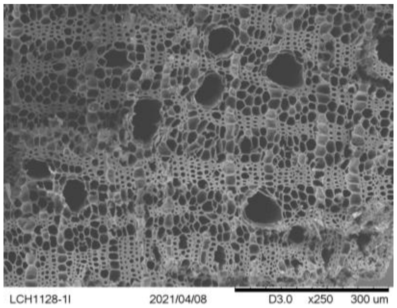


Unit 61 House Structure (1792 to 1523 BCE)

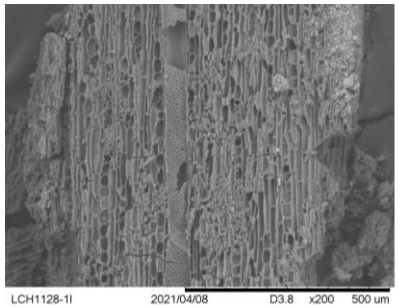


Scientific Name: CELASTRACEAE *Cheiloclinium cognatum* (Miers) A.C. Sm.
Common Name: fruta de mono, cocora

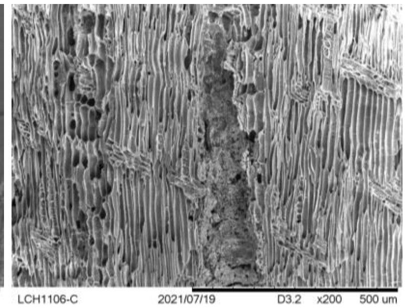
Transverse View



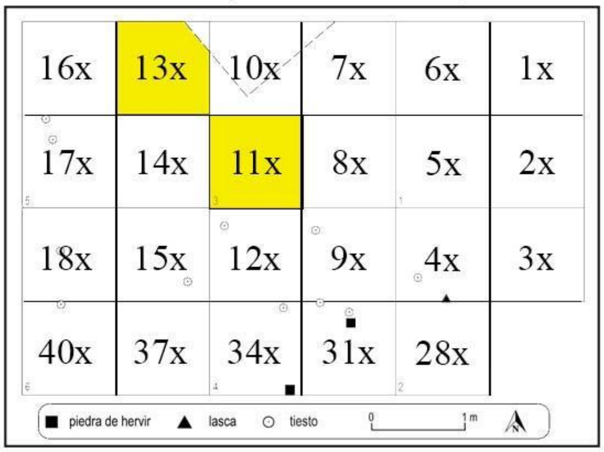
Tangential View



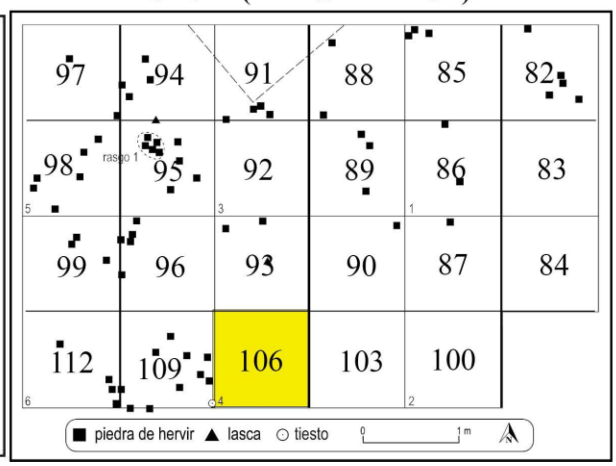
Radial View



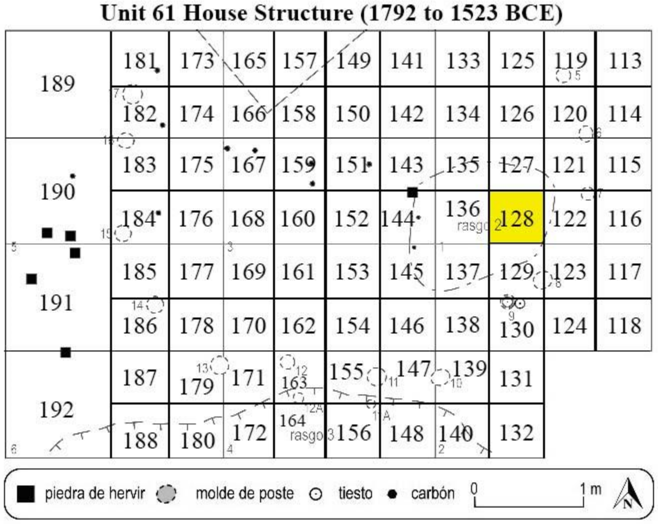
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

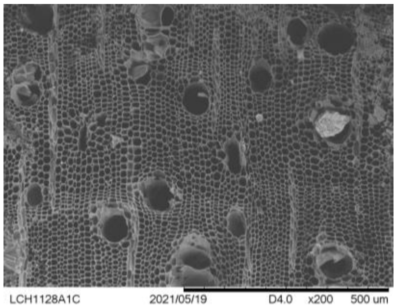


Unit 61 House Structure (1792 to 1523 BCE)

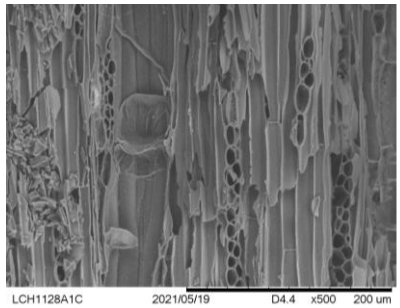


Scientific Name: CELASTRACEAE *Maytenus* sp.
Common Name: mayten

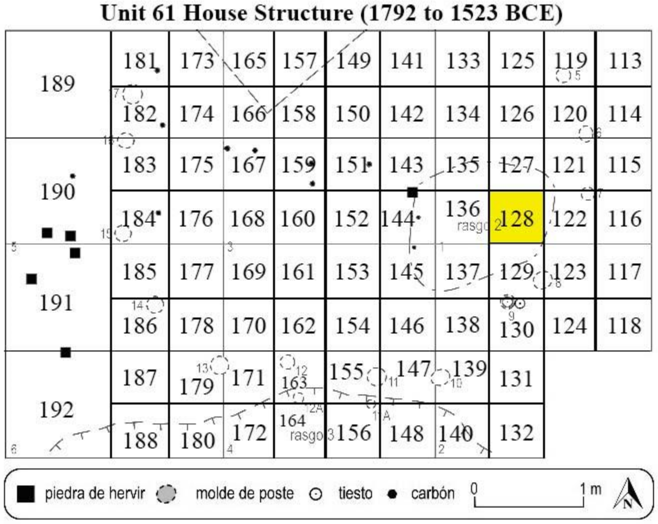
Transverse View



Tangential View

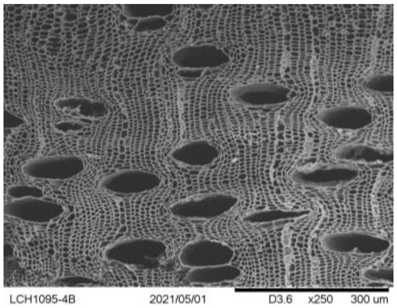


Unit 61 House Structure (1792 to 1523 BCE)

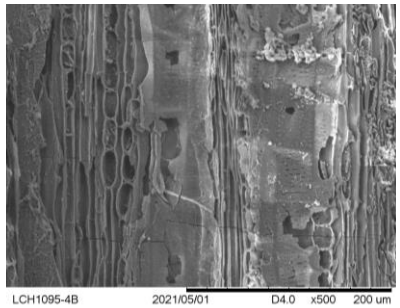


Scientific Name: CELASTRACEAE *Salacia* sp.
Common Name: salacia

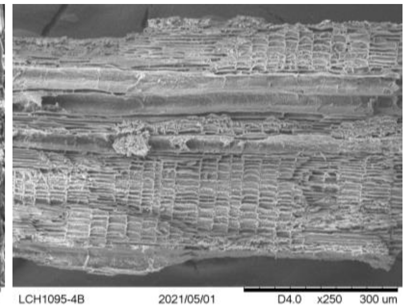
Transverse View



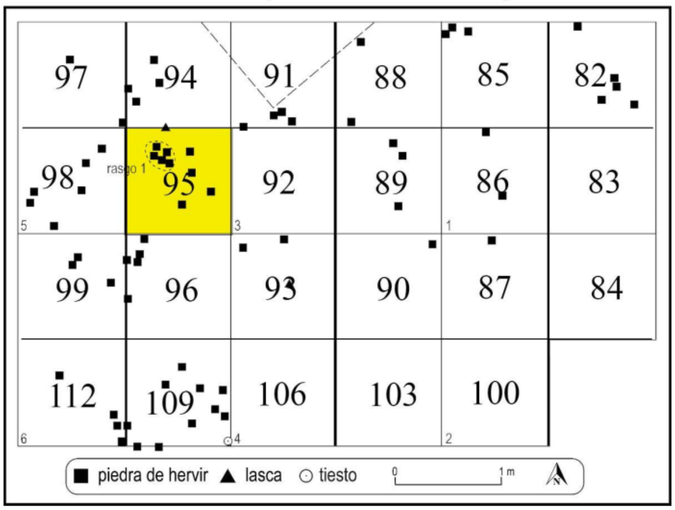
Tangential View



Radial View

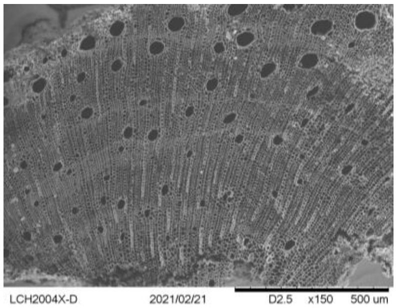


Unit 60 (1692 to 1456 BCE)

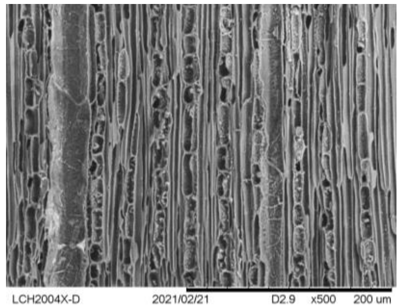


Scientific Name: CELASTRACEAE *Wimmeria* sp.
Common Name: no common name

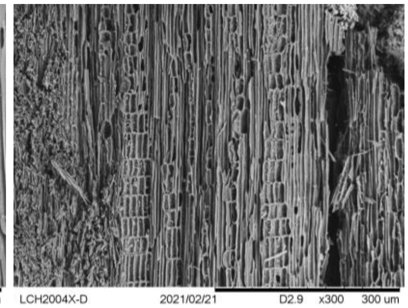
Transverse View



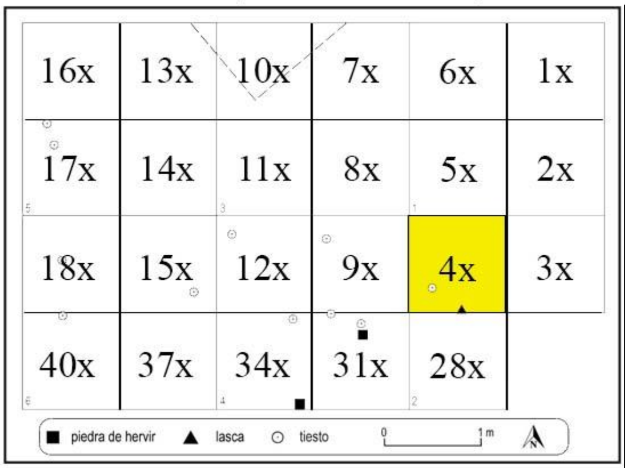
Tangential View



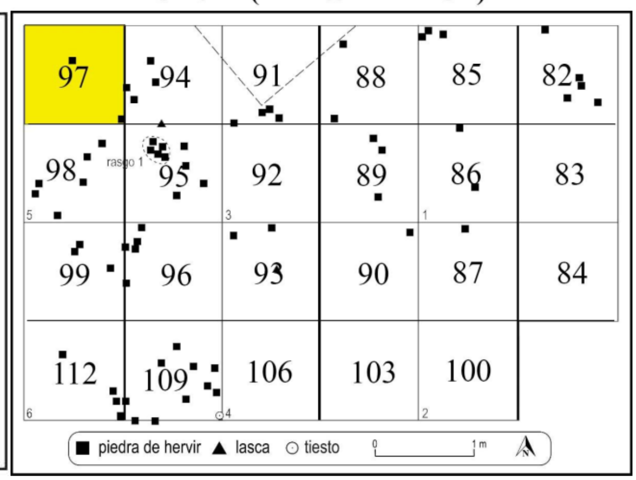
Radial View



Unit 54 (500 BCE to 100 CE)

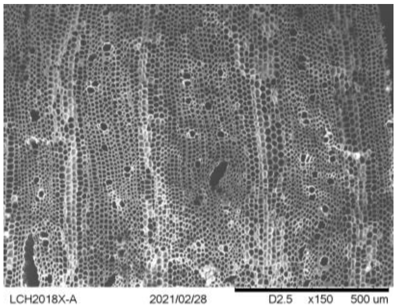


Unit 60 (1692 to 1456 BCE)

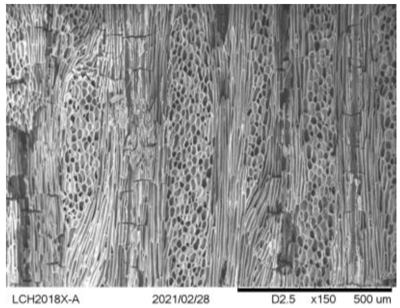


Scientific Name: CHLORANTHACEAE *Hedyosmum* sp.
Common Name: sauquillo, limoncillo

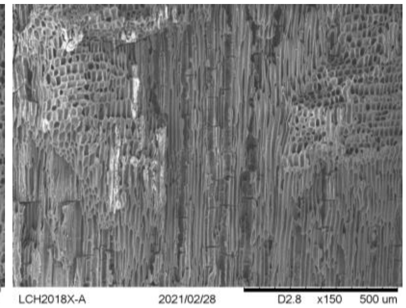
Transverse View



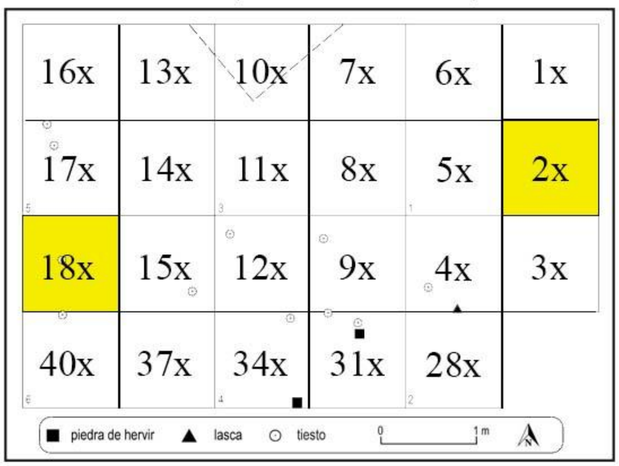
Tangential View



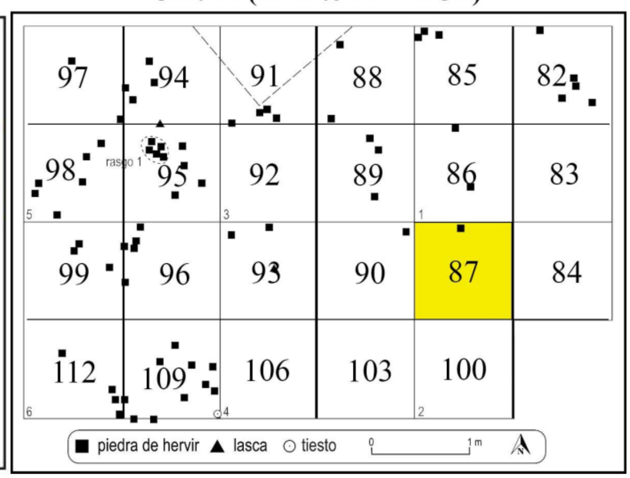
Radial View



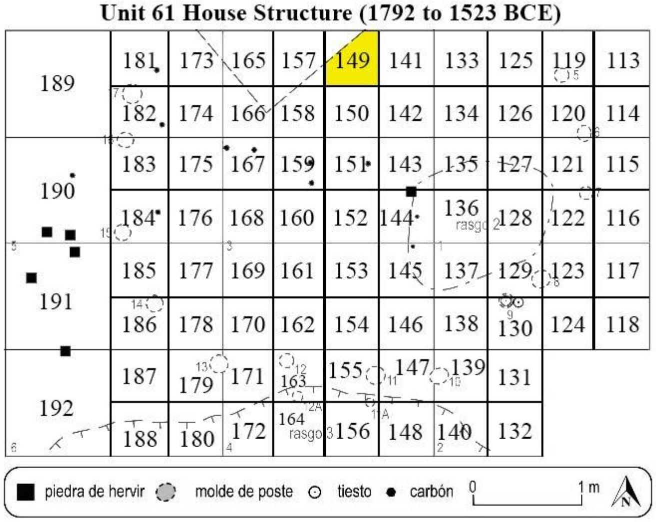
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

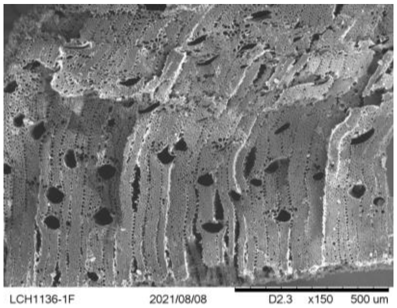


Unit 61 House Structure (1792 to 1523 BCE)

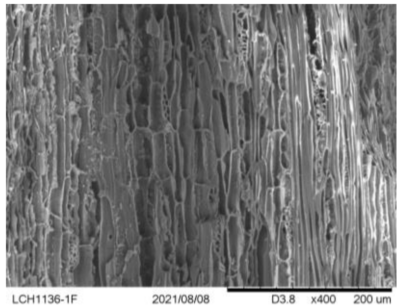


Scientific Name: CHRYSOBALANACEAE *Hirtella* sp.
Common Name: camaron, garrapato, conejo

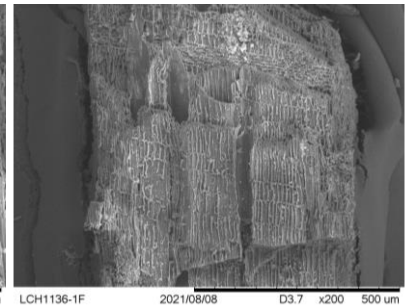
Transverse View



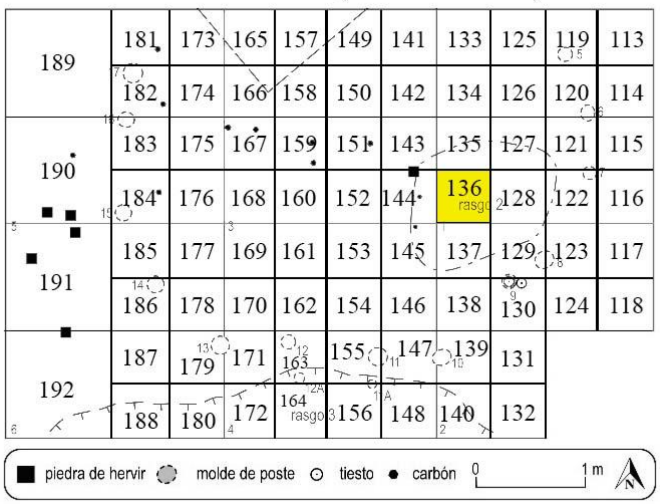
Tangential View



Radial View

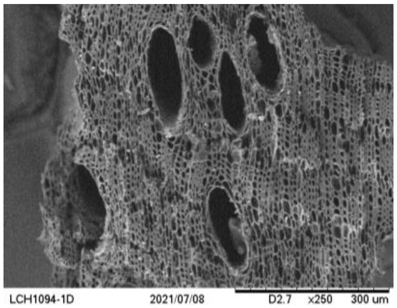


Unit 61 House Structure (1792 to 1523 BCE)

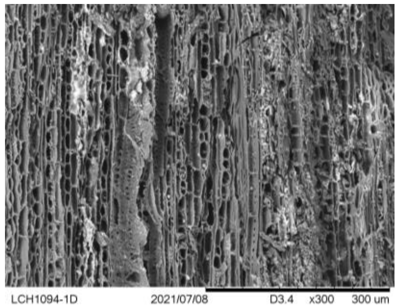


Scientific Name: CHRYSOBALANACEAE *Licania* sp.
Common Name: corocillo, garrapato, raspa, rasca, rascador, sapote, sangre

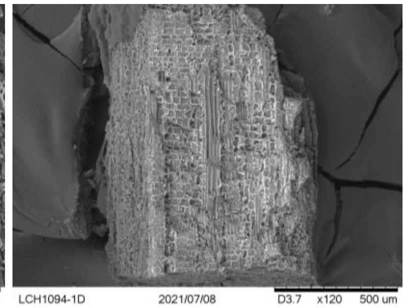
Transverse View



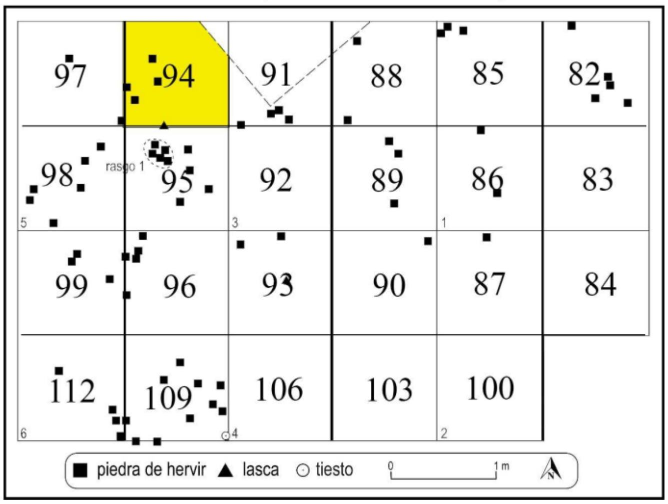
Tangential View



Radial View

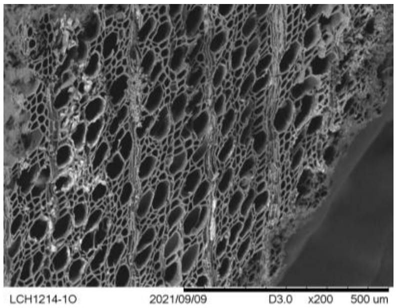


Unit 60 (1692 to 1456 BCE)

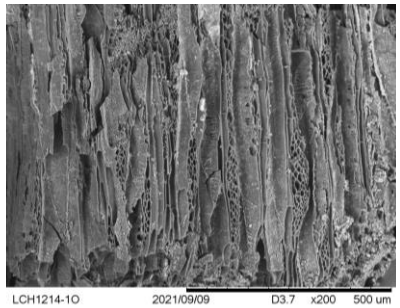


Scientific Name: CLETHRACEAE *Clethra* sp.
Common Name: nancito, nancillo, nance macho, memeicillo, pepperbush

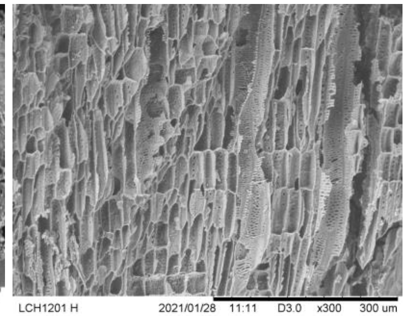
Transverse View

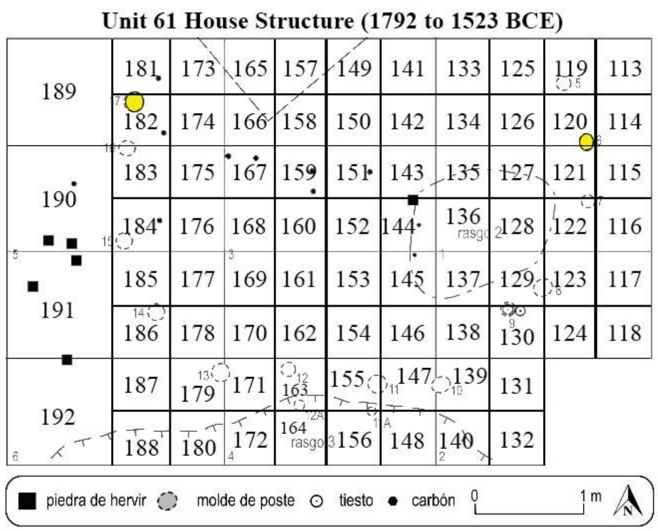


Tangential View



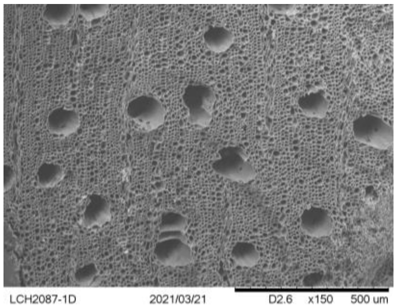
Radial View



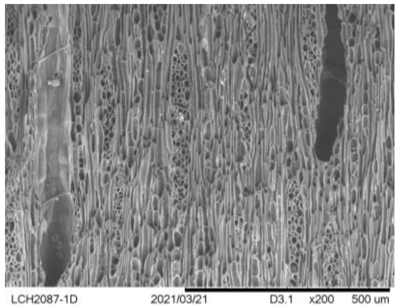


Scientific Name: CLUSIACEAE *Garcinia* sp.
Common Name: madroño, chaparrón, sastra, sastro

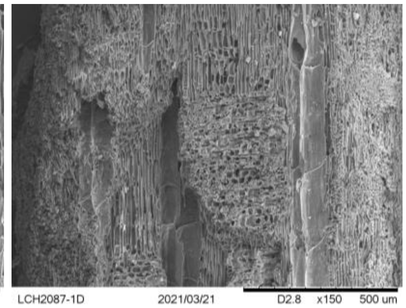
Transverse View



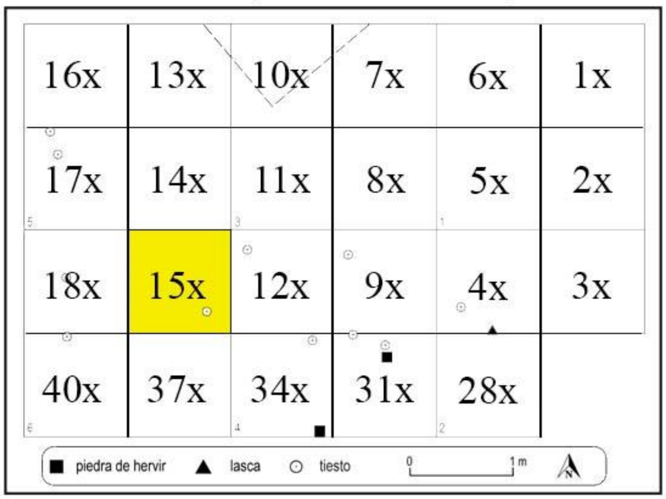
Tangential View



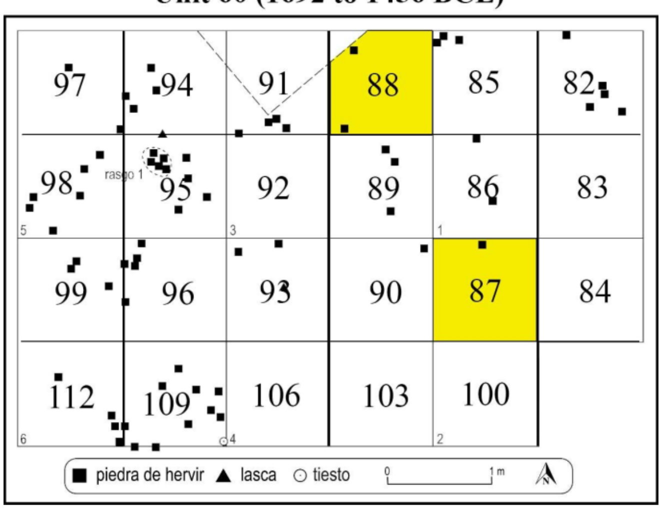
Radial View



Unit 54 (500 BCE to 100 CE)

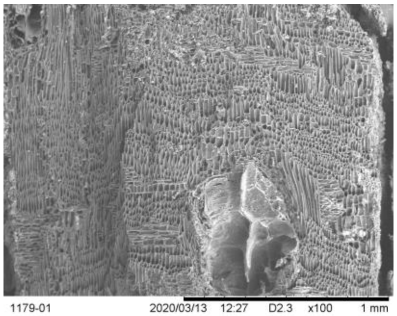


Unit 60 (1692 to 1456 BCE)

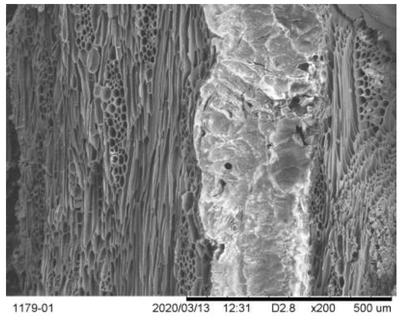


Scientific Name: CLUSIACEAE *Symphonia globulifera* L. f.
Common Name: cerillo, cero, barillo

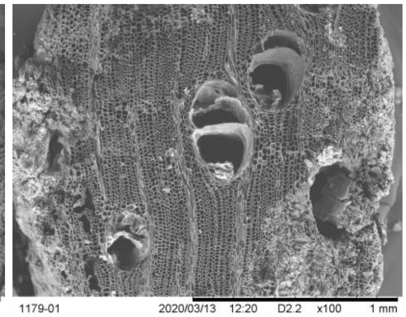
Transverse View



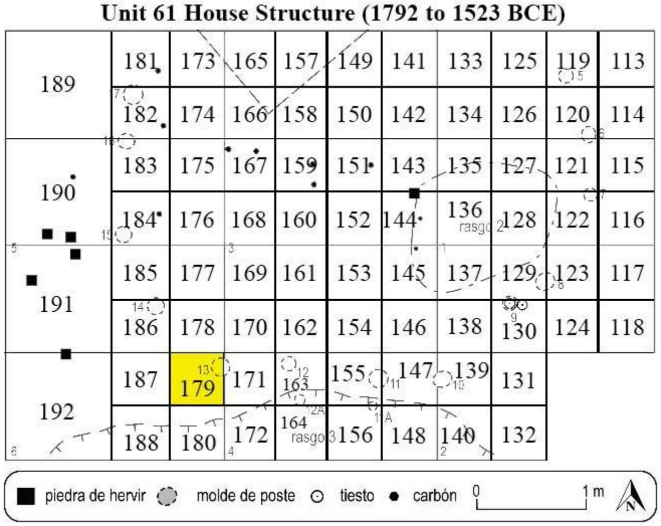
Tangential View



Radial View

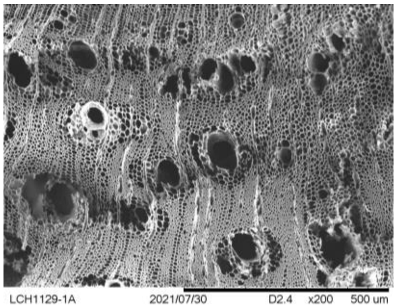


Unit 61 House Structure (1792 to 1523 BCE)

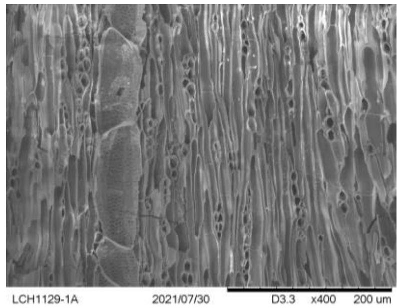


Scientific Name: COMBRETACEAE *Buchenavia* sp.
Common Name: amarillo, amarillo de pepita

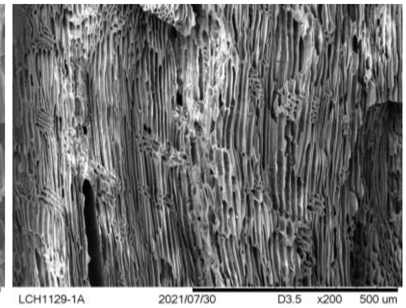
Transverse View



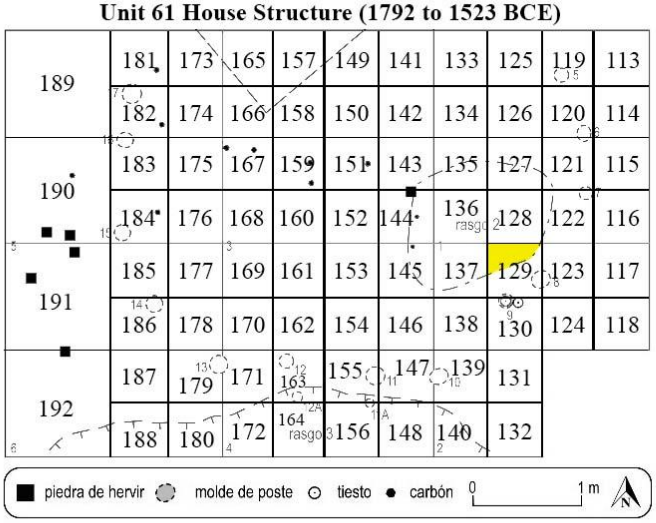
Tangential View



Radial View

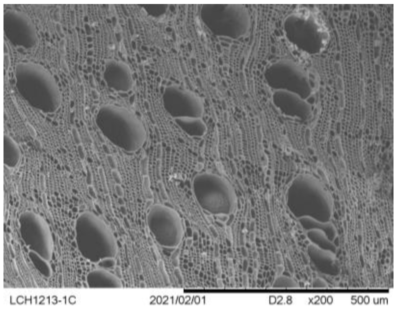


Unit 61 House Structure (1792 to 1523 BCE)

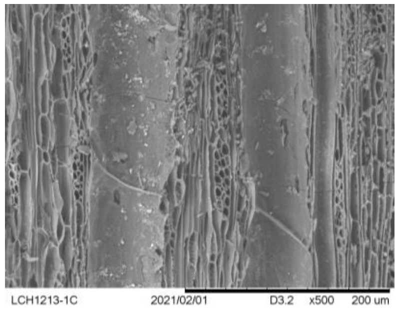


Scientific Name: COMBRETACEAE *Terminalia* sp. (wood charcoal only - fruits in Appendix G)
Common Name: tropical almond, black olive, guayabo de montaña, guayabillo, guayabón, amarillo, roble amarillo, carabazuelo

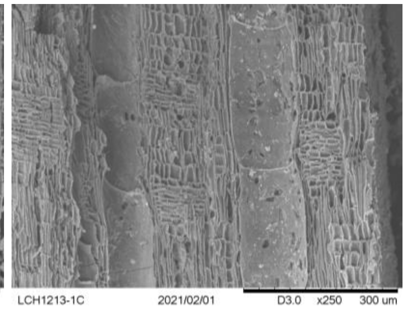
Transverse View



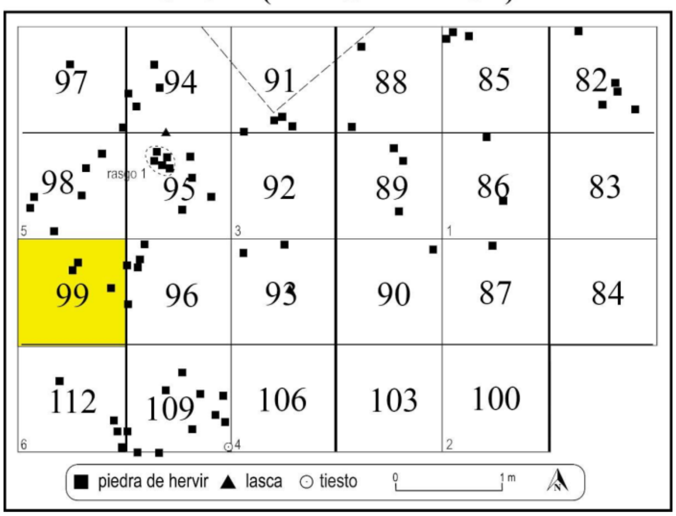
Tangential View



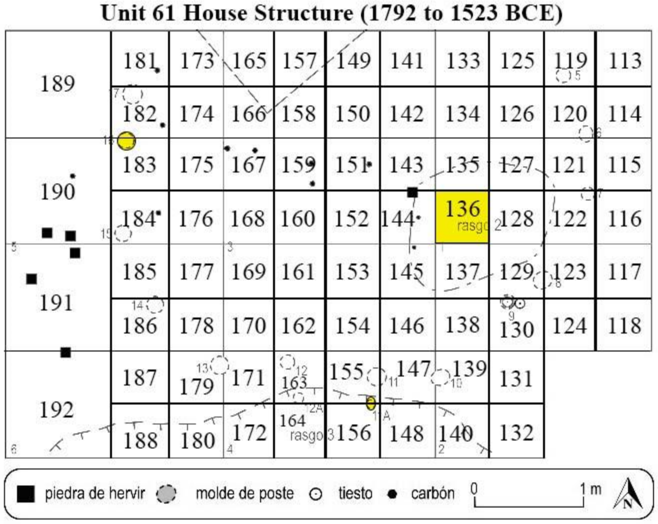
Radial View



Unit 60 (1692 to 1456 BCE)

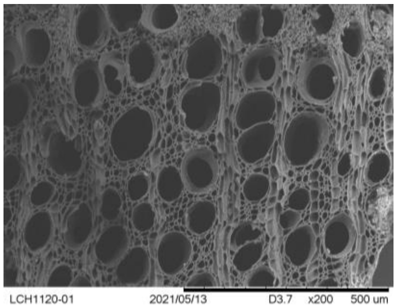


Unit 61 House Structure (1792 to 1523 BCE)

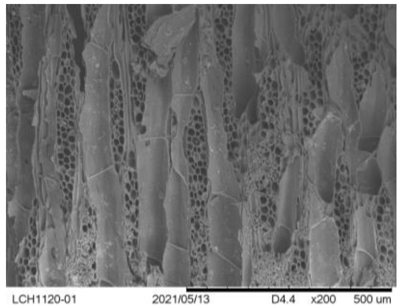


Scientific Name: CORNACEAE *Cornus* cf. *disciflora* DC.
Common Name: lloró, mata hombro, dogwood

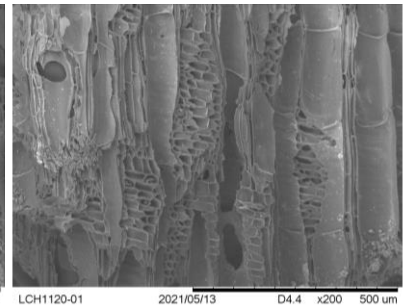
Transverse View



Tangential View

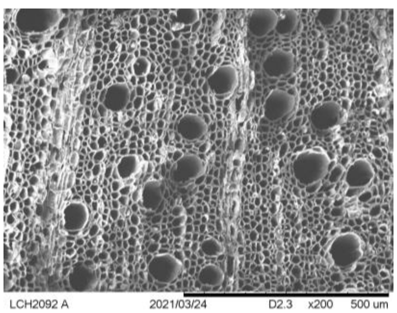


Radial View

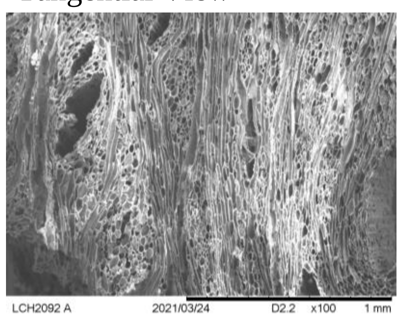


Scientific Name: CORNACEAE *Cornus* cf. *florida* L.
Common Name: lloró, mata hombro, dogwood

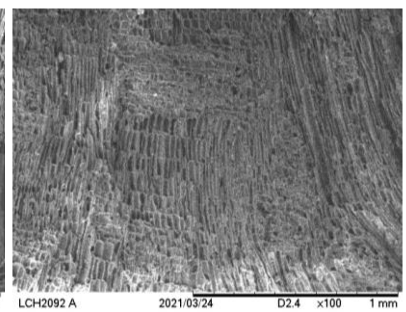
Transverse View



Tangential View

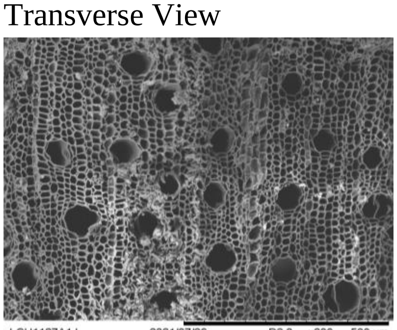


Radial View

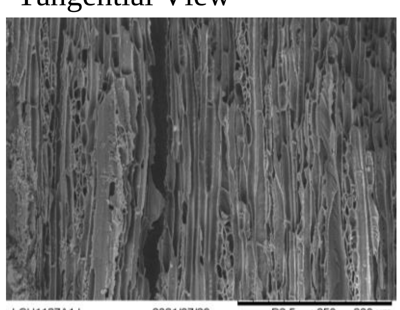


Scientific Name: CORNACEAE *Cornus* cf. *peruviana* J.F. Macbr.
Common Name: lloró, mata hombro, dogwood

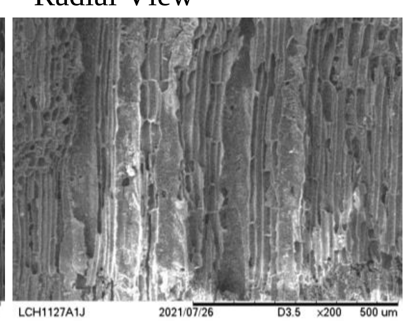
Transverse View



Tangential View

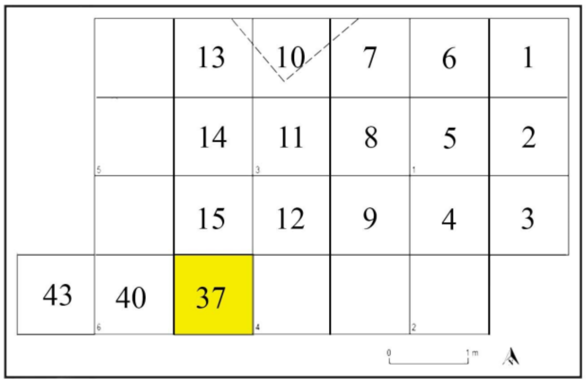


Radial View

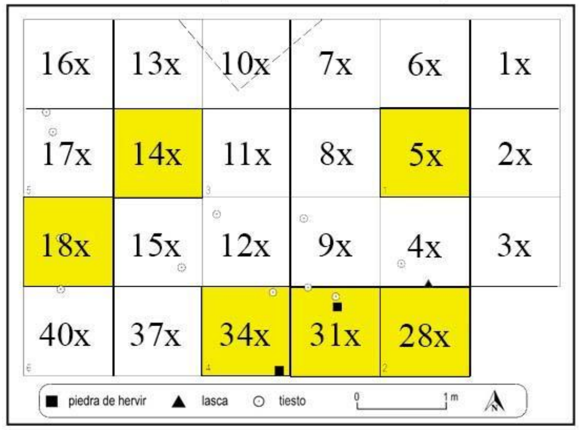


*Maps are of *Cornus* spp. combined

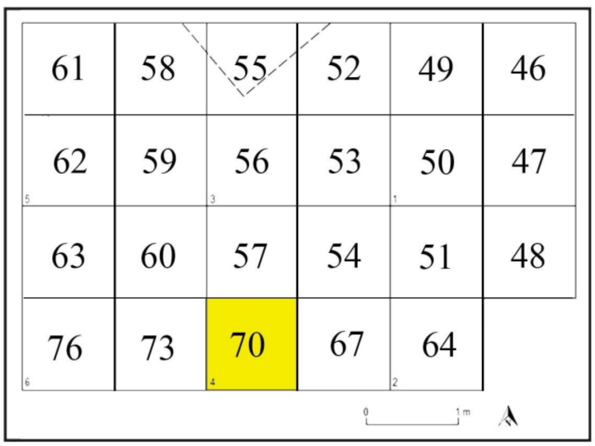
AR 16-15 (100 BCE to 100 CE)



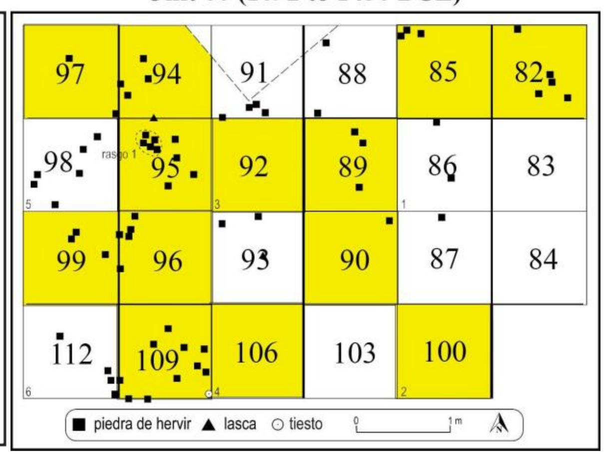
Unit 54 (500 BCE to 100 CE)



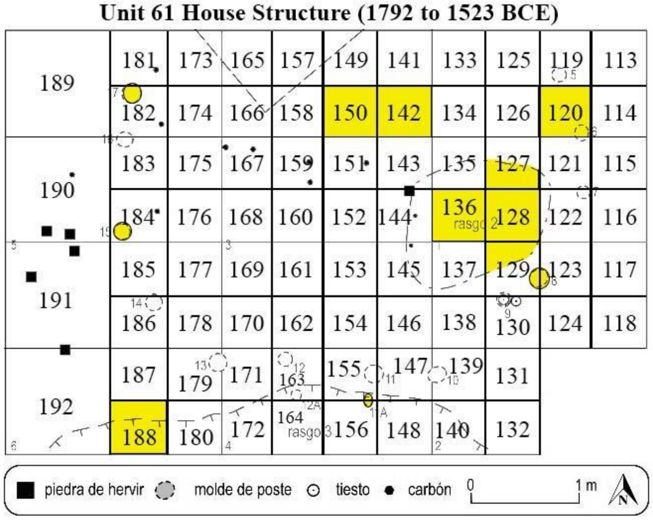
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

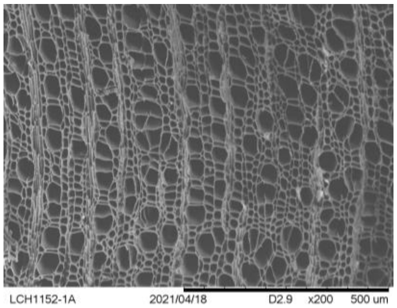


Unit 61 House Structure (1792 to 1523 BCE)

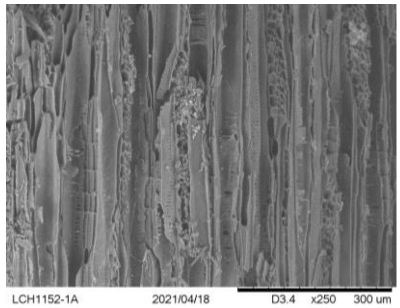


Scientific Name: CUNONIACEAE *Weinmannia* sp.
Common Name: white myrtle, bastard braziletto, arrayán

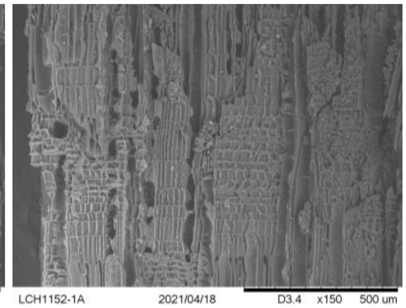
Transverse View



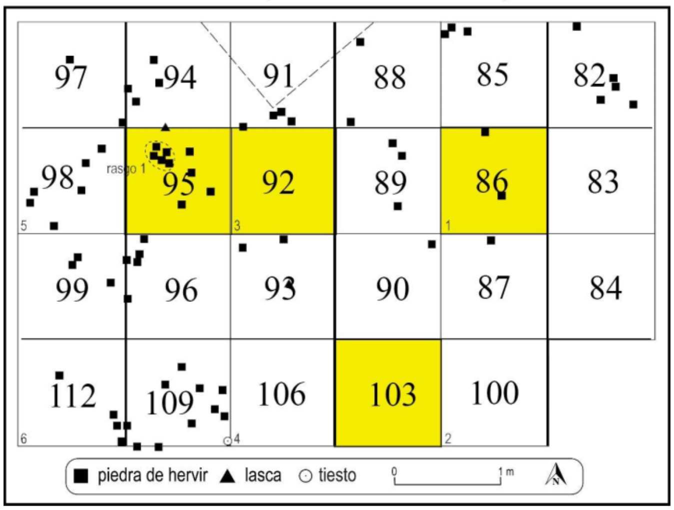
Tangential View



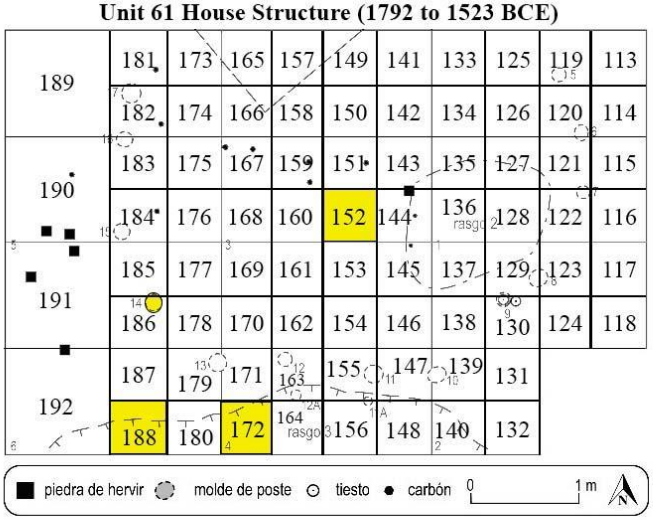
Radial View



Unit 60 (1692 to 1456 BCE)

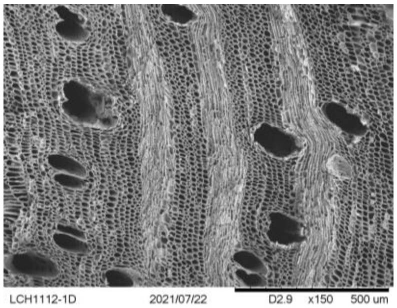


Unit 61 House Structure (1792 to 1523 BCE)

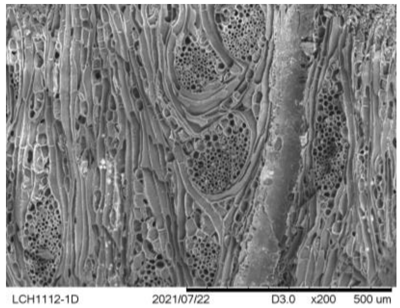


Scientific Name: DILLENIACEAE cf. *Curatella americana* L.
Common Name: chumico

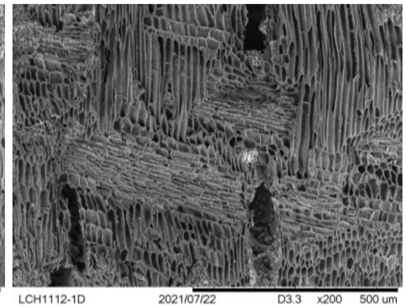
Transverse View



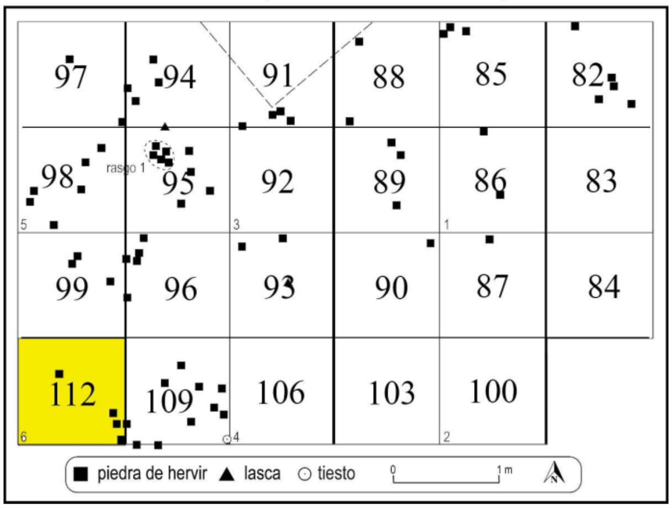
Tangential View



Radial View

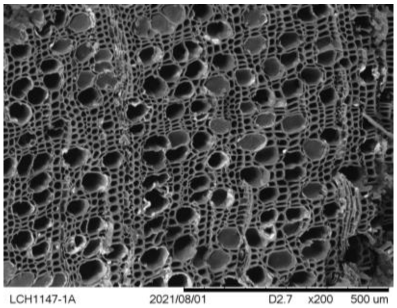


Unit 60 (1692 to 1456 BCE)

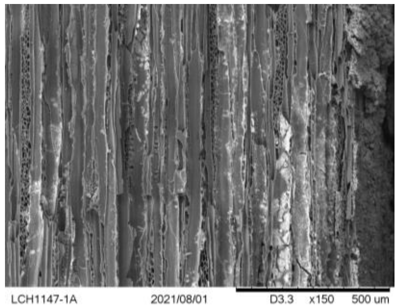


Scientific Name: DIPENTODONTACEAE *Perrottetia* sp.
Common Name: olomea

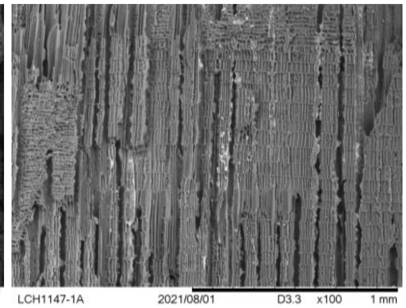
Transverse View



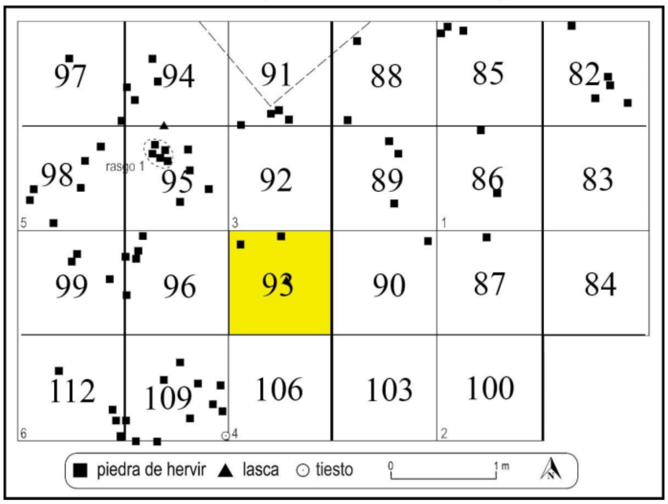
Tangential View



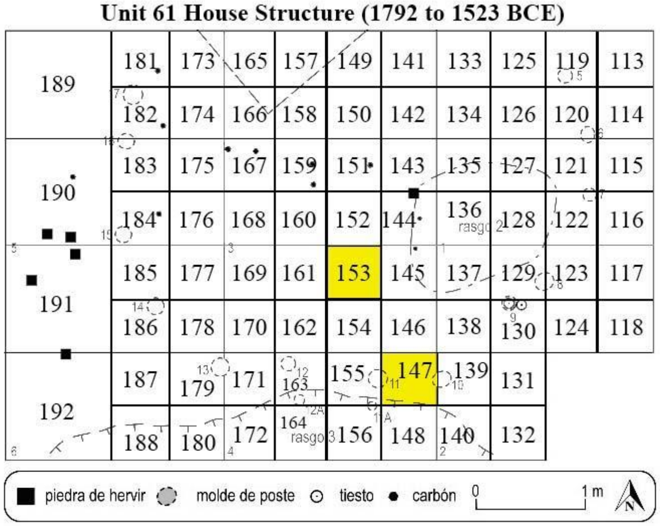
Radial View



Unit 60 (1692 to 1456 BCE)

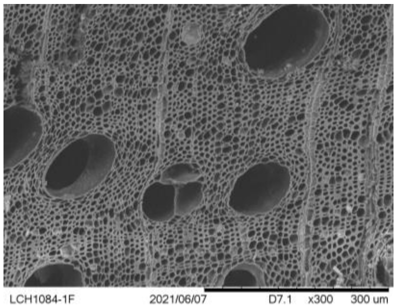


Unit 61 House Structure (1792 to 1523 BCE)

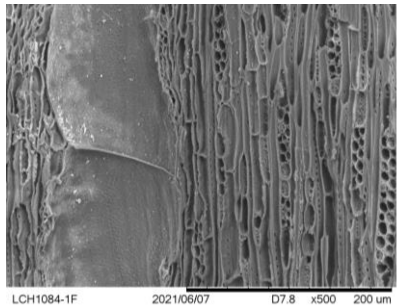


Scientific Name: EBENACEAE *Diospyros* sp.
Common Name: sapote negro

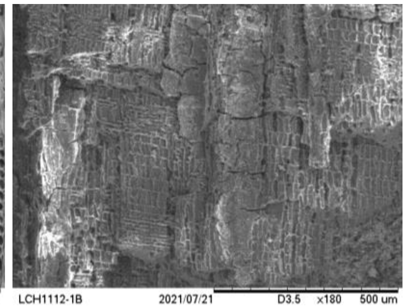
Transverse View



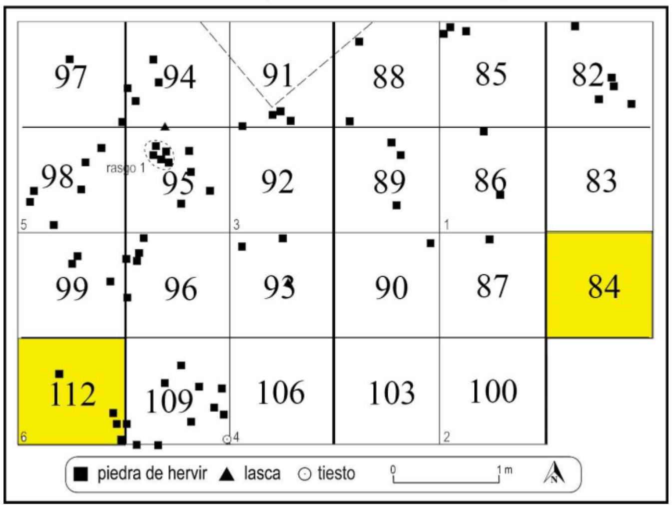
Tangential View



Radial View

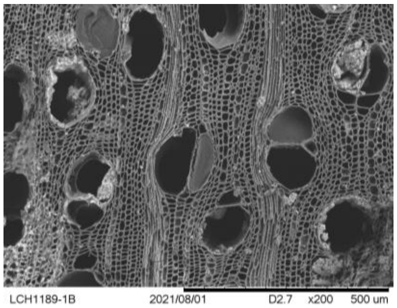


Unit 60 (1692 to 1456 BCE)

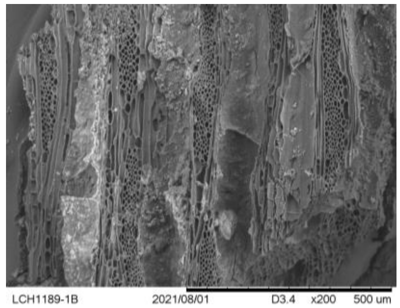


Scientific Name: ELAEOCARPACEAE *Sloanea* sp.
Common Name: carabeen, terciopelo, mameicillo, casaco

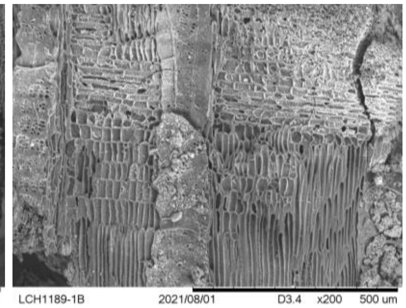
Transverse View



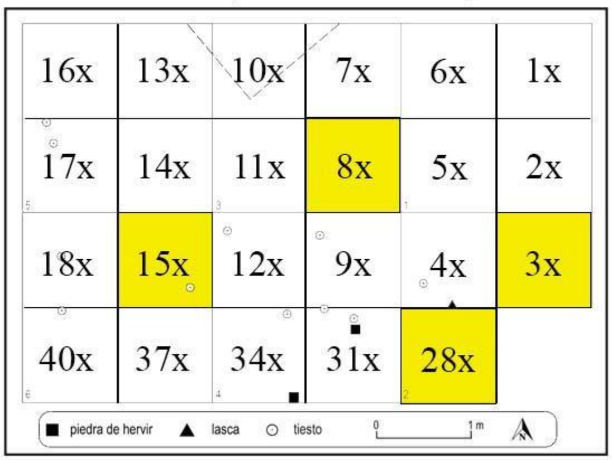
Tangential View



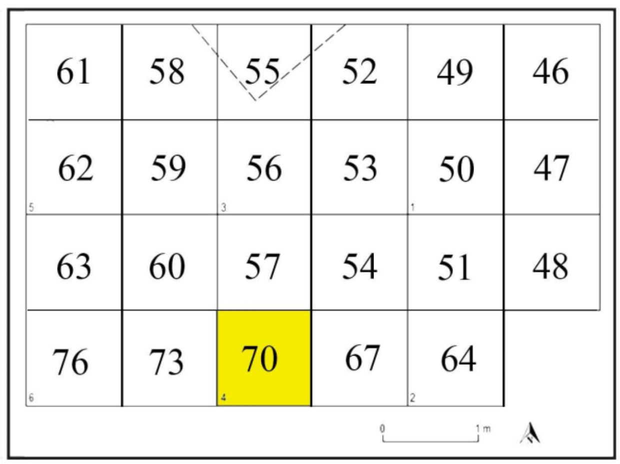
Radial View



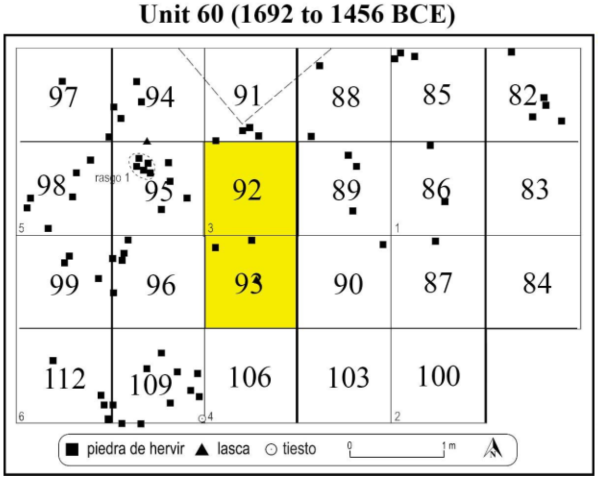
Unit 54 (500 BCE to 100 CE)



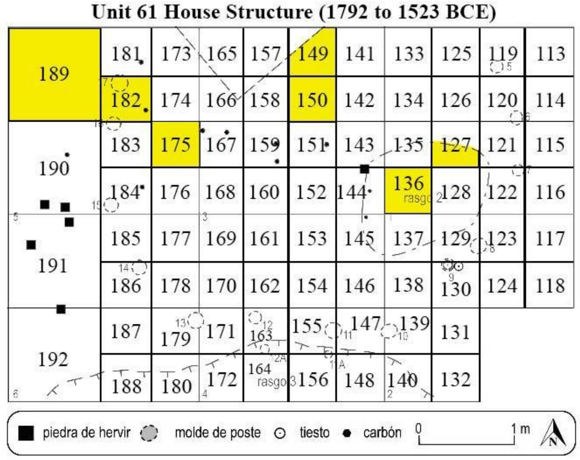
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

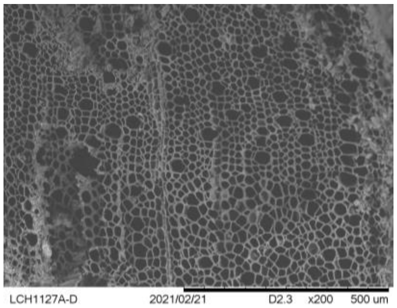


Unit 61 House Structure (1792 to 1523 BCE)

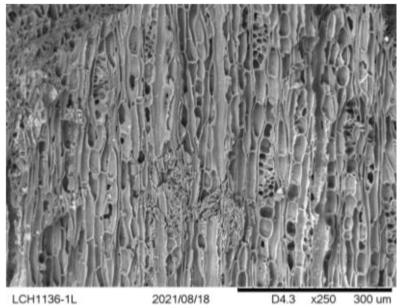


Scientific Name: ERICACEAE *Gaultheria* sp.
Common Name: uvita, mortiño

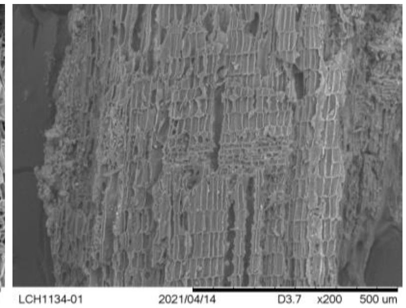
Transverse View



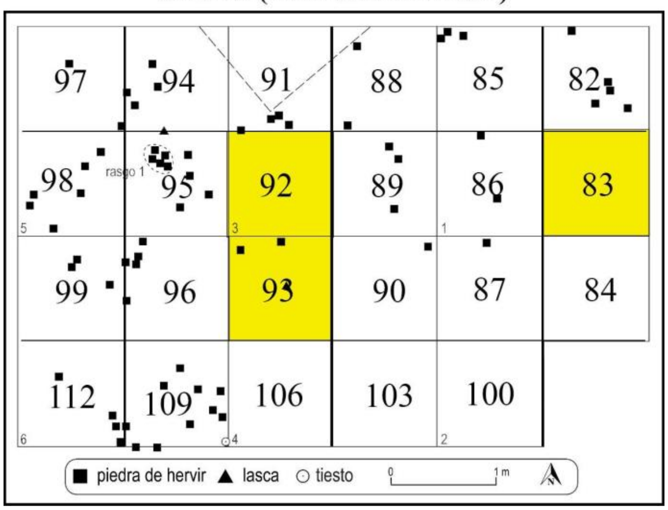
Tangential View



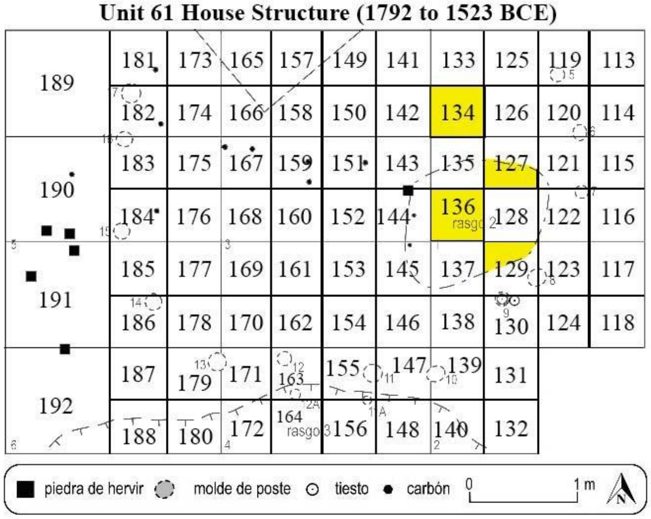
Radial View



Unit 60 (1692 to 1456 BCE)

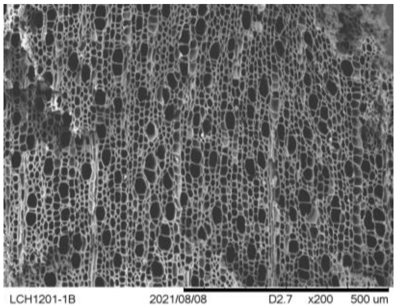


Unit 61 House Structure (1792 to 1523 BCE)

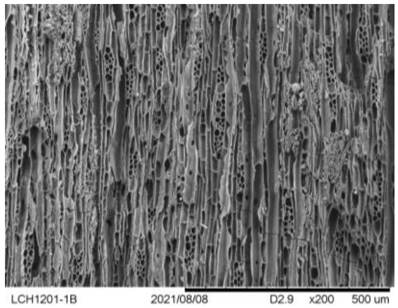


Scientific Name: ESCALLONIACEAE *Escallonia* sp.
Common Name: madrono, corontillo

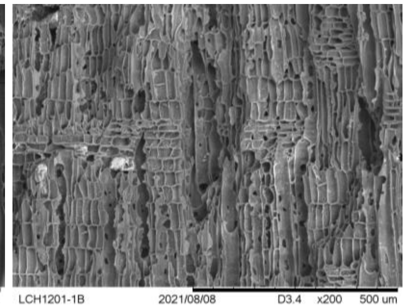
Transverse View



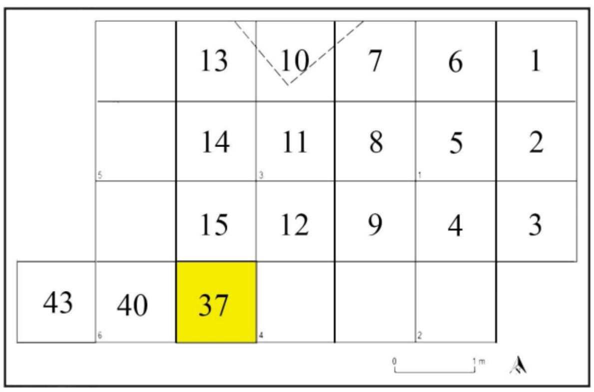
Tangential View



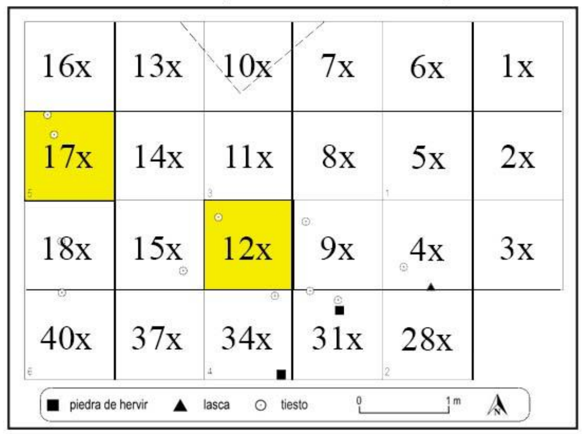
Radial View



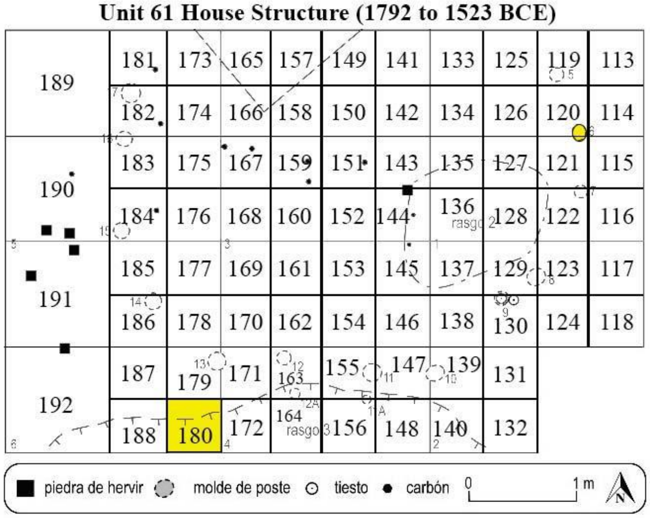
AR 16-15 (100 BCE to 100 CE)



Unit 54 (500 BCE to 100 CE)

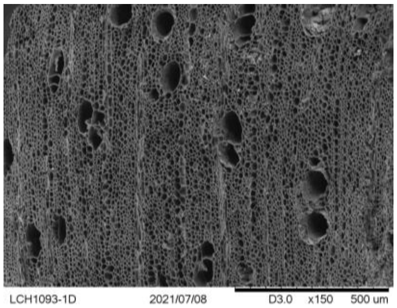


Unit 61 House Structure (1792 to 1523 BCE)

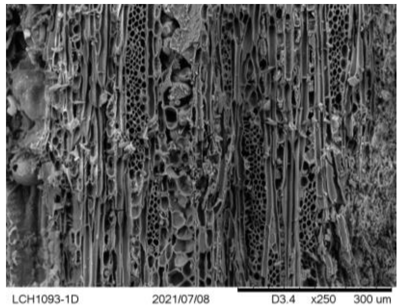


Scientific Name: EUPHORBIACEAE *Acalypha* sp.
Common Name: palito feo, prende-prende

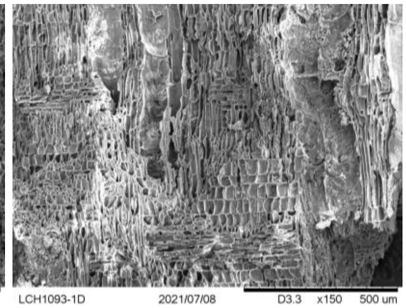
Transverse View



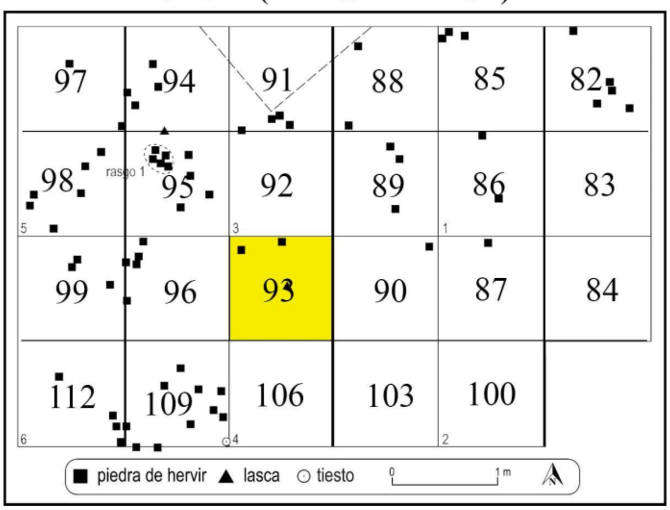
Tangential View



Radial View

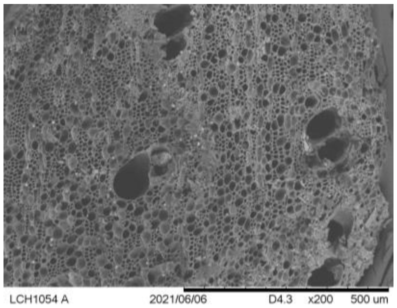


Unit 60 (1692 to 1456 BCE)

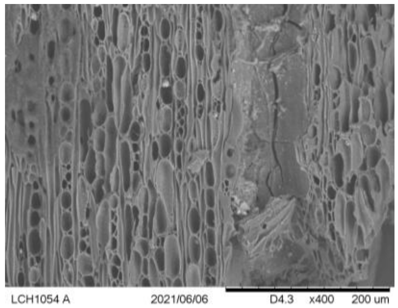


Scientific Name: EUPHORBIACEAE *Adelia* sp.
Common Name: bagre

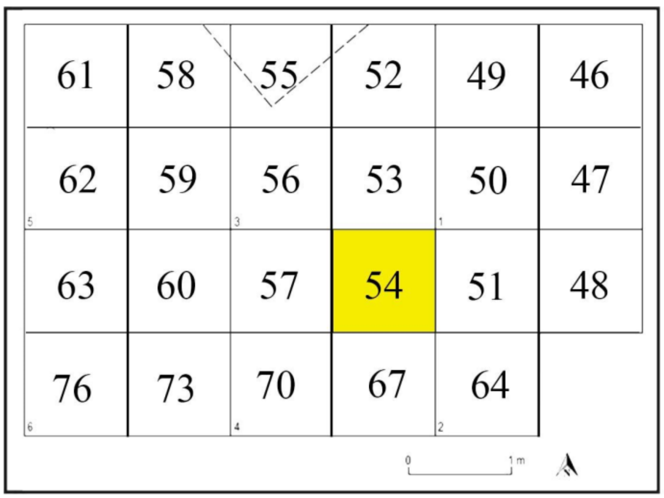
Transverse View



Tangential View

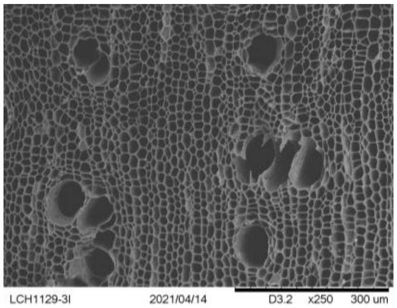


AR 14-9 (1456 to 500 BCE)

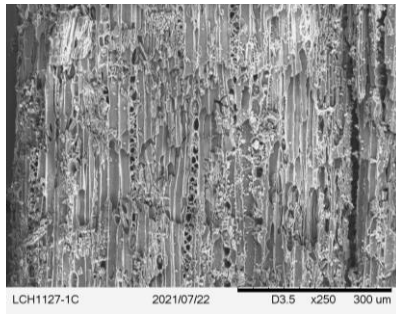


Scientific Name: EUPHORBIACEAE *Alchornea* sp.
Common Name: achiotillo

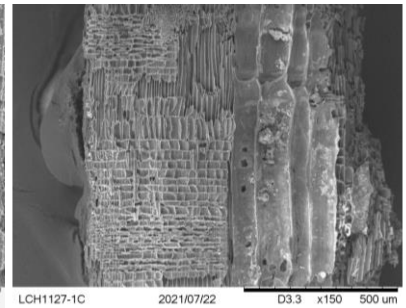
Transverse View



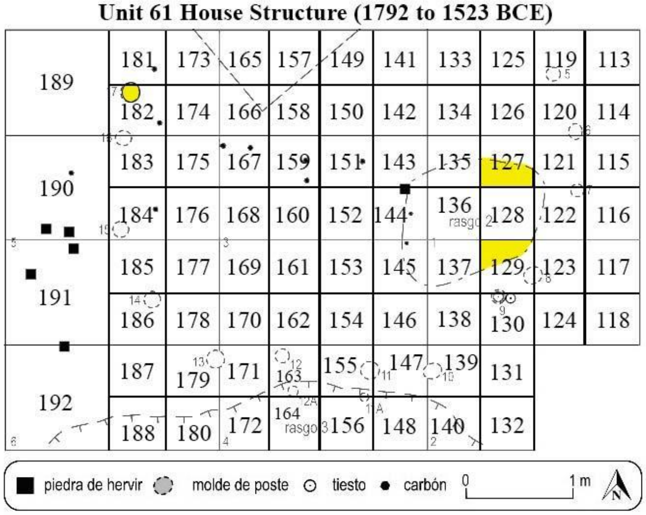
Tangential View



Radial View

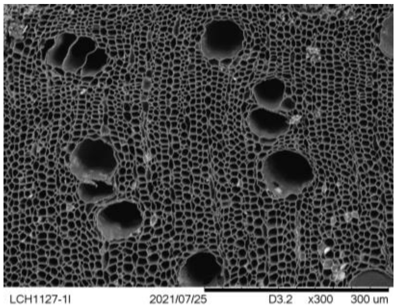


Unit 61 House Structure (1792 to 1523 BCE)

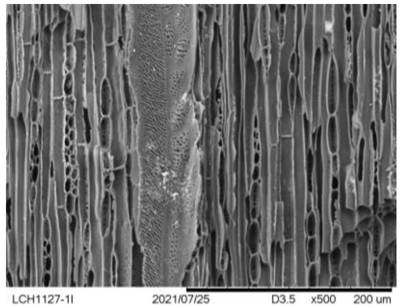


Scientific Name: EUPHORBIACEAE *Croton* sp.
Common Name: sangrillo, sangare, algodoncillo

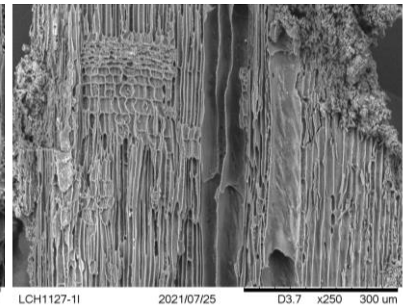
Transverse View



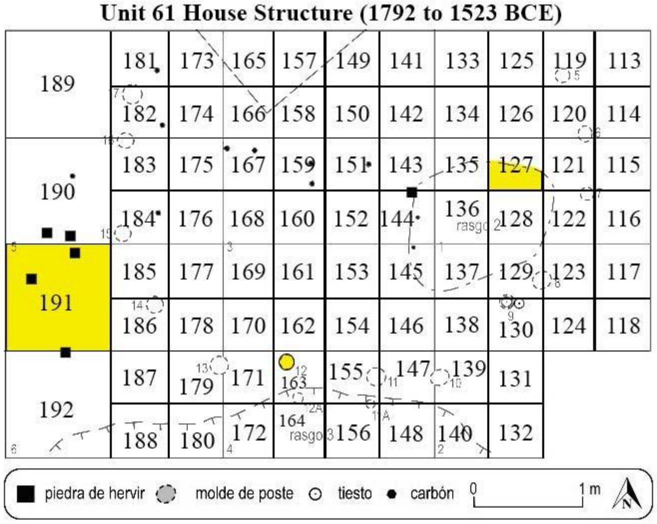
Tangential View



Radial View

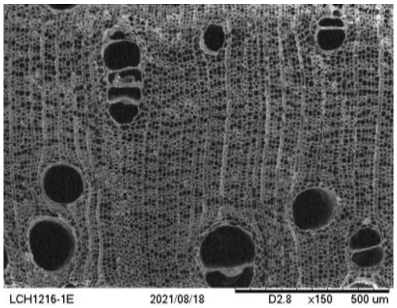


Unit 61 House Structure (1792 to 1523 BCE)

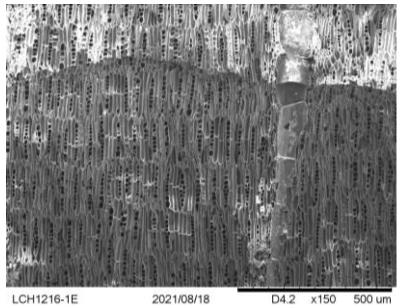


Scientific Name: EUPHORBIACEAE *Hura crepitans* L.
Common Name: nuno, tronador, havillo, ceibo, sandbox tree

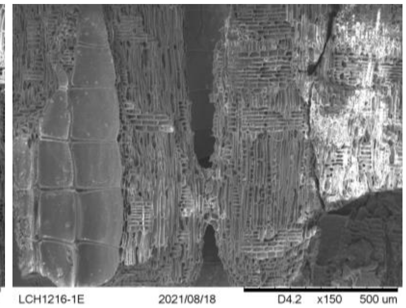
Transverse View



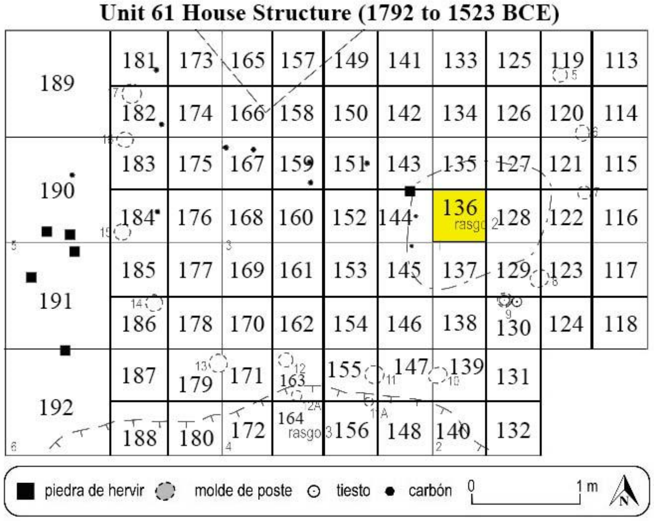
Tangential View



Radial View

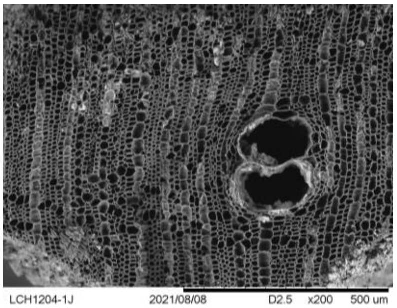


Unit 61 House Structure (1792 to 1523 BCE)

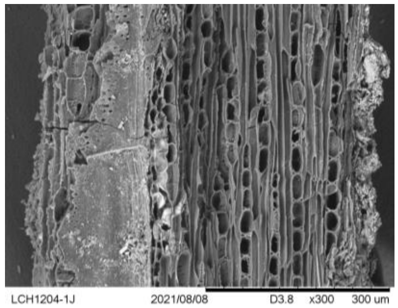


Scientific Name: EUPHORBIACEAE *Mabea* sp.
Common Name: casiquillo

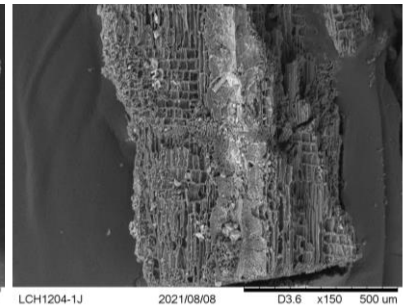
Transverse View



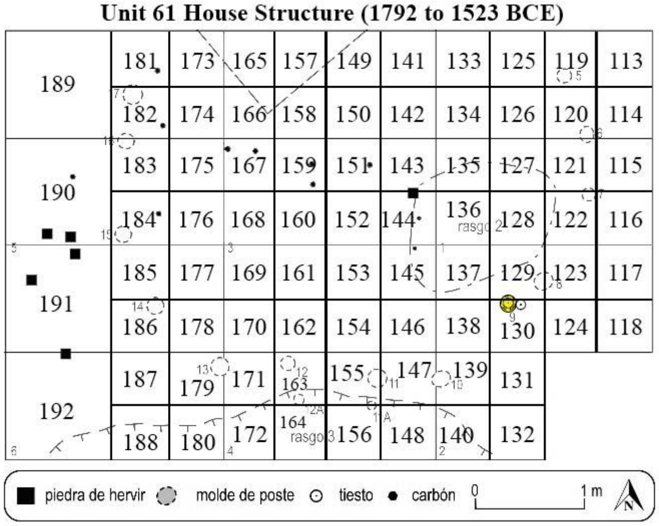
Tangential View



Radial View

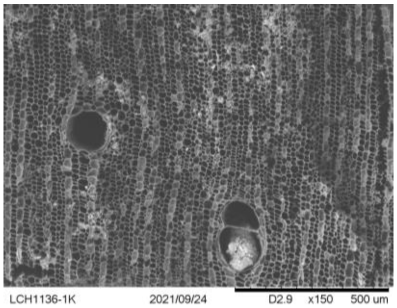


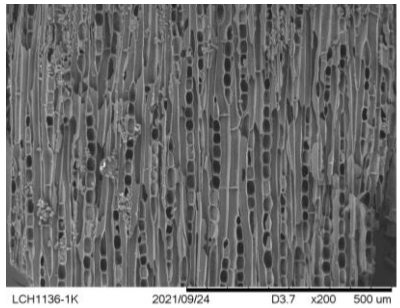
Unit 61 House Structure (1792 to 1523 BCE)

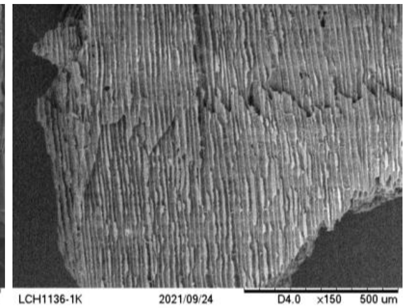


Scientific Name: EUPHORBIACEAE *Manihot* sp.
Common Name: manioc, yuca

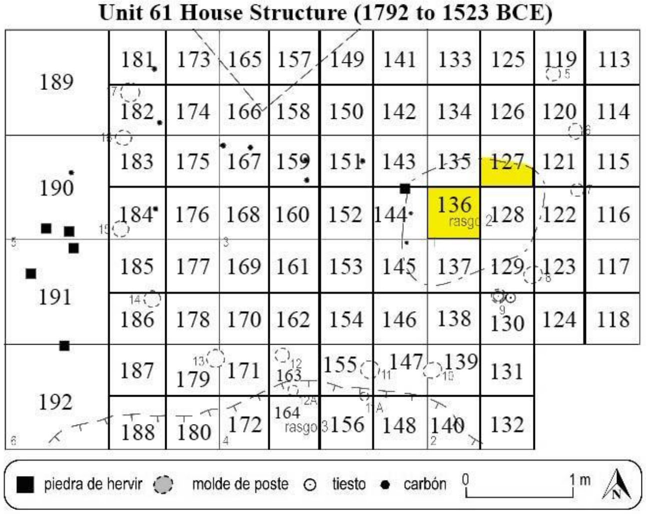
Transverse View | Tangential View | Radial View





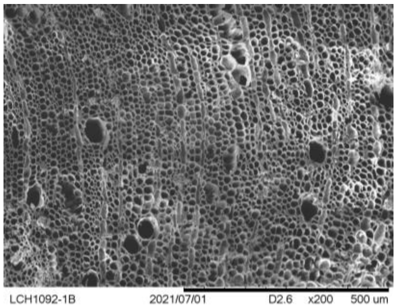


Unit 61 House Structure (1792 to 1523 BCE)

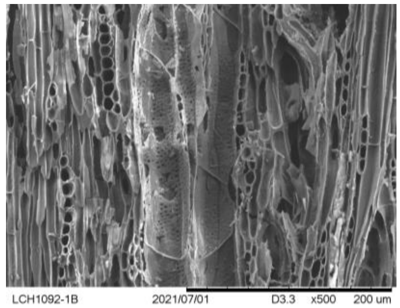


Scientific Name: EUPHORBIACEAE *Sebastiania* sp.
Common Name: milkwood

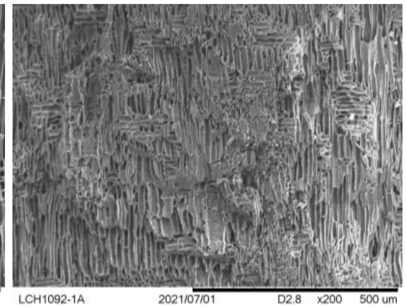
Transverse View



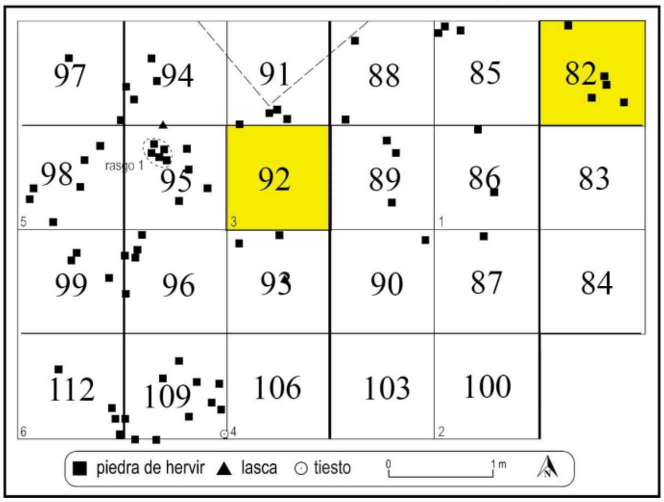
Tangential View



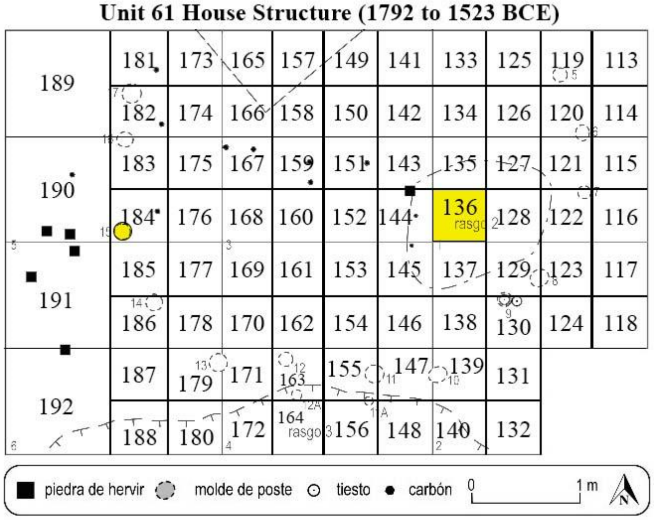
Radial View



Unit 60 (1692 to 1456 BCE)

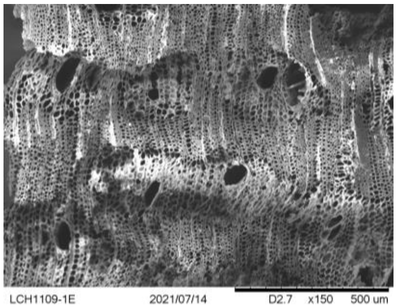


Unit 61 House Structure (1792 to 1523 BCE)

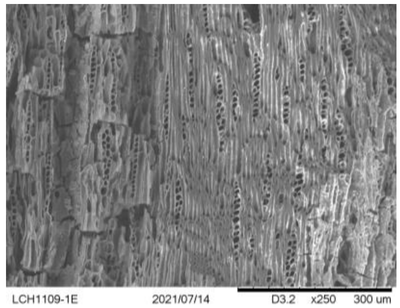


Scientific Name: FABACEAE *Abarema* sp.
Common Name: unknown

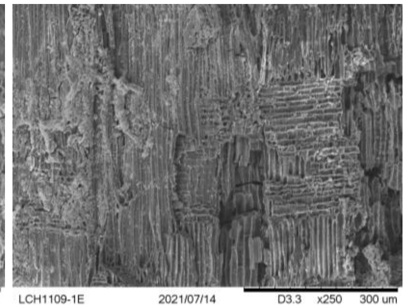
Transverse View



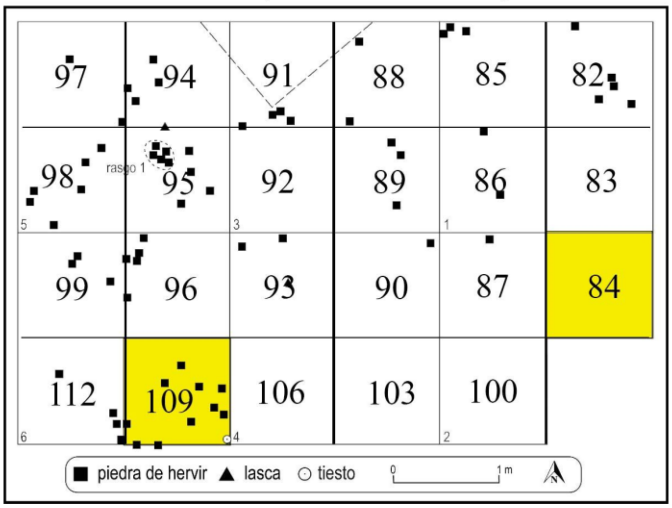
Tangential View



Radial View

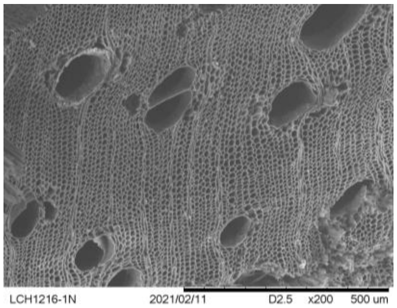


Unit 60 (1692 to 1456 BCE)

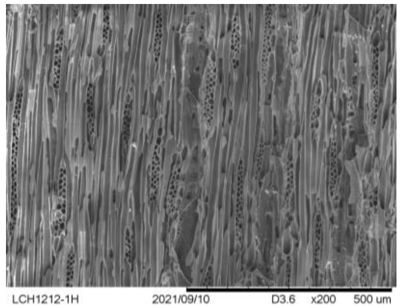


Scientific Name: FABACEAE *Acacia* sp.
Common Name: acacia

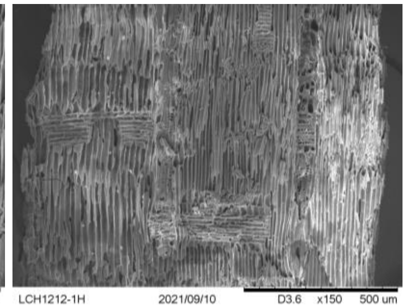
Transverse View



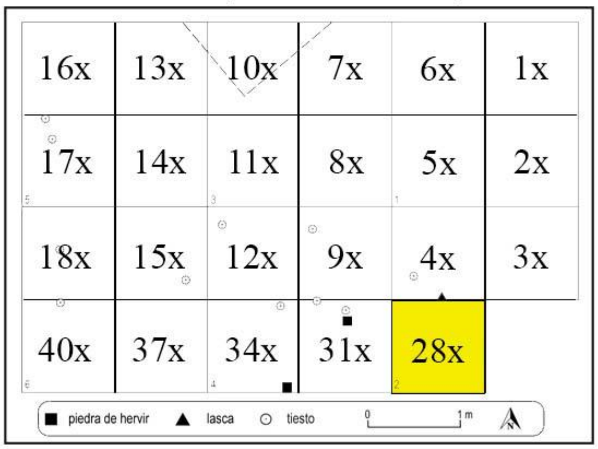
Tangential View



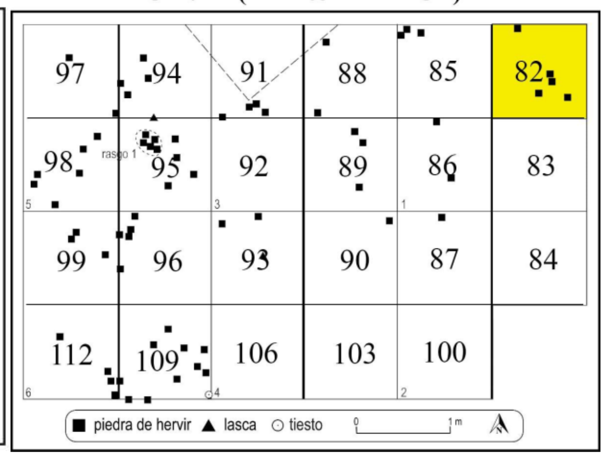
Radial View



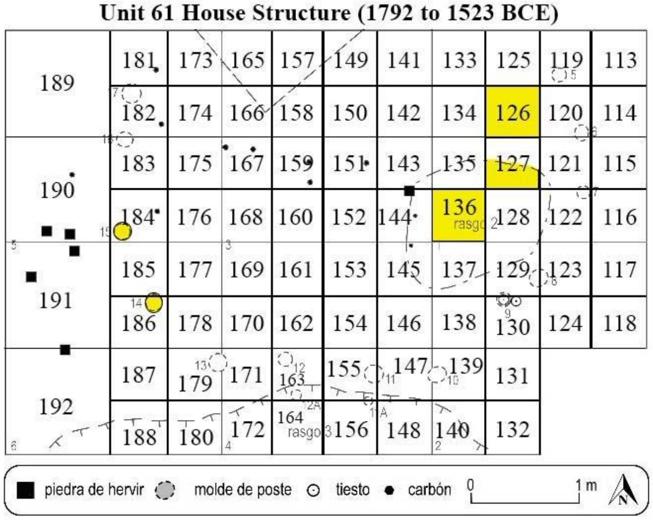
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

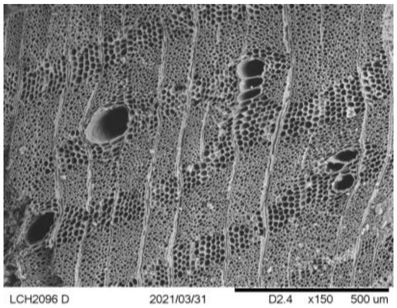


Unit 61 House Structure (1792 to 1523 BCE)

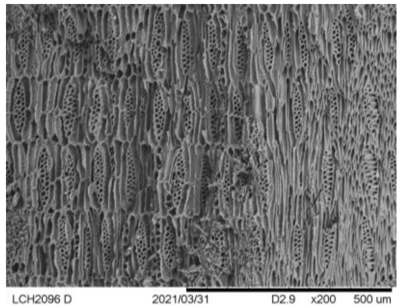


Scientific Name: FABACEAE *Andira inermis* (W. Wright) Kunth ex DC.
Common Name: almendro de río, harino, quira

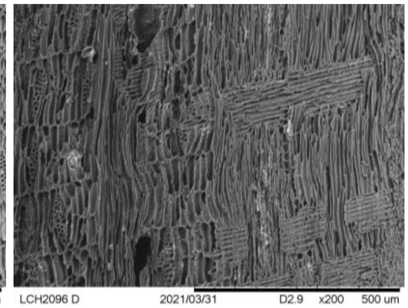
Transverse View



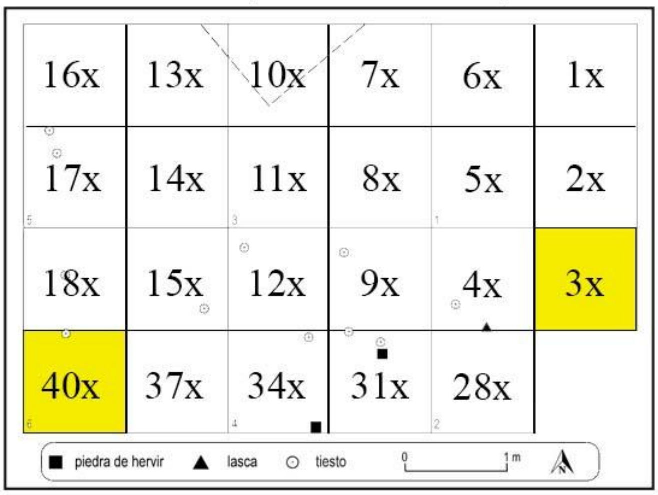
Tangential View



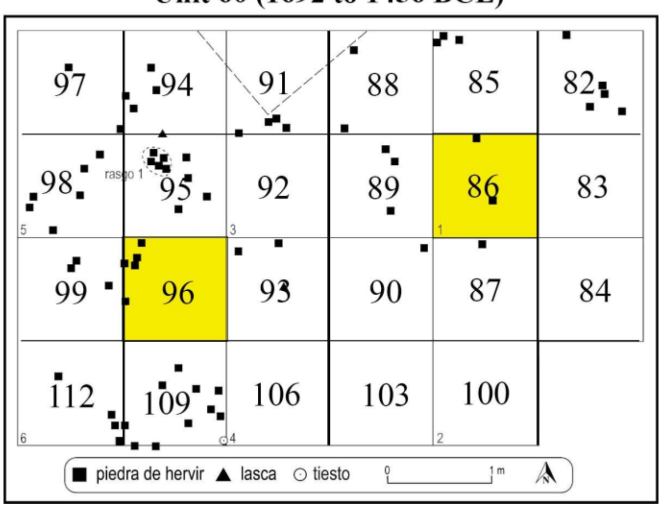
Radial View



Unit 54 (500 BCE to 100 CE)

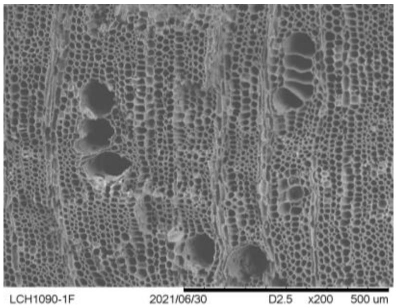


Unit 60 (1692 to 1456 BCE)

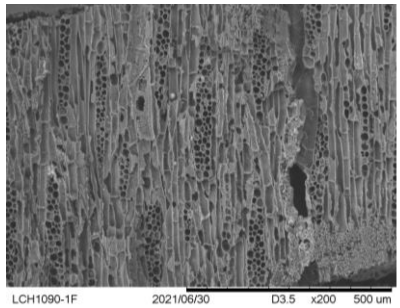


Scientific Name: FABACEAE *Calliandra* sp.
Common Name: gallito

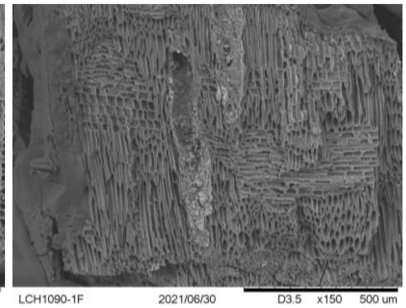
Transverse View



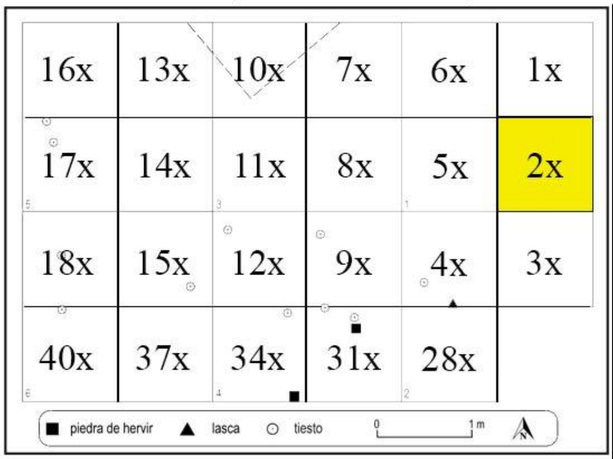
Tangential View



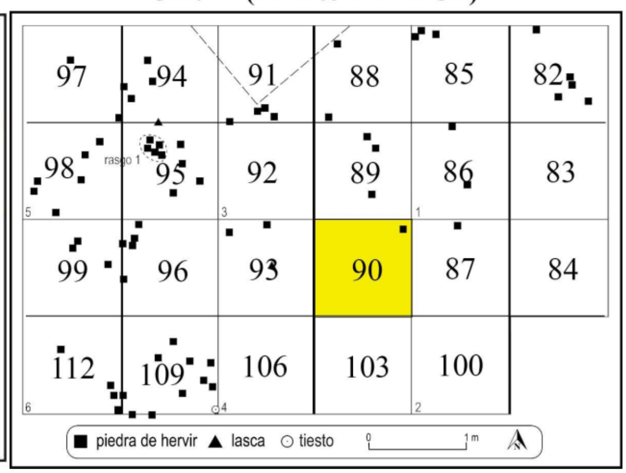
Radial View



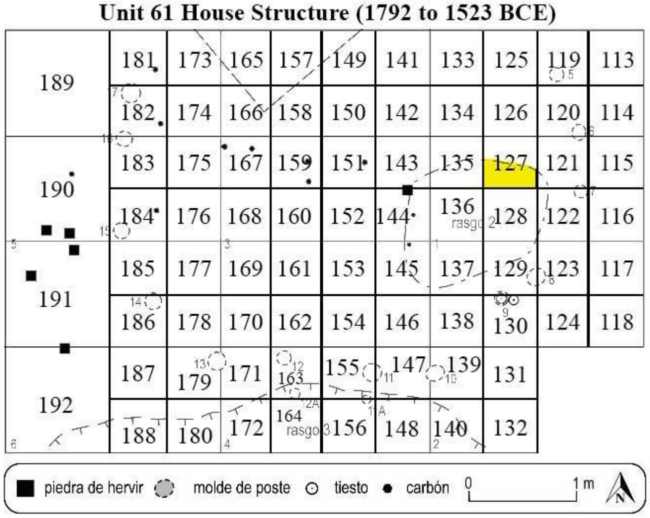
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

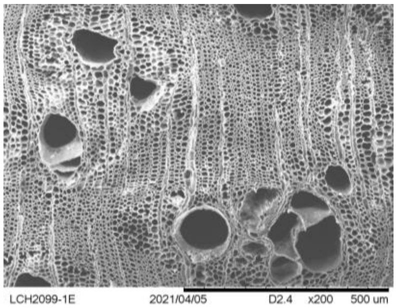


Unit 61 House Structure (1792 to 1523 BCE)

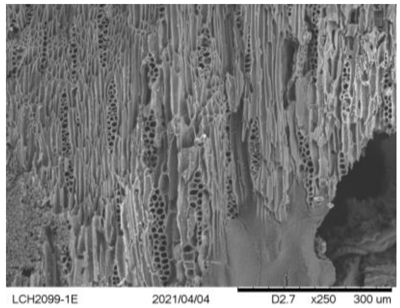


Scientific Name: FABACEAE *Cassia* sp.
Common Name: caña fistula, casia amarilla, carao

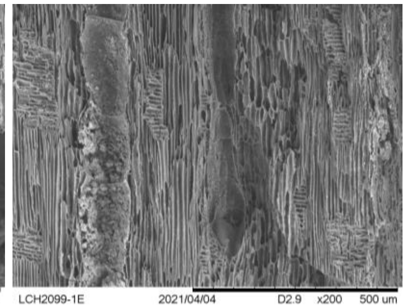
Transverse View



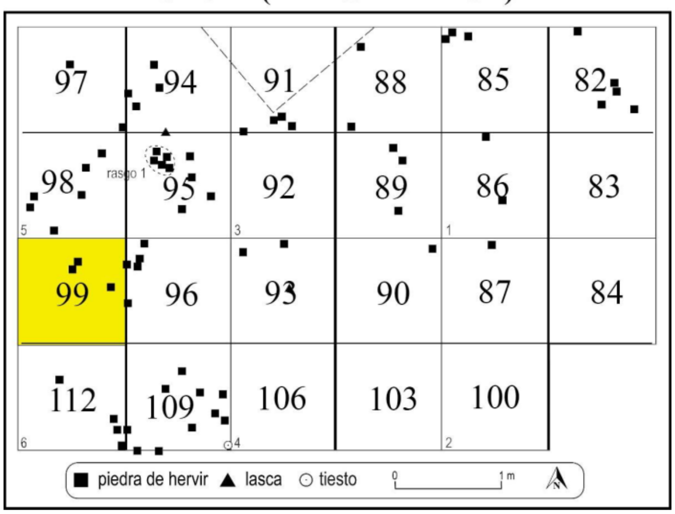
Tangential View



Radial View

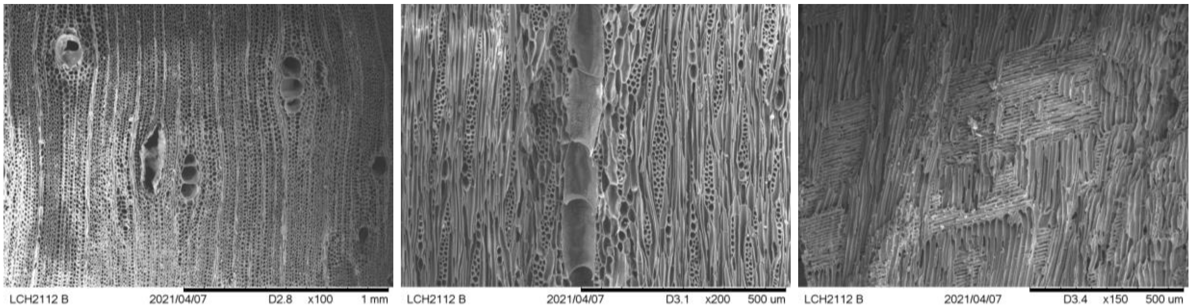


Unit 60 (1692 to 1456 BCE)

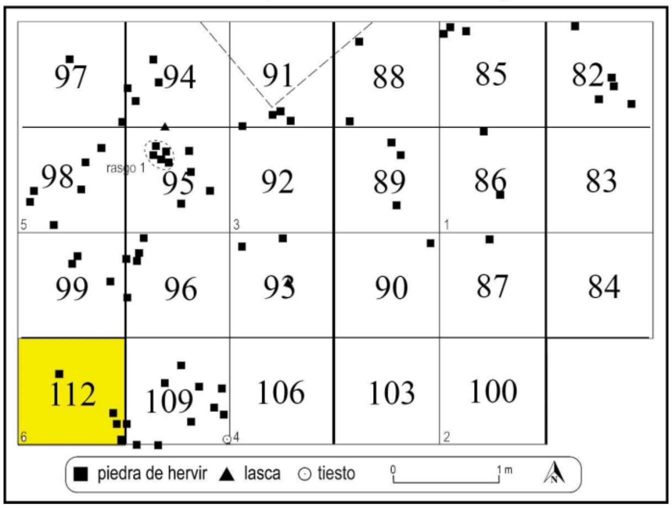


Scientific Name: FABACEAE *Copaifera* sp.
Common Name: cabimo

Transverse View | Tangential View | Radial View

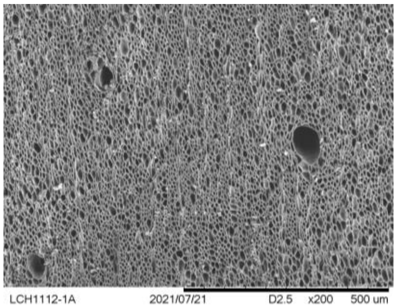


Unit 60 (1692 to 1456 BCE)

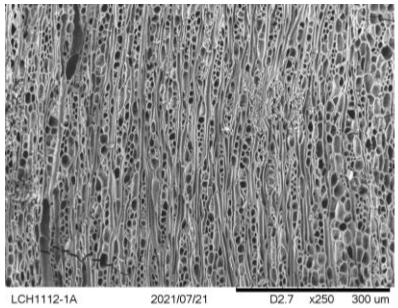


Scientific Name: FABACEAE *Dalbergia* sp.
Common Name: rosewood, cocobolo

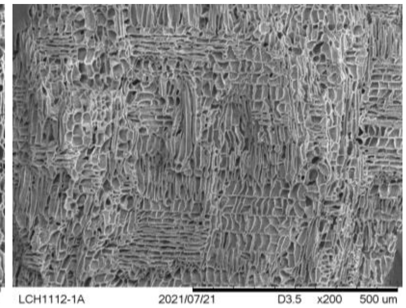
Transverse View



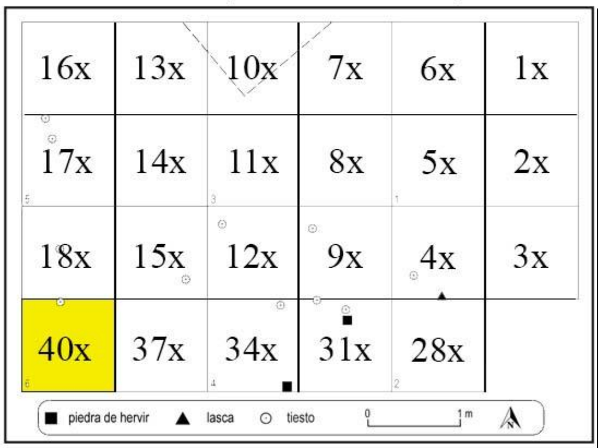
Tangential View



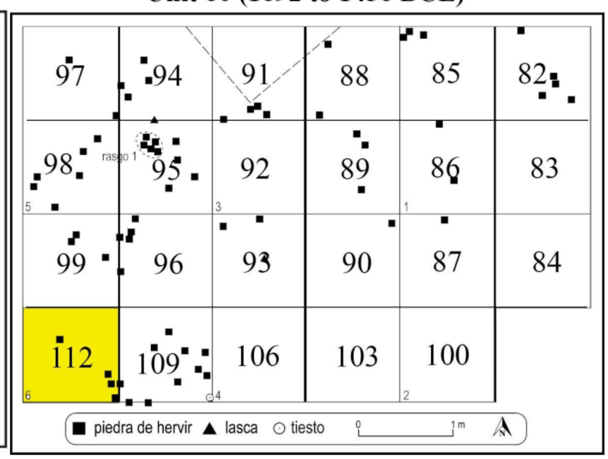
Radial View



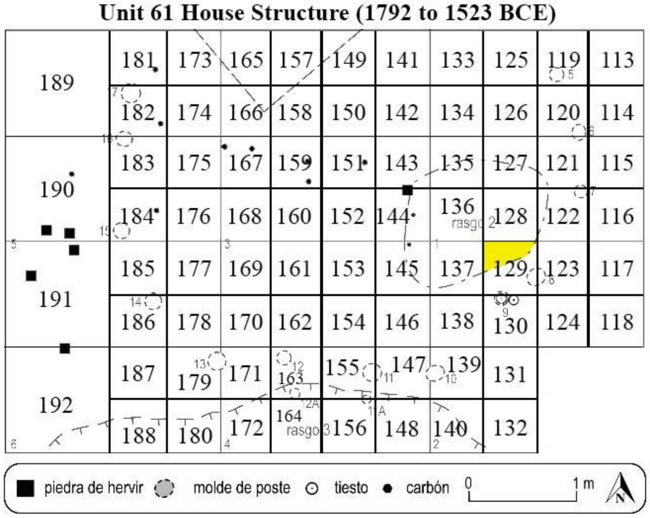
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

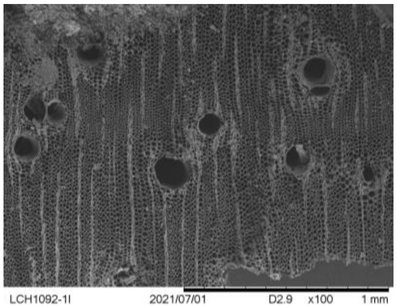


Unit 61 House Structure (1792 to 1523 BCE)

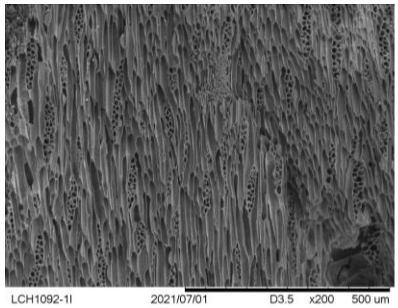


Scientific Name: FABACEAE *Enterolobium* spp.
Common Name: corotú, guanacaste, timbauba

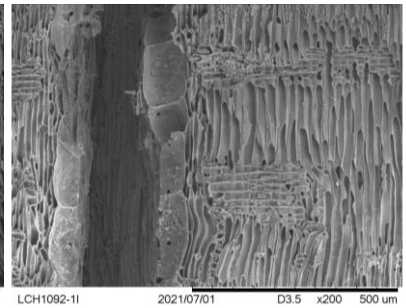
Transverse View



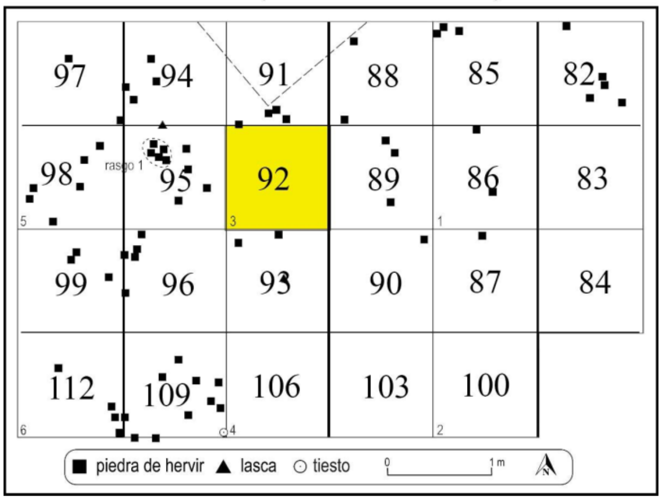
Tangential View



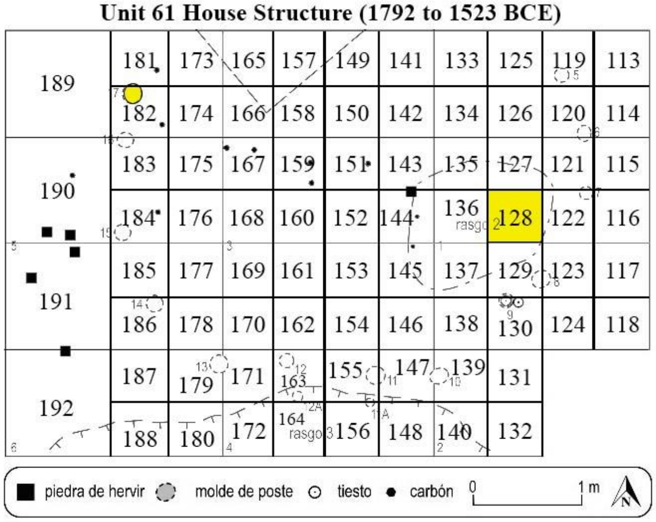
Radial View



Unit 60 (1692 to 1456 BCE)

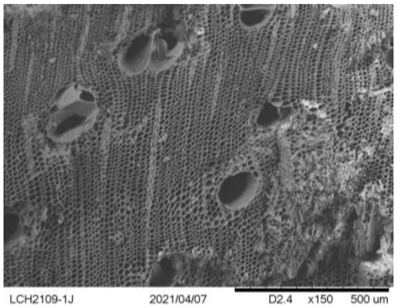


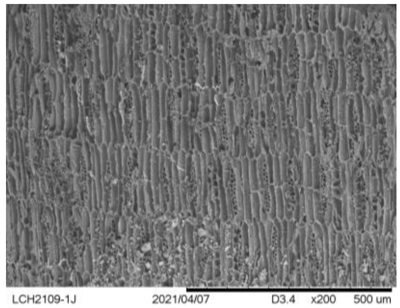
Unit 61 House Structure (1792 to 1523 BCE)

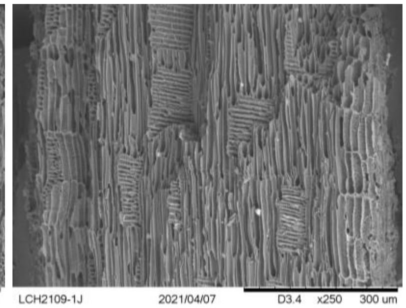


Scientific Name: FABACEAE *Gliricidia sepium* (Jacq.) Kunth ex Walp.
Common Name: balo, madero negro

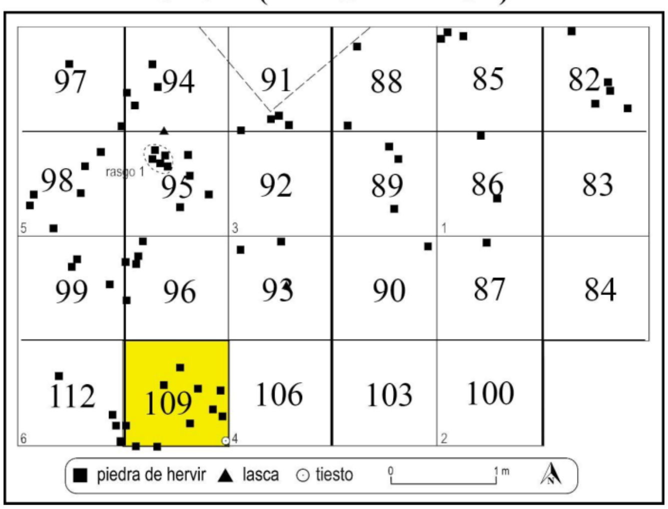
Transverse View | Tangential View | Radial View



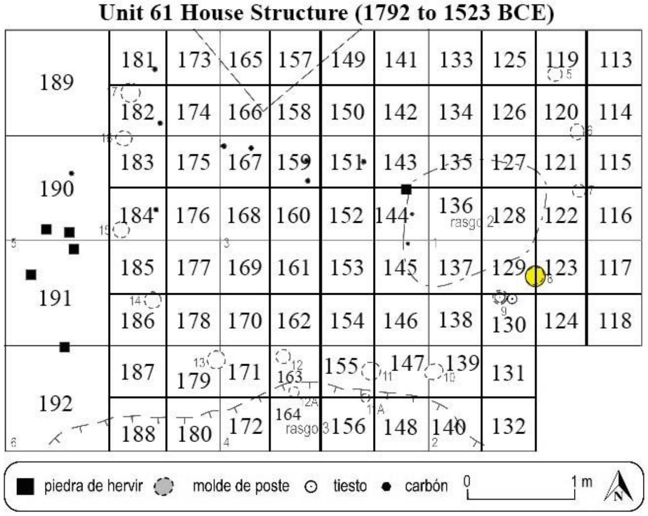




Unit 60 (1692 to 1456 BCE)

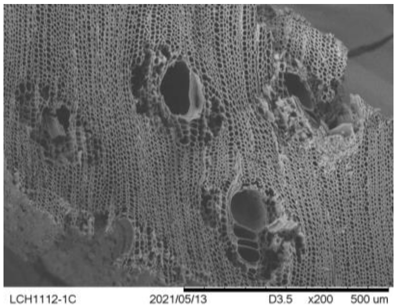


Unit 61 House Structure (1792 to 1523 BCE)

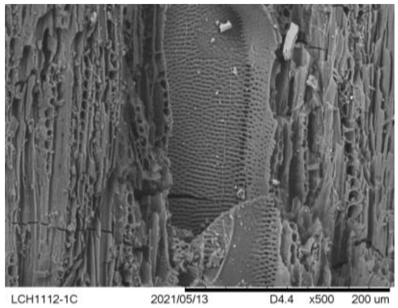


Scientific Name: FABACEAE *Inga* sp.
Common Name: guama, guaba, guabito, paterna, ice cream bean

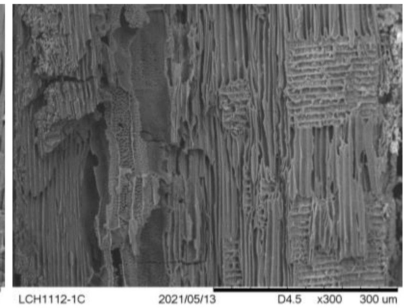
Transverse View



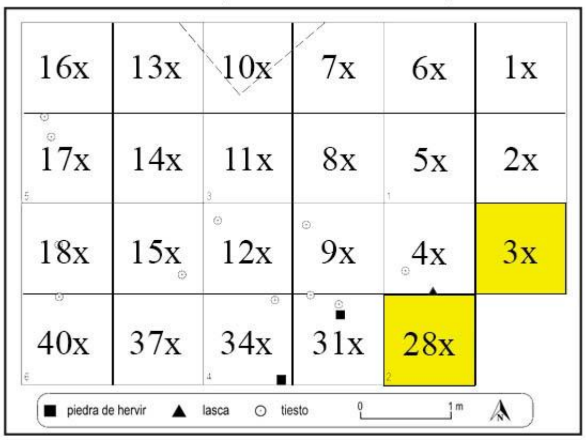
Tangential View



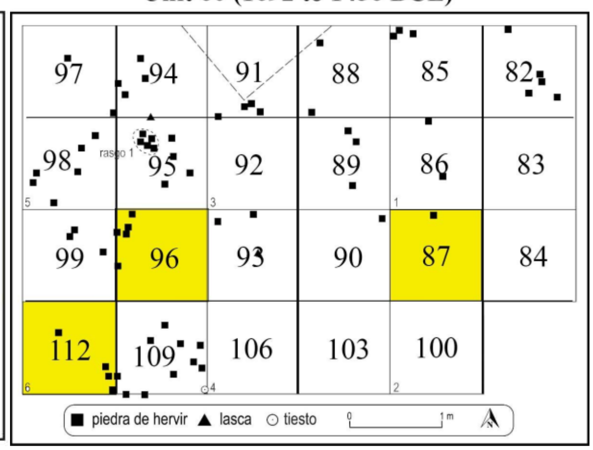
Radial View



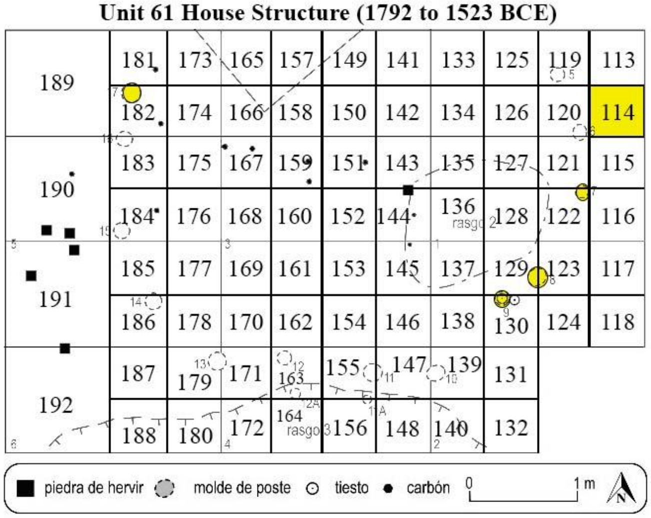
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

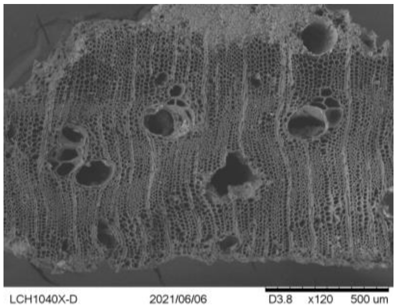


Unit 61 House Structure (1792 to 1523 BCE)

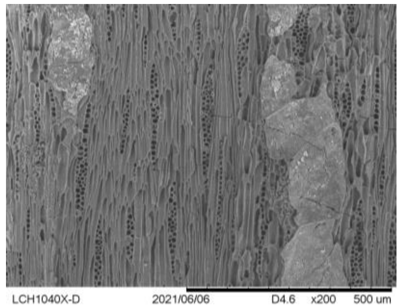


Scientific Name: FABACEAE *Lonchocarpus* sp.
Common Name: chaperno, guabito, frijolillo, malvecino, zorro

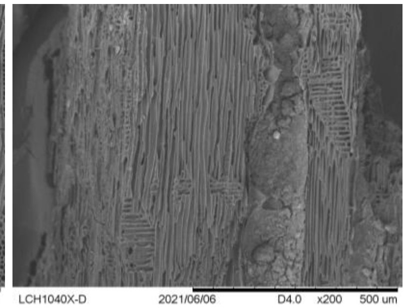
Transverse View



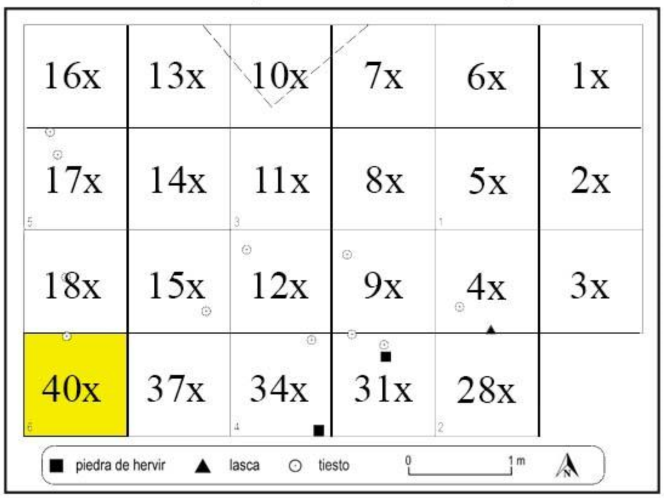
Tangential View



Radial View

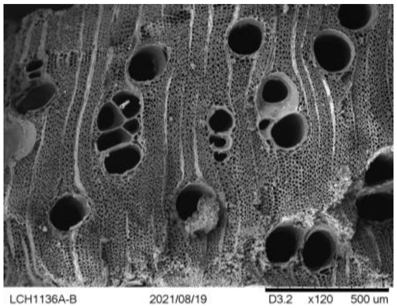


Unit 54 (500 BCE to 100 CE)

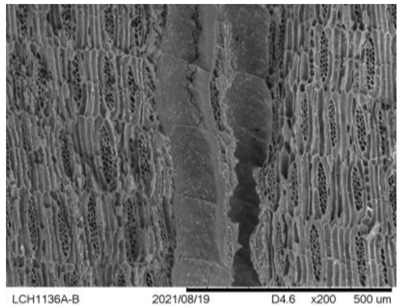


Scientific Name: FABACEAE *cf. Myroxylon balsamum*
Common Name: bálsamo, bálsamo de tolú, sándalo

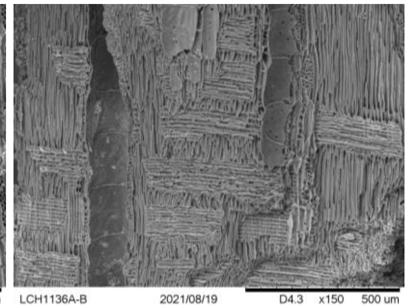
Transverse View



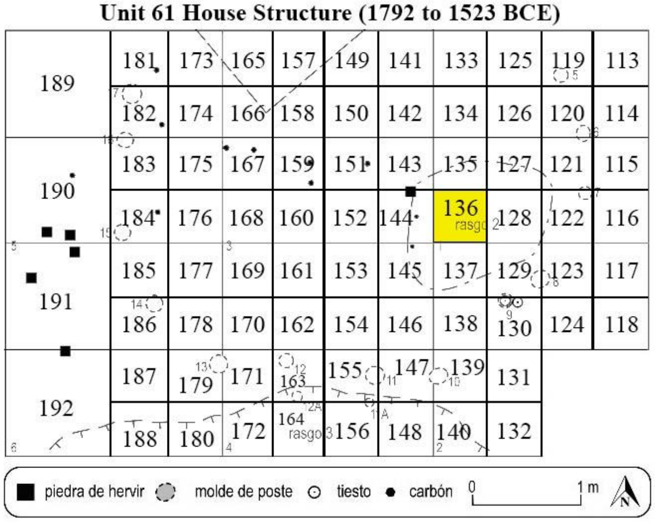
Tangential View



Radial View

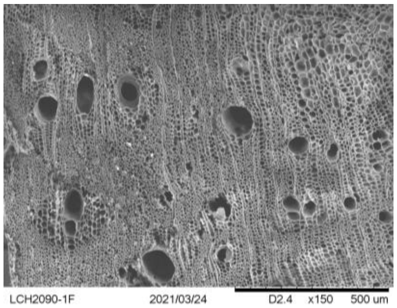


Unit 61 House Structure (1792 to 1523 BCE)

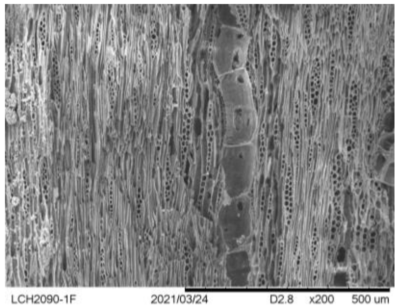


Scientific Name: FABACEAE *Parkinsonia aculeata* L.
Common Name: árbol sarigua, palo verde

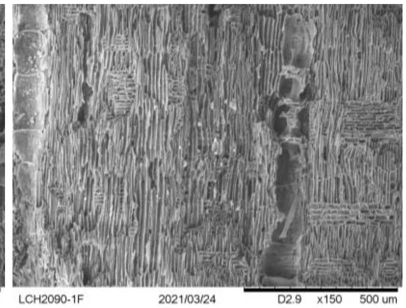
Transverse View



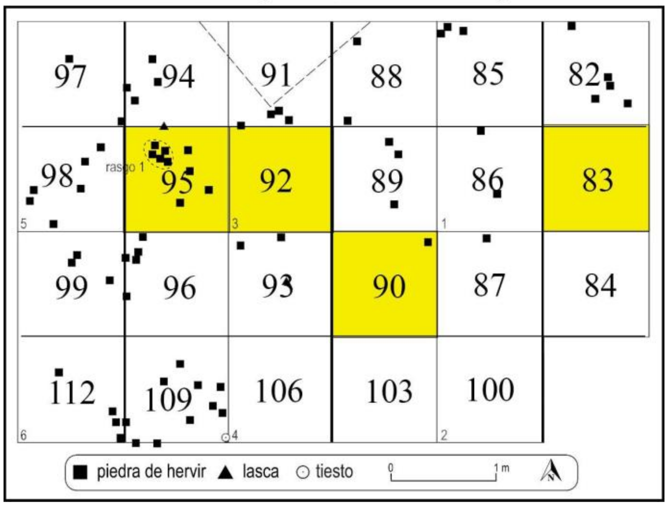
Tangential View



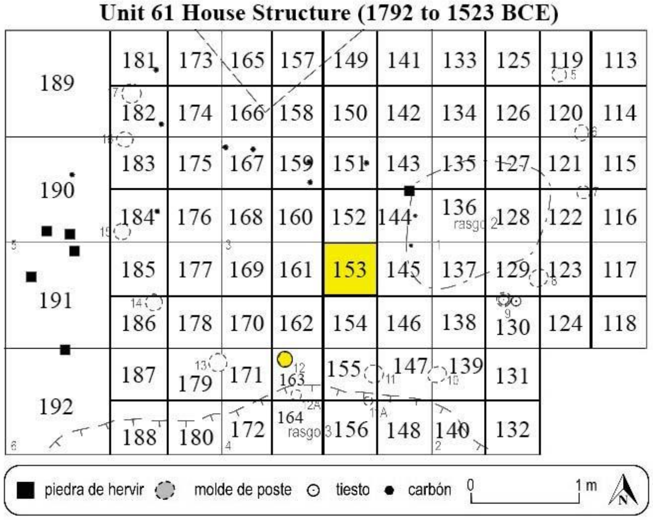
Radial View



Unit 60 (1692 to 1456 BCE)

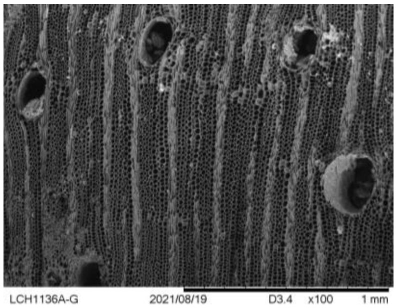


Unit 61 House Structure (1792 to 1523 BCE)

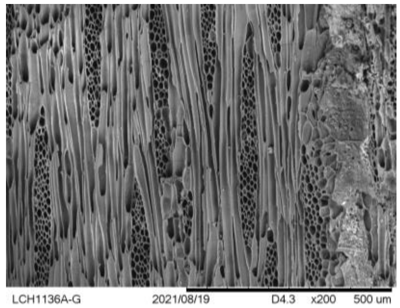


Scientific Name: FABACEAE *Peltogyne* sp.
Common Name: purple heart, nazareno, amaranto

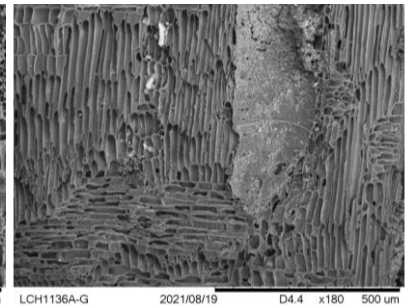
Transverse View



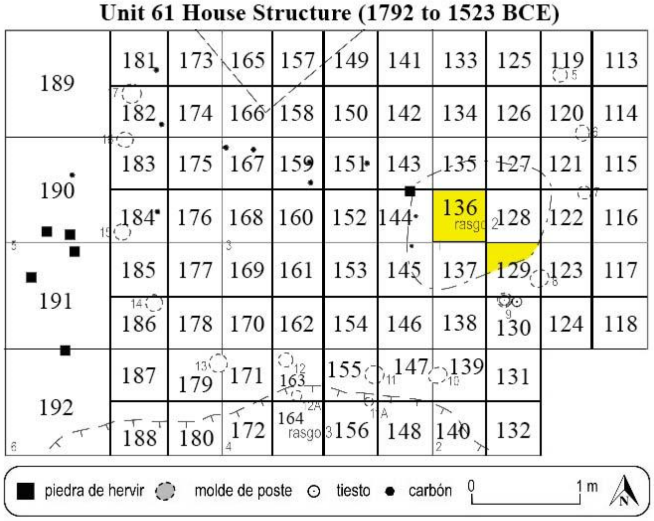
Tangential View



Radial View

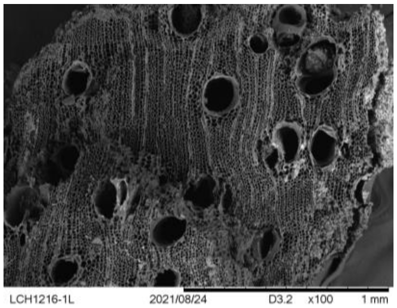


Unit 61 House Structure (1792 to 1523 BCE)

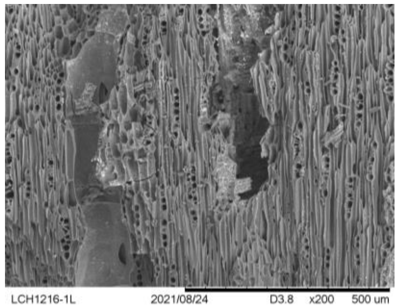


Scientific Name: FABACEAE *Platymiscium* sp.
Common Name: granadillo

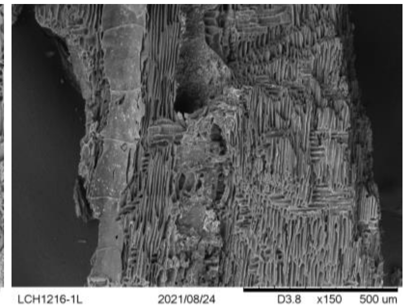
Transverse View



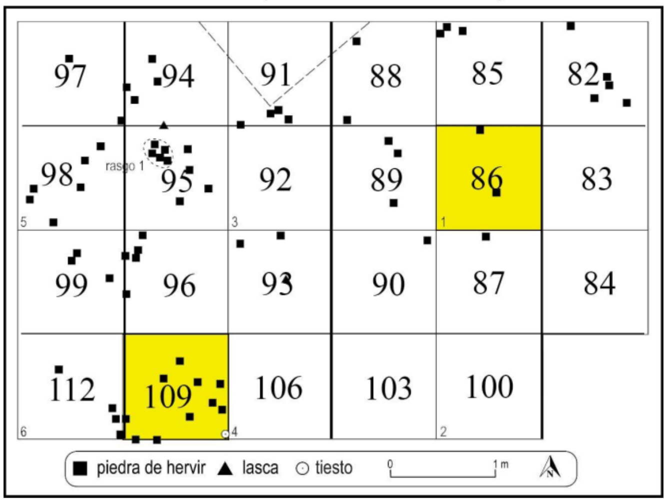
Tangential View



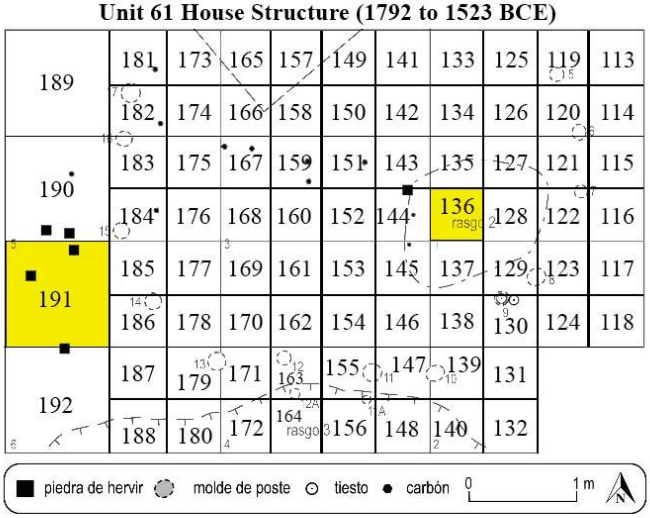
Radial View



Unit 60 (1692 to 1456 BCE)

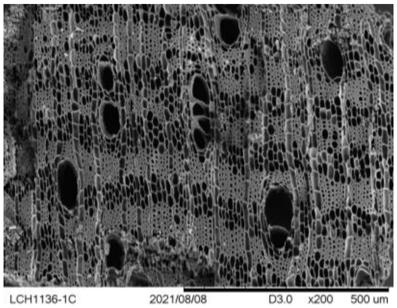


Unit 61 House Structure (1792 to 1523 BCE)

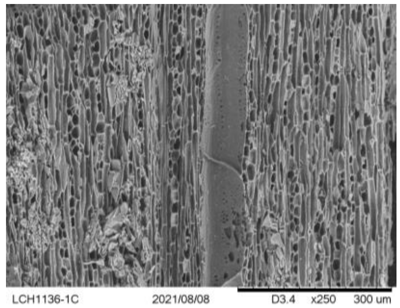


Scientific Name: FABACEAE cf. *Pterocarpus* sp.
Common Name: bloodwood

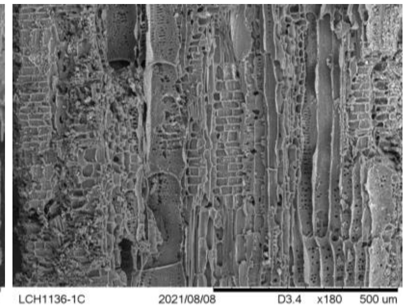
Transverse View



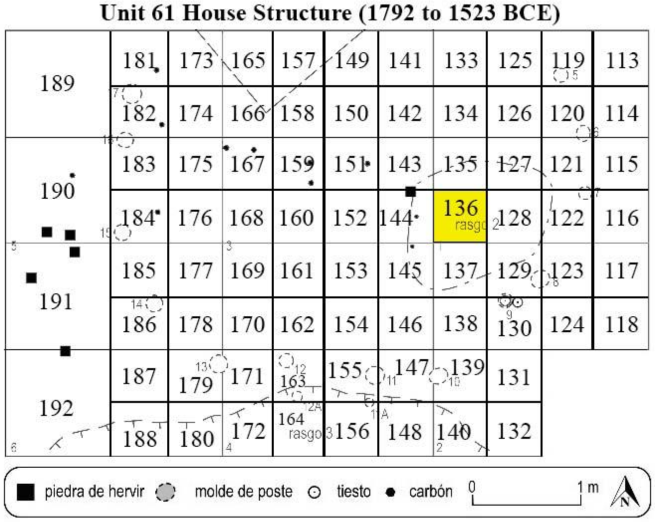
Tangential View



Radial View

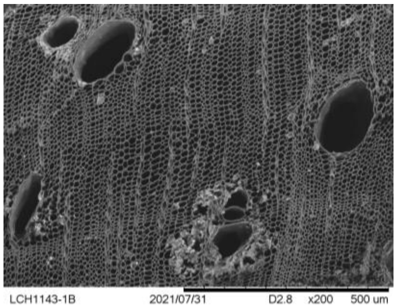


Unit 61 House Structure (1792 to 1523 BCE)

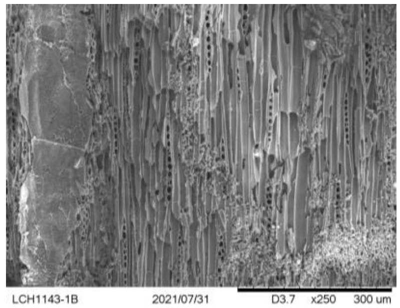


Scientific Name: FABACEAE cf. *Tachigali* sp.
Common Name: tachi

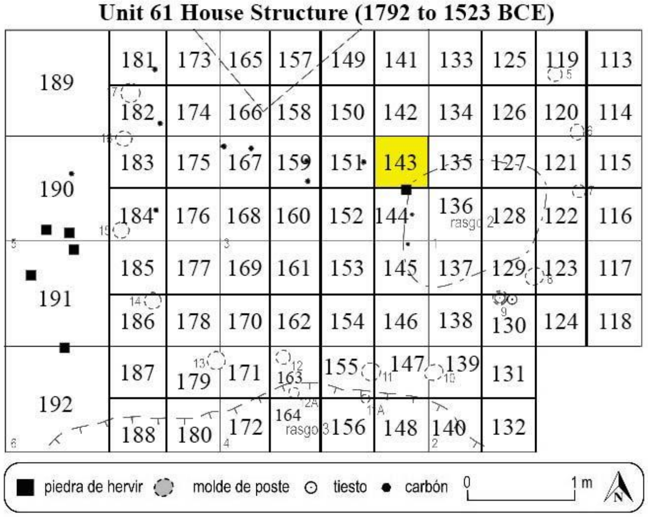
Transverse View



Tangential View

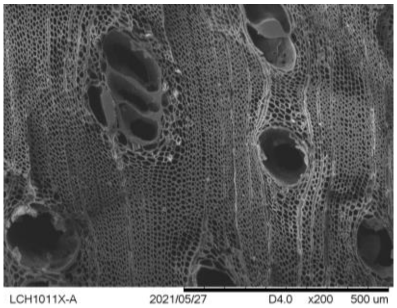


Unit 61 House Structure (1792 to 1523 BCE)

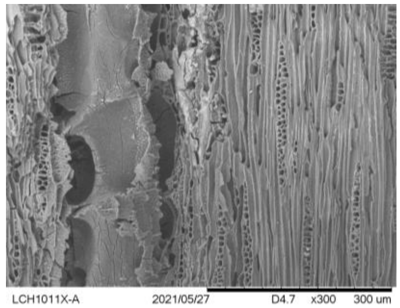


Scientific Name: FABACEAE *Zygia* sp.
Common Name: guabito cansa boca, guabito de río, pichindé

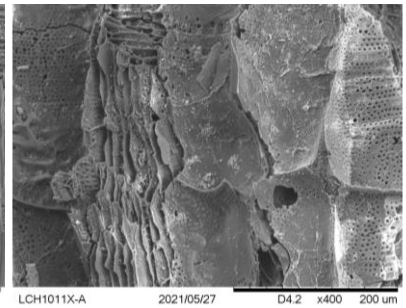
Transverse View



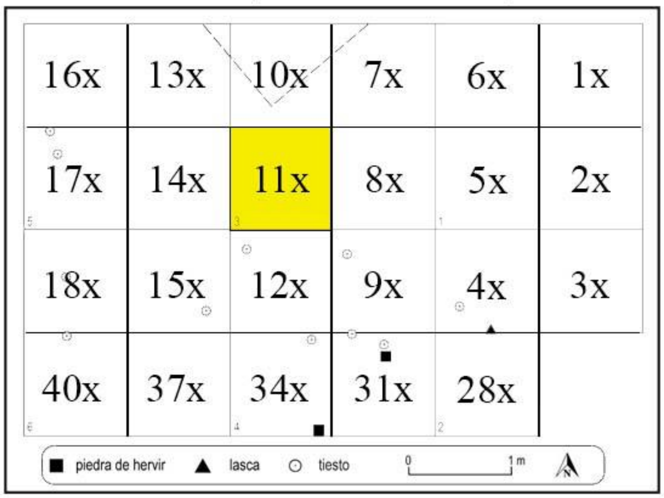
Tangential View



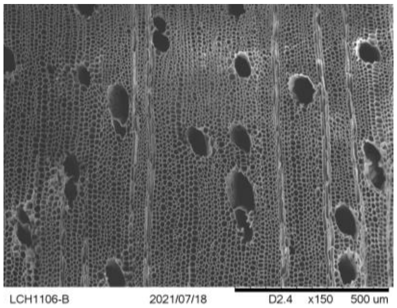
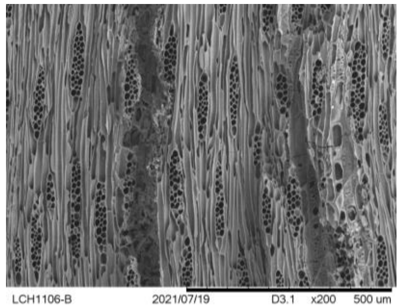
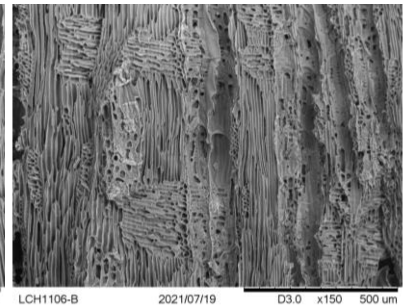
Radial View



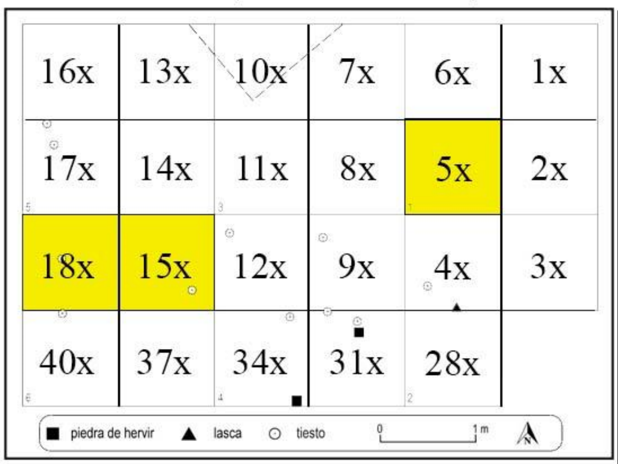
Unit 54 (500 BCE to 100 CE)



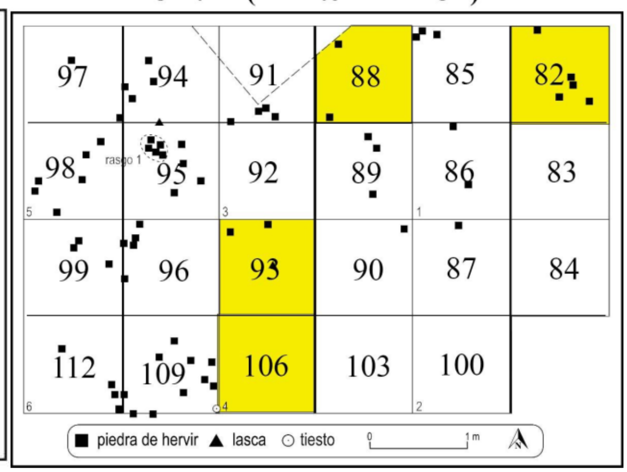
Scientific Name: LAURACEAE *Nectandra/Ocotea* sp.
Common Name: sigua

Transverse View	Tangential View	Radial View
		

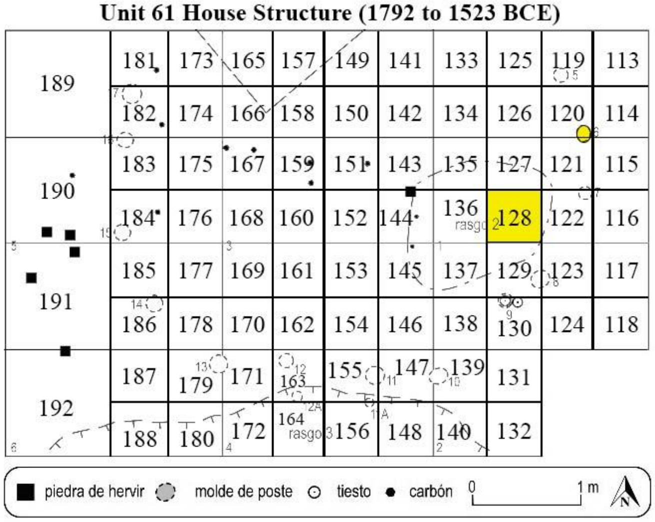
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

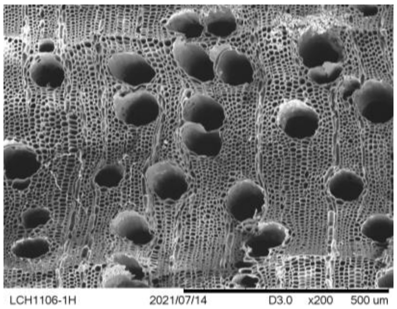


Unit 61 House Structure (1792 to 1523 BCE)

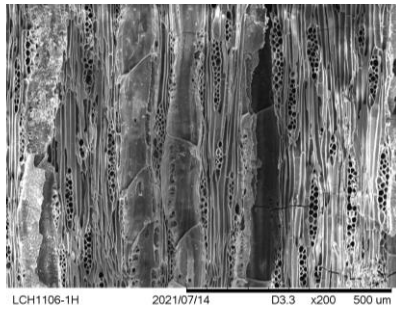


Scientific Name: LAURACEAE *Persea* sp.
Common Name: aguacate, avocado

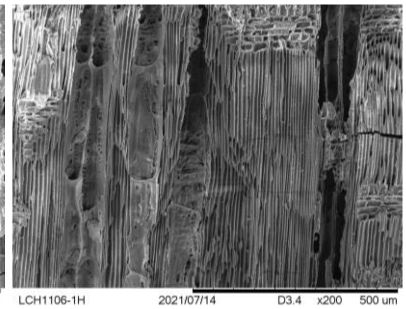
Transverse View



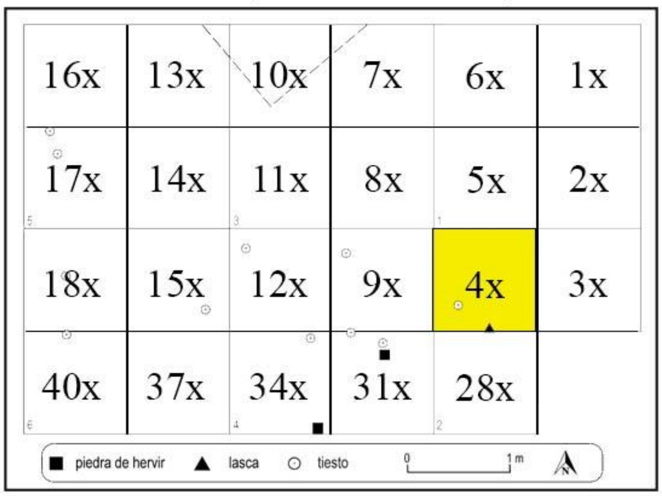
Tangential View



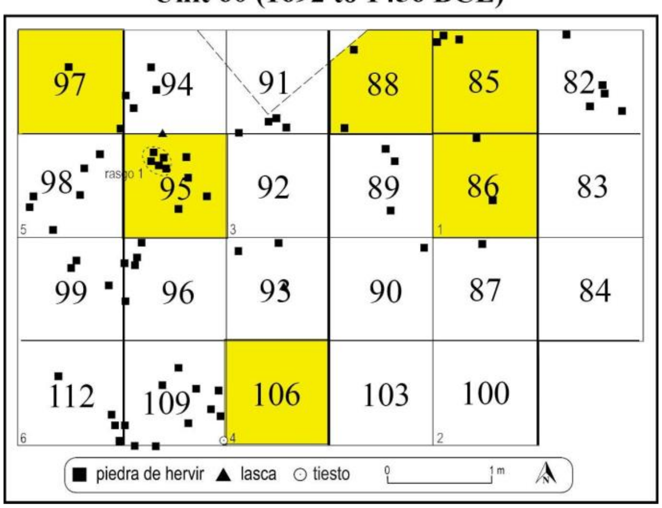
Radial View



Unit 54 (500 BCE to 100 CE)

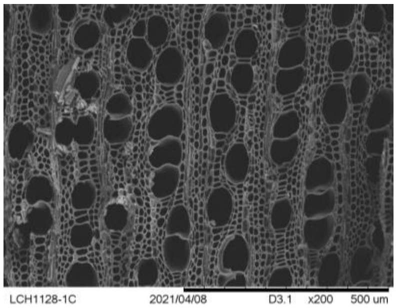


Unit 60 (1692 to 1456 BCE)

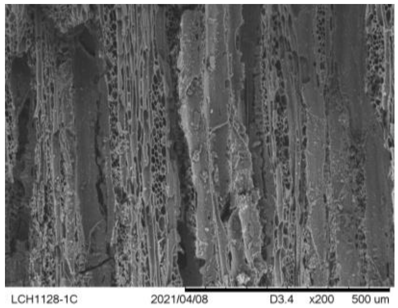


Scientific Name: MAGNOLIACEAE *Magnolia* sp.
Common Name: magnolia

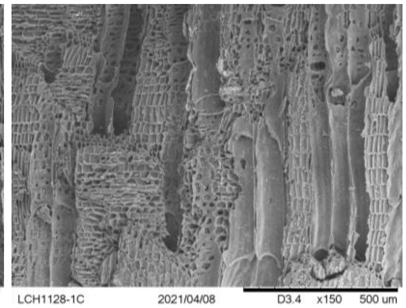
Transverse View



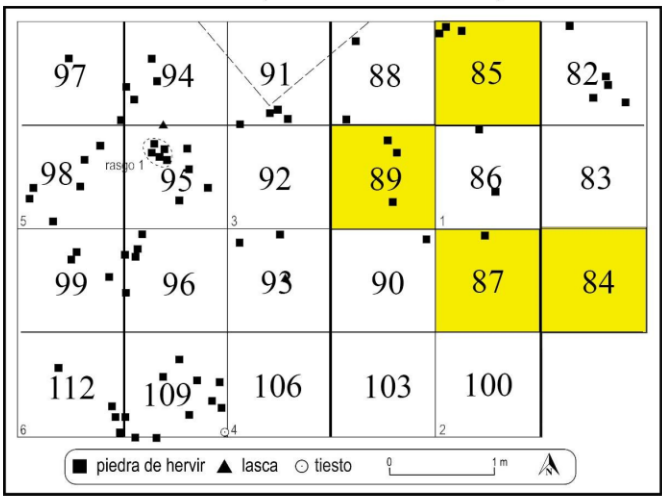
Tangential View



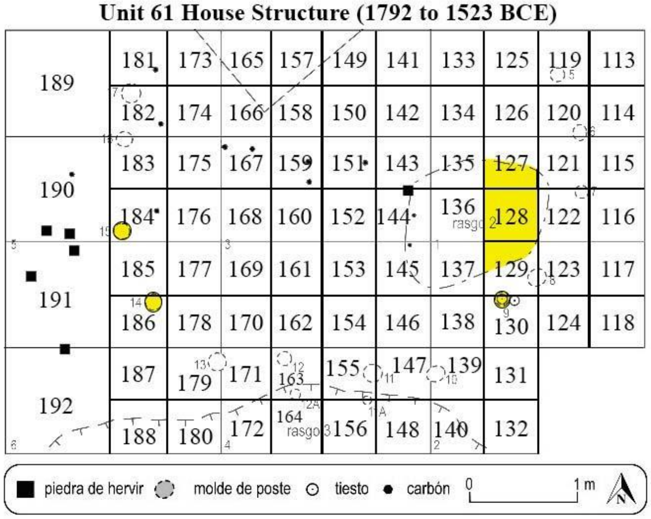
Radial View



Unit 60 (1692 to 1456 BCE)

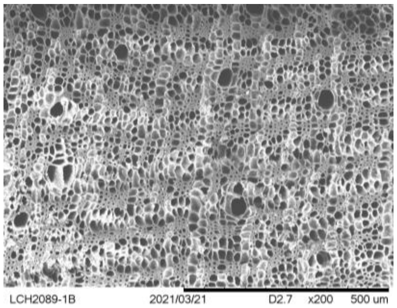


Unit 61 House Structure (1792 to 1523 BCE)

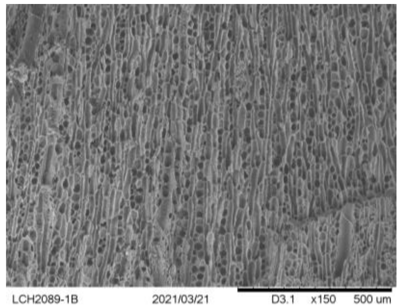


Scientific Name: MALPIGHIACEAE *Bunchosia* sp.
Common Name: cerezo de monte

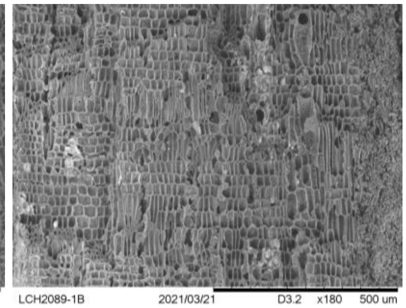
Transverse View



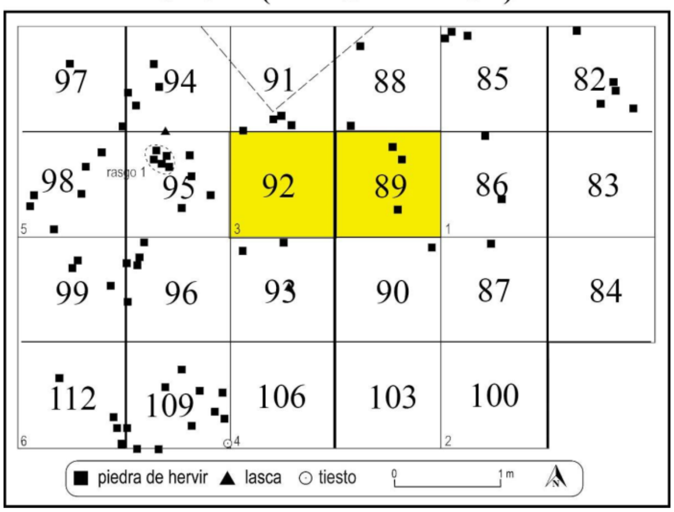
Tangential View



Radial View

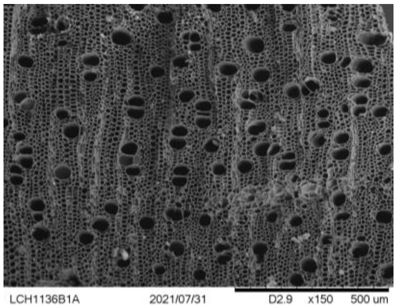


Unit 60 (1692 to 1456 BCE)

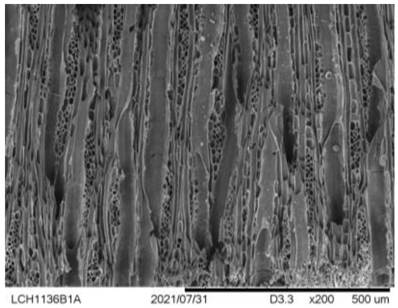


Scientific Name: MALPIGHIACEAE cf. *Byrsonima* sp.
Common Name: nance, nancillo

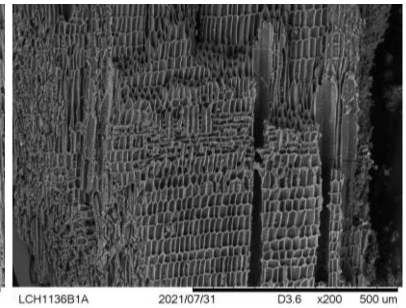
Transverse View



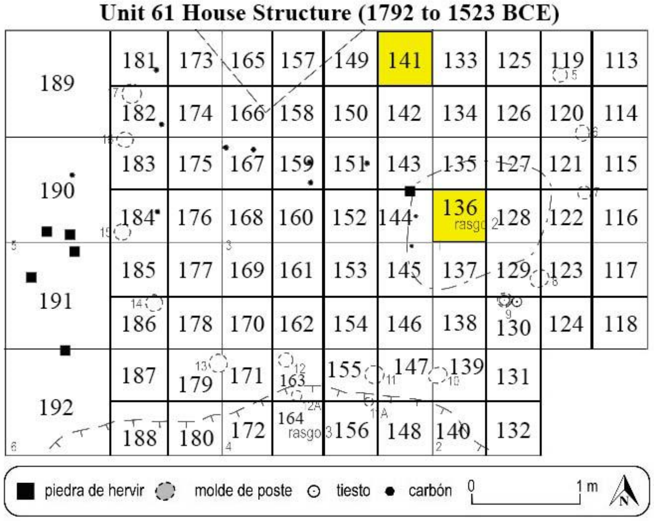
Tangential View



Radial View

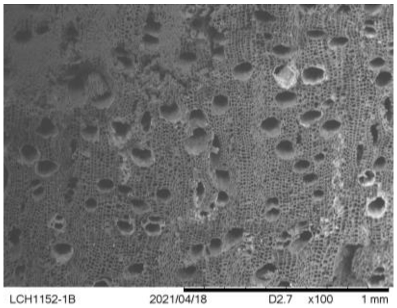


Unit 61 House Structure (1792 to 1523 BCE)

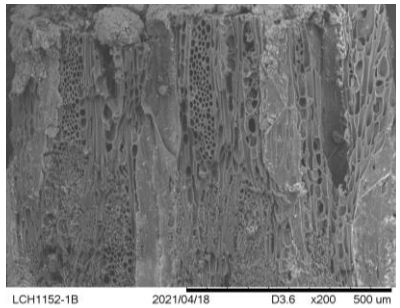


Scientific Name: MALVACEAE BOMBACOIDEAE *Cavanillesia platanifolia* (Bonpl.) Kunth
Common Name: pijio, bongo, cuipo, petrino

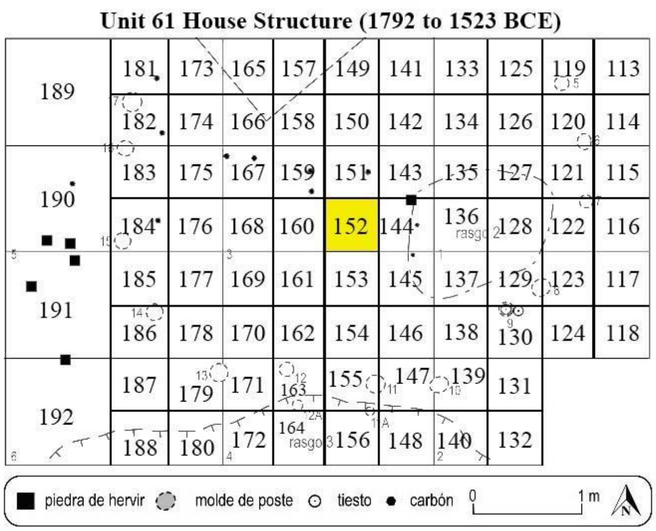
Transverse View



Tangential View

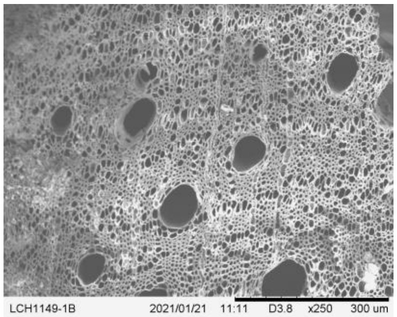


Radial View

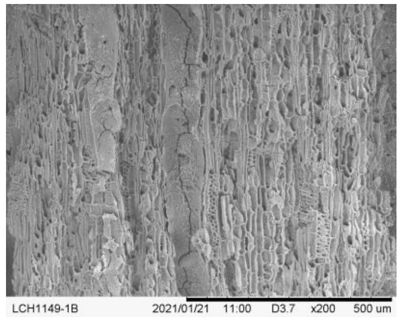


Scientific Name: MALVACEAE BOMBACOIDEAE *Ceiba* sp.
Common Name: ceiba

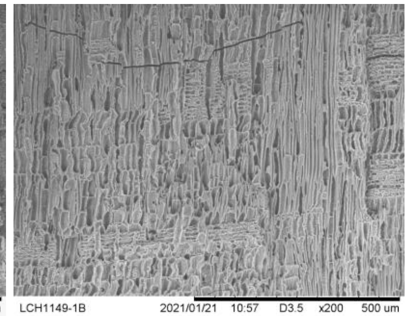
Transverse View



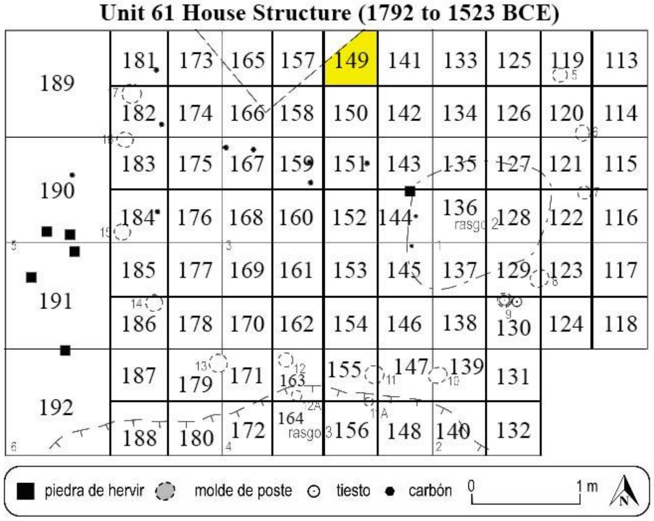
Tangential View



Radial View

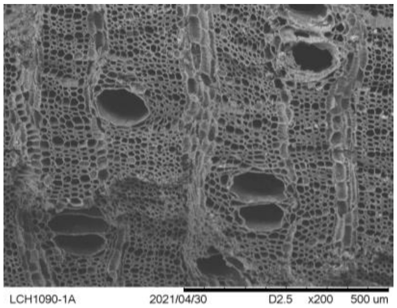


Unit 61 House Structure (1792 to 1523 BCE)

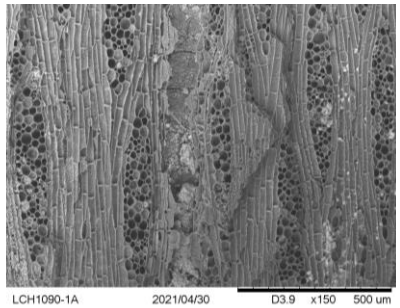


Scientific Name: MALVACEAE BOMBACOIDEAE *Quararibea* sp.
Common Name: guayabillo

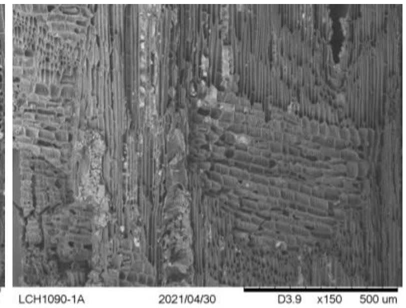
Transverse View



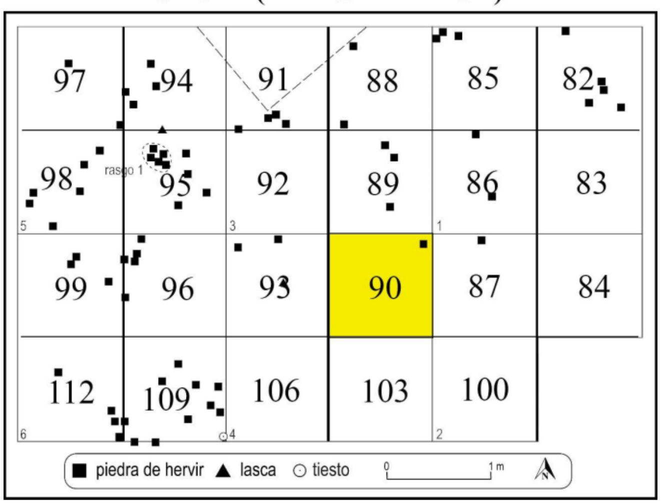
Tangential View



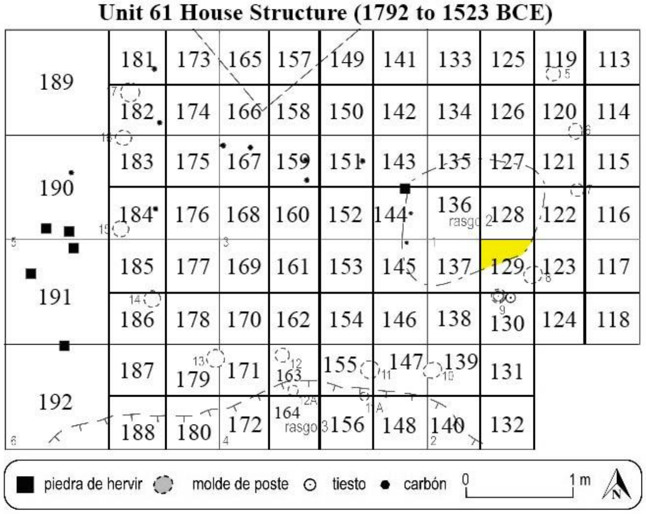
Radial View



Unit 60 (1692 to 1456 BCE)

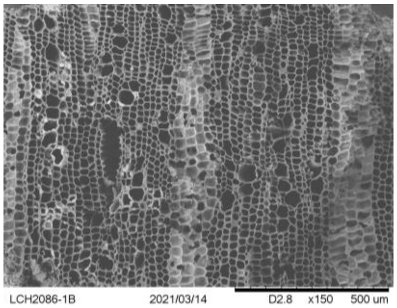


Unit 61 House Structure (1792 to 1523 BCE)

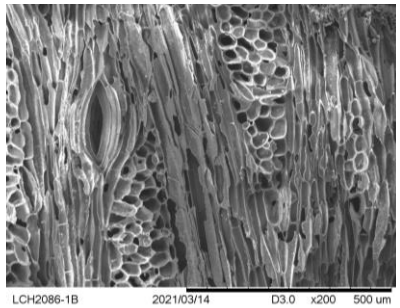


Scientific Name: MALVACEAE BYTTNERIOIDEAE *Herrania* sp.
Common Name: cacao de monte

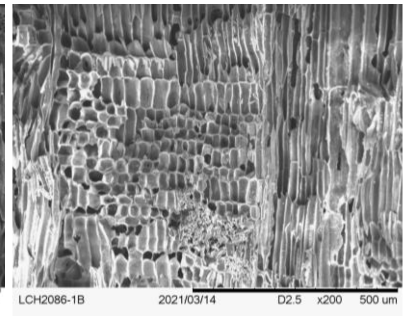
Transverse View



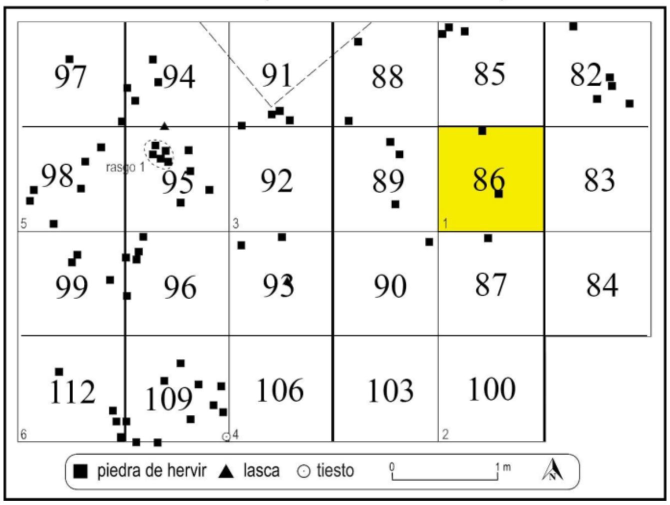
Tangential View



Radial View

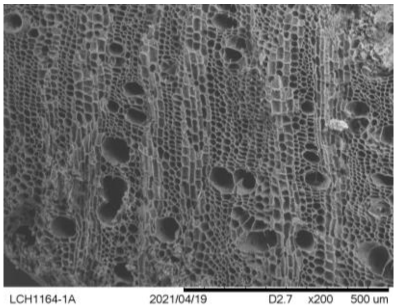


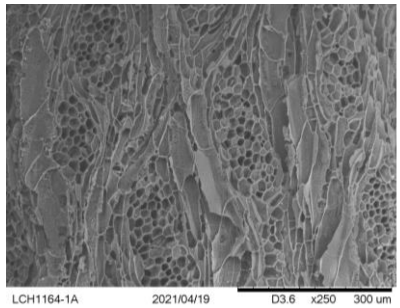
Unit 60 (1692 to 1456 BCE)

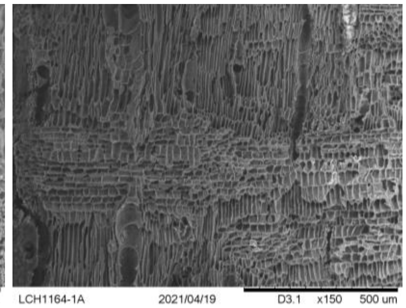


Scientific Name: MALVACEAE BYTTNERIOIDEAE *Theobroma* sp.
Common Name: cacao

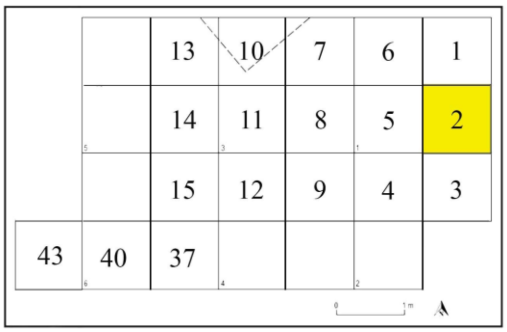
Transverse View | Tangential View | Radial View



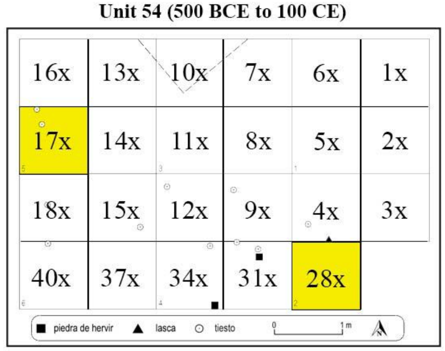




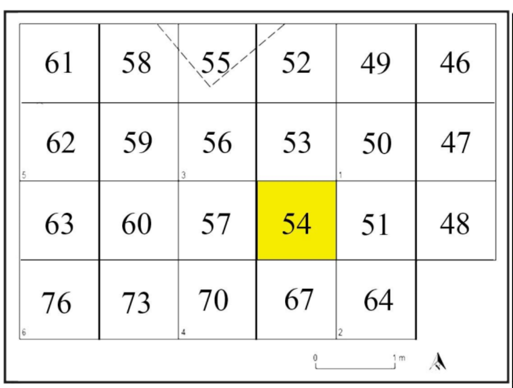
AR 16-15 (100 BCE to 100 CE)



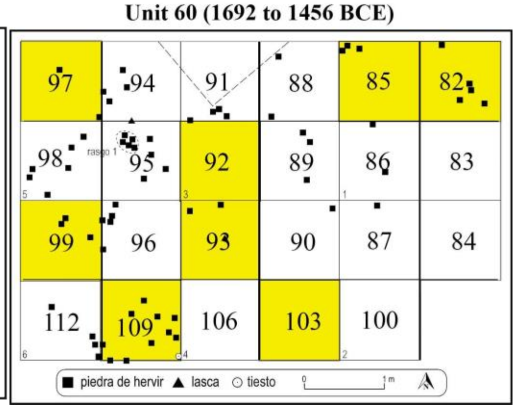
Unit 54 (500 BCE to 100 CE)



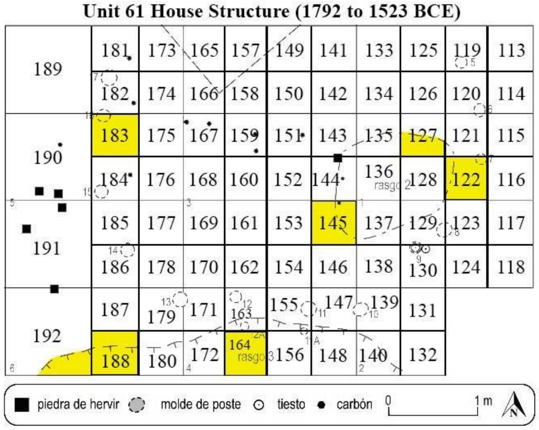
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

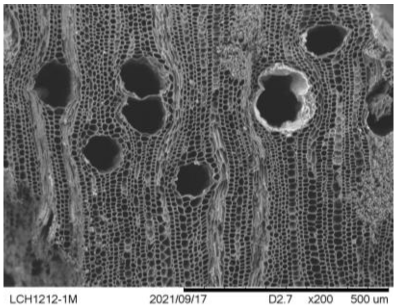


Unit 61 House Structure (1792 to 1523 BCE)

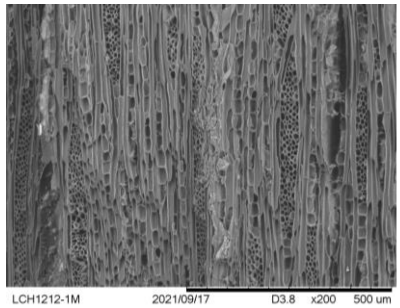


Scientific Name: MALVACEAE GREWIOIDEAE *Apeiba* cf. *membranacea* Spruce ex Benth.
Common Name: peinecillo, monkeys comb

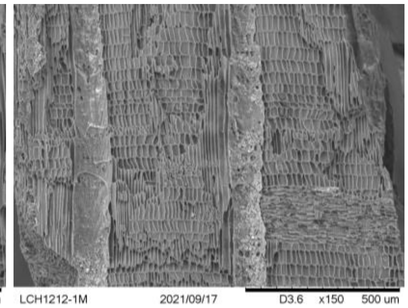
Transverse View



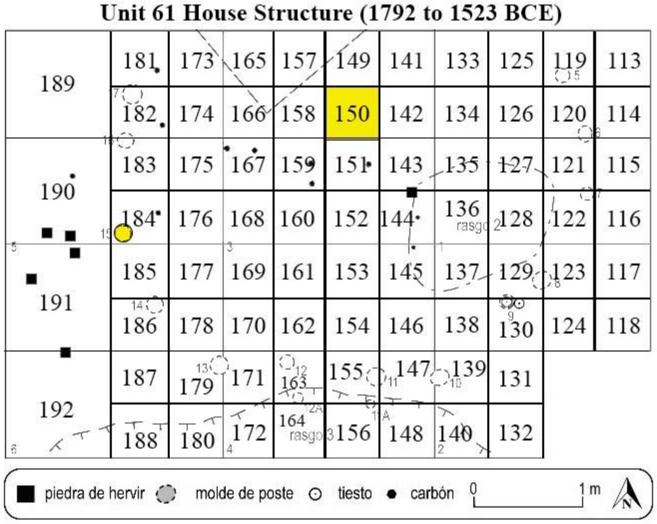
Tangential View



Radial View

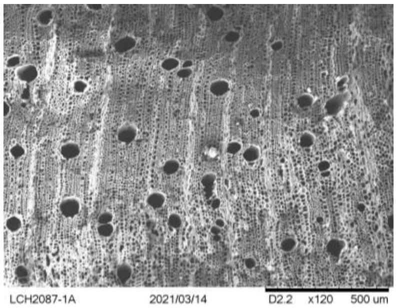


Unit 61 House Structure (1792 to 1523 BCE)

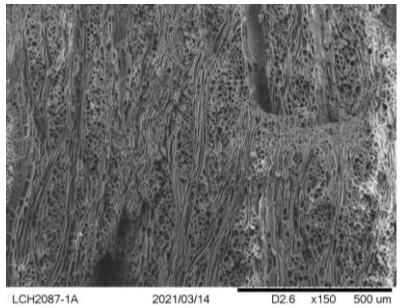


Scientific Name: MALVACEAE GREWIOIDEAE *Heliocarpus* sp.
Common Name: majaguillo, majagua

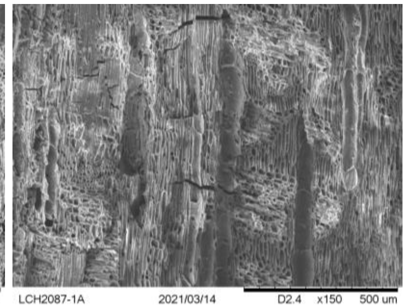
Transverse View



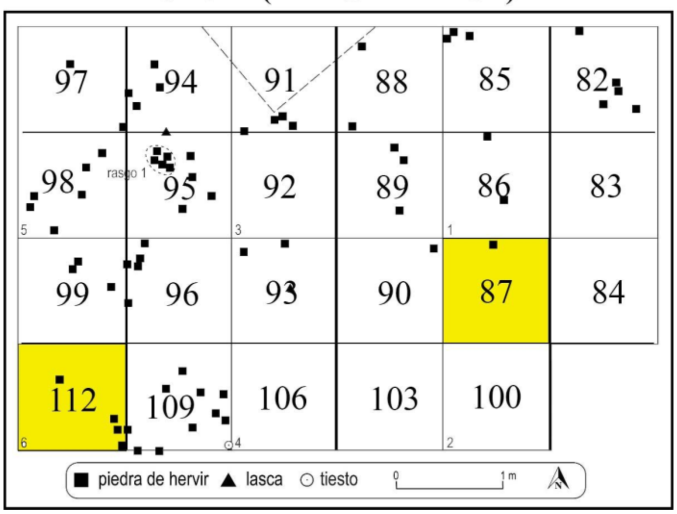
Tangential View



Radial View

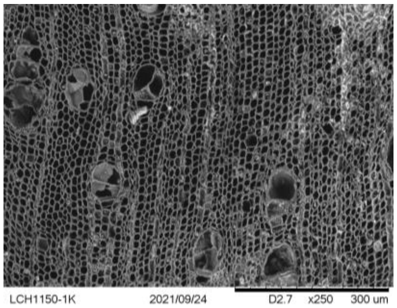


Unit 60 (1692 to 1456 BCE)

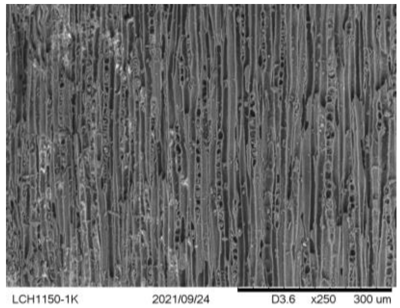


Scientific Name: MELASTOMATACEAE *Bellucia* sp.
Common Name: coronillo

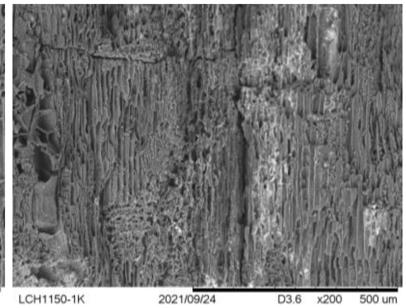
Transverse View



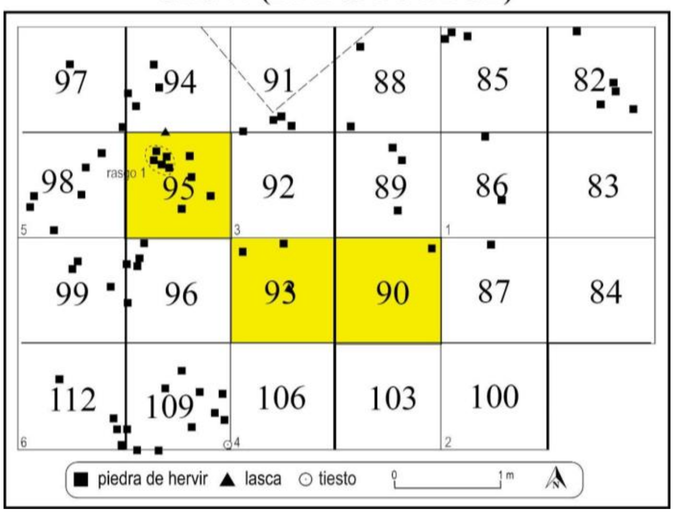
Tangential View



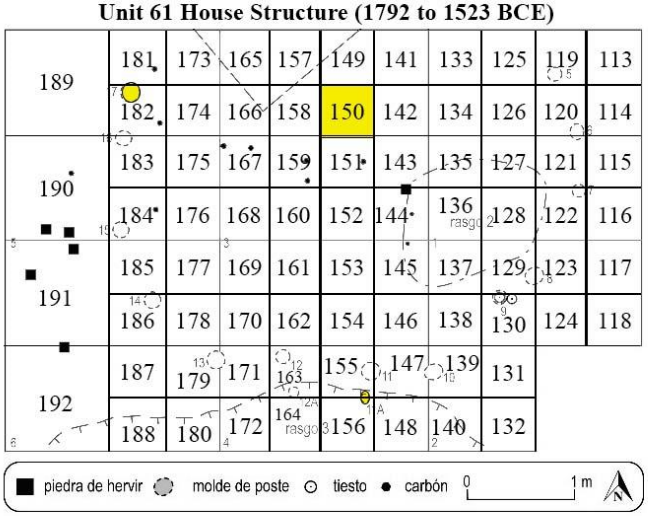
Radial View



Unit 60 (1692 to 1456 BCE)

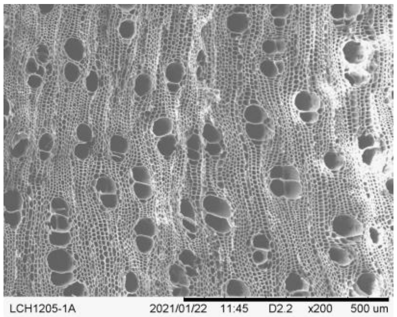


Unit 61 House Structure (1792 to 1523 BCE)

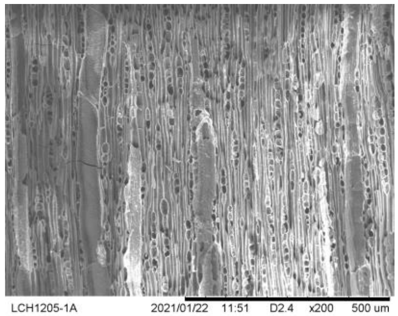


Scientific Name: MELASTOMATACEAE *Clidemia* sp.
Common Name: canillo, soapbush

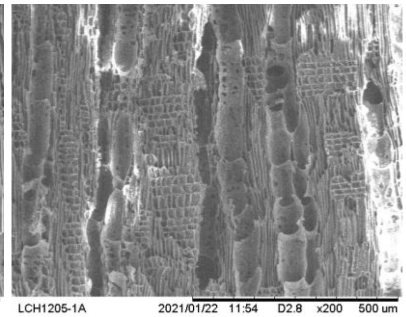
Transverse View



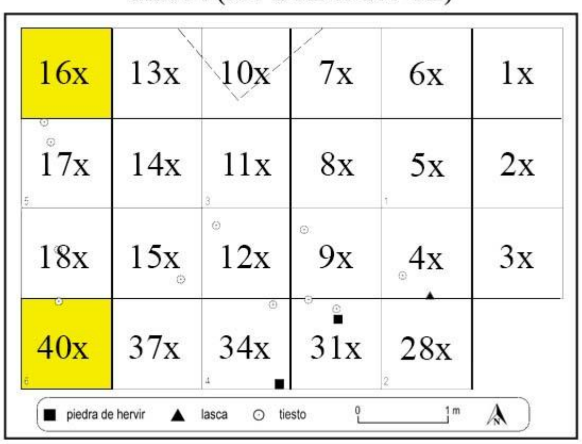
Tangential View



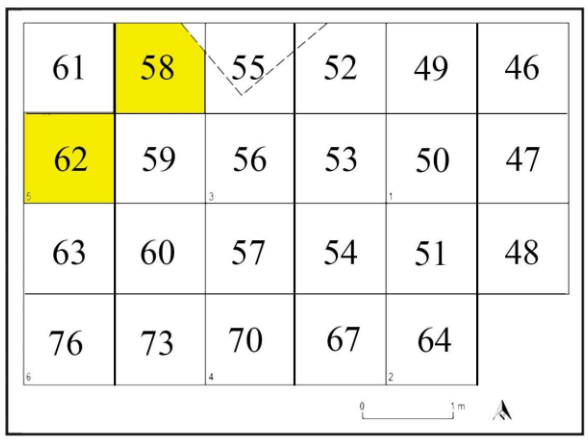
Radial View



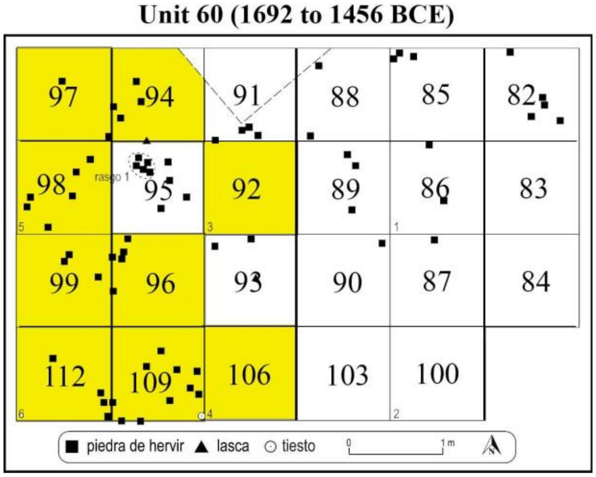
Unit 54 (500 BCE to 100 CE)



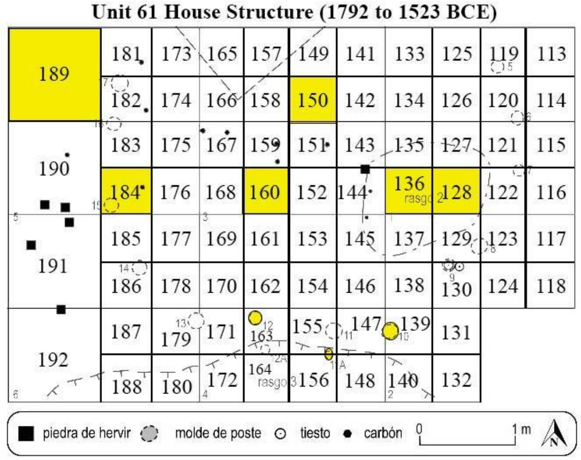
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

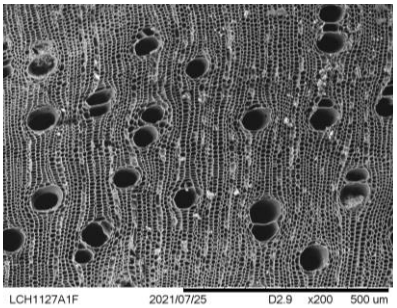


Unit 61 House Structure (1792 to 1523 BCE)

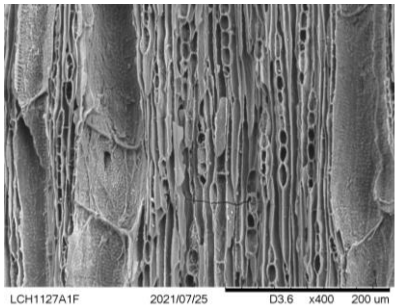


Scientific Name: MELASTOMATACEAE *Miconia* sp.
Common Name: canillo, soapbush

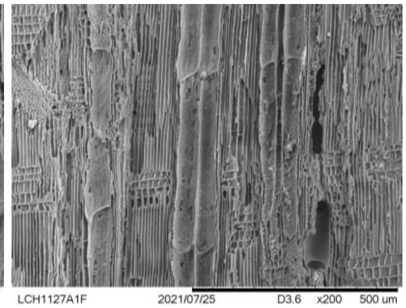
Transverse View



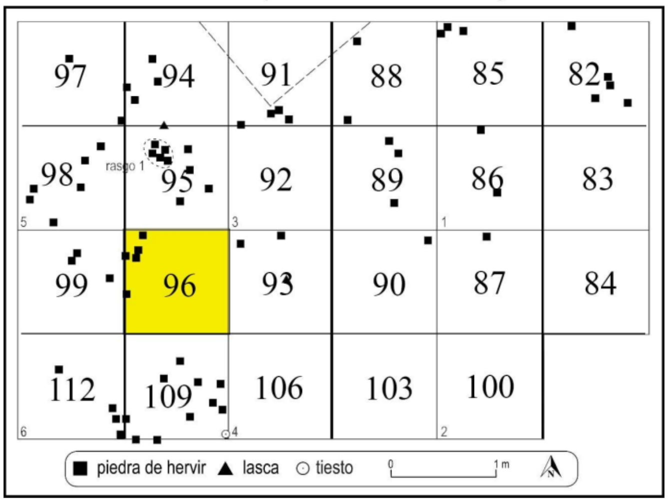
Tangential View



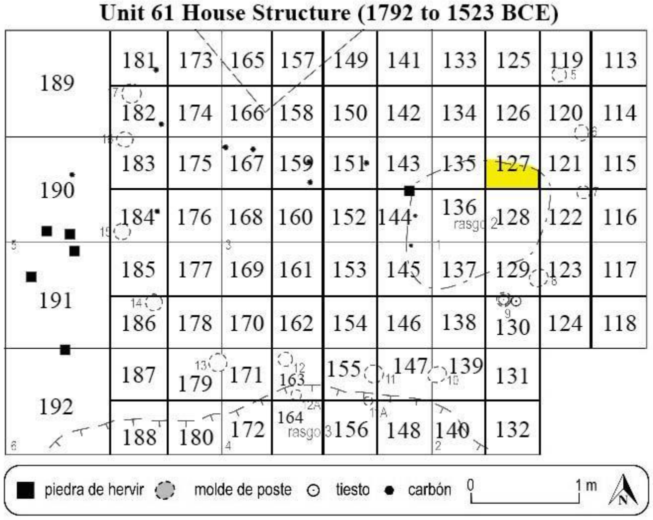
Radial View



Unit 60 (1692 to 1456 BCE)

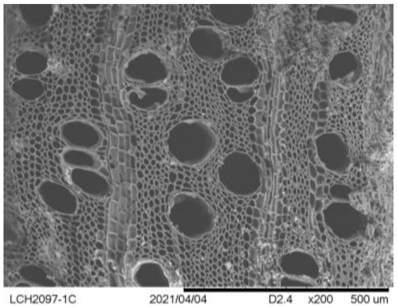


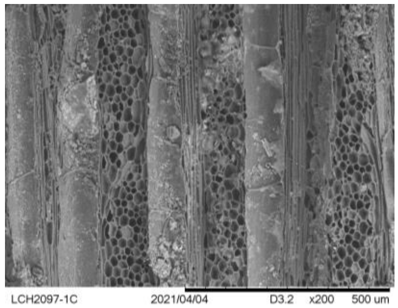
Unit 61 House Structure (1792 to 1523 BCE)

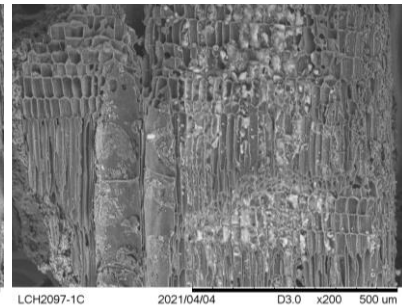


Scientific Name: MELIACEAE *Carapa* sp.
Common Name: tangaré, cedro bateo

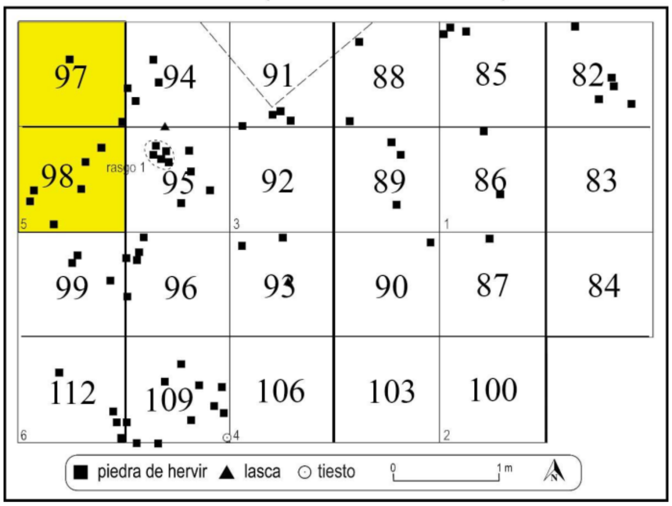
Transverse View | Tangential View | Radial View





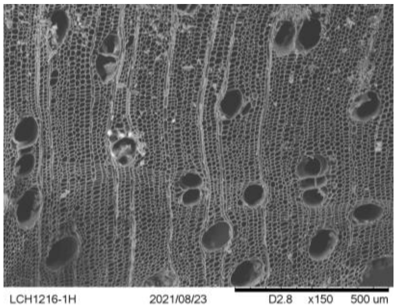


Unit 60 (1692 to 1456 BCE)

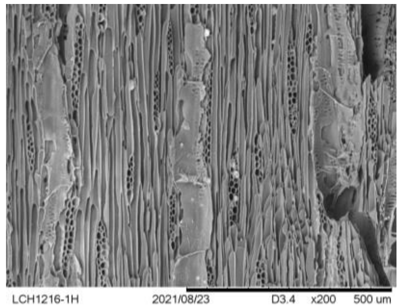


Scientific Name: MELIACEAE *Cedrela* sp.
Common Name: cedro

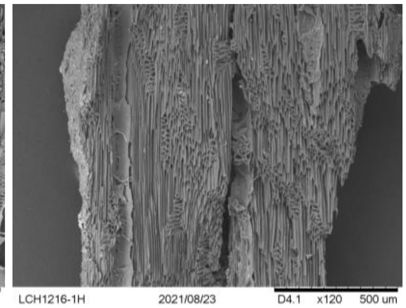
Transverse View



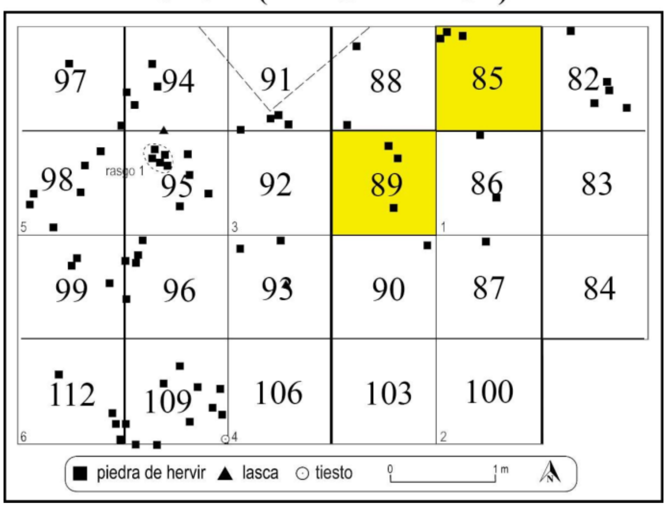
Tangential View



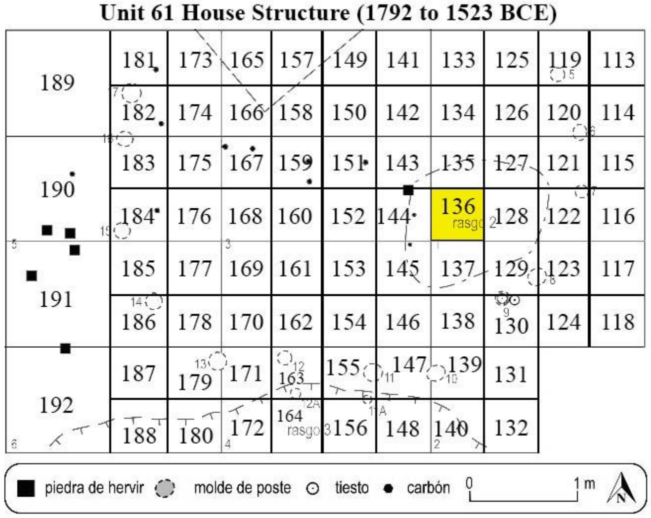
Radial View



Unit 60 (1692 to 1456 BCE)

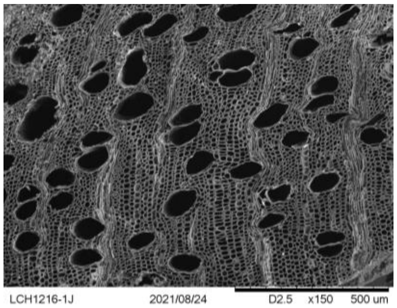


Unit 61 House Structure (1792 to 1523 BCE)

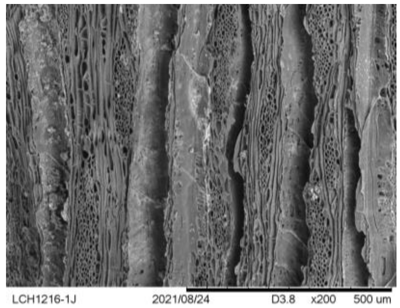


Scientific Name: MELIACEAE *Swietenia humilis* Zucc.
Common Name: mahogany

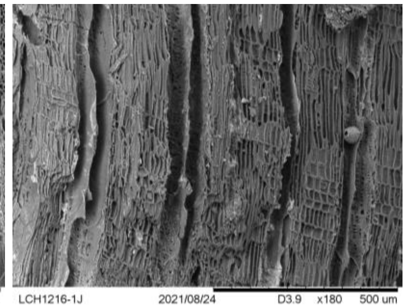
Transverse View



Tangential View

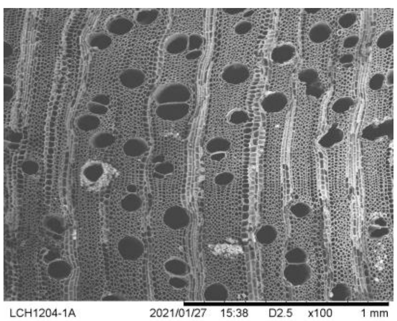


Radial View

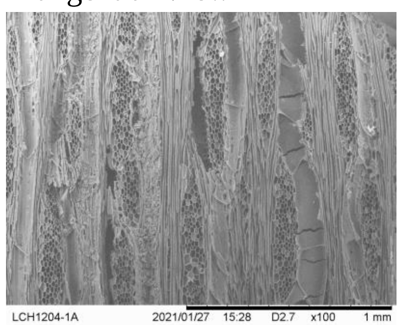


Scientific Name: MELIACEAE *Swietenia macrophylla* King
Common Name: mahogany, caoba

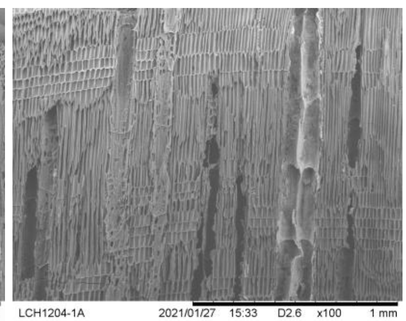
Transverse View



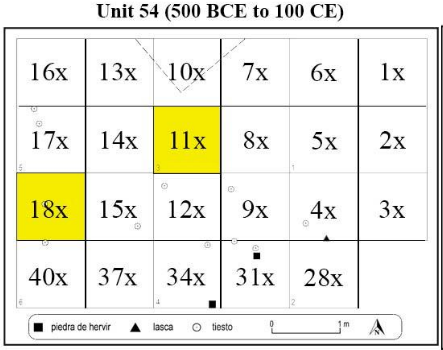
Tangential View



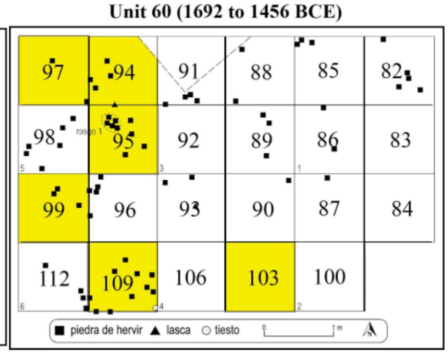
Radial View



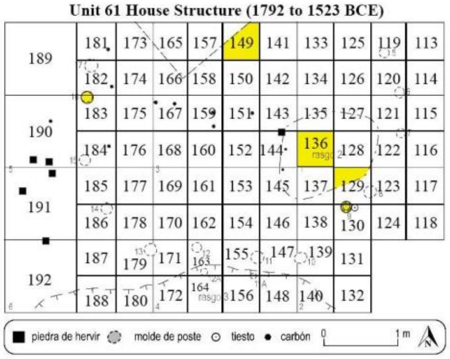
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)



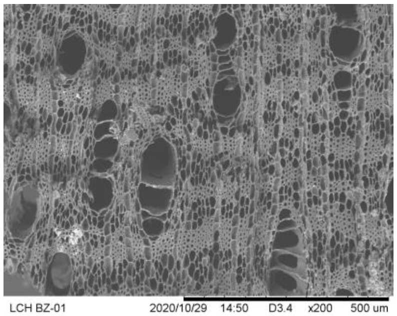
Unit 61 House Structure (1792 to 1523 BCE)



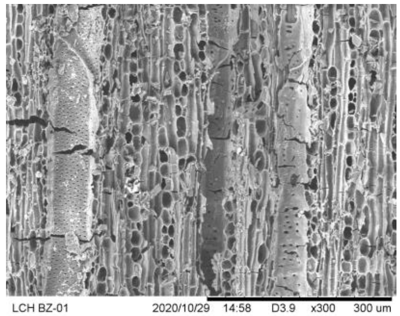
* All *Swietenia* spp. are combined in maps

Scientific Name: MELIACEAE *Trichilia* sp.
Common Name: terciopelo, conejo colorado, fosforito, alfajía colorado, alfaje

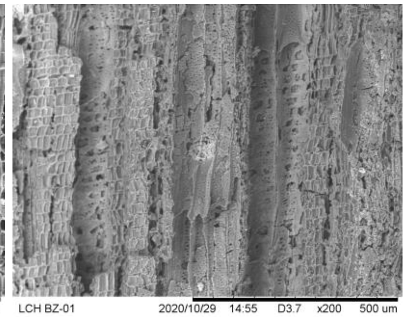
Transverse View



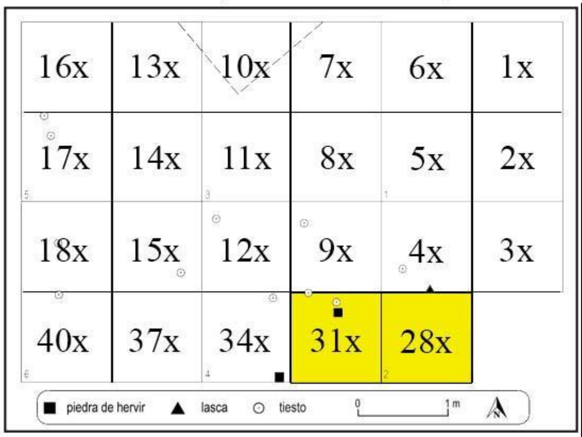
Tangential View



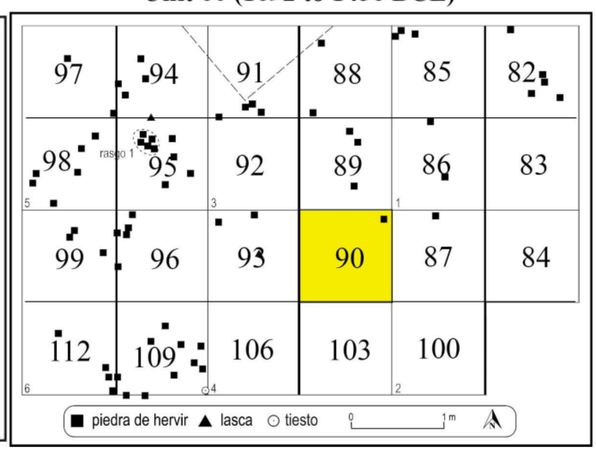
Radial View



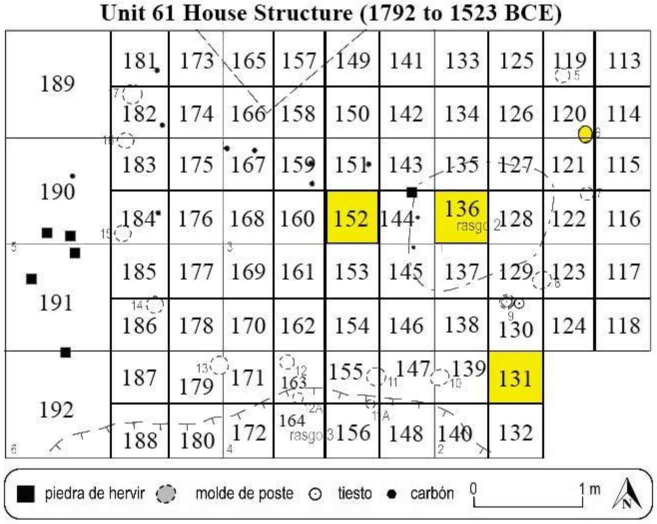
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

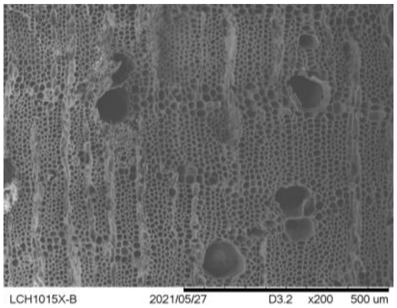


Unit 61 House Structure (1792 to 1523 BCE)

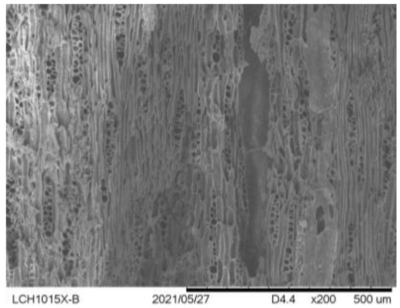


Scientific Name: MORACEAE *Brosimum* sp.
Common Name: sande, mastate, breadnut

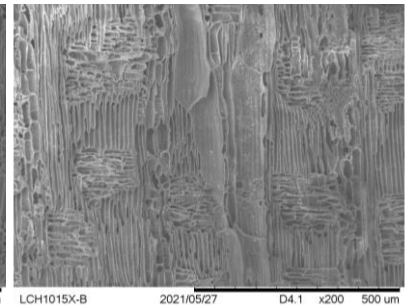
Transverse View



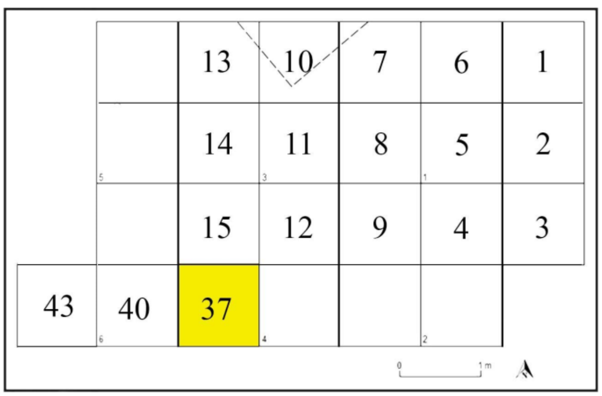
Tangential View



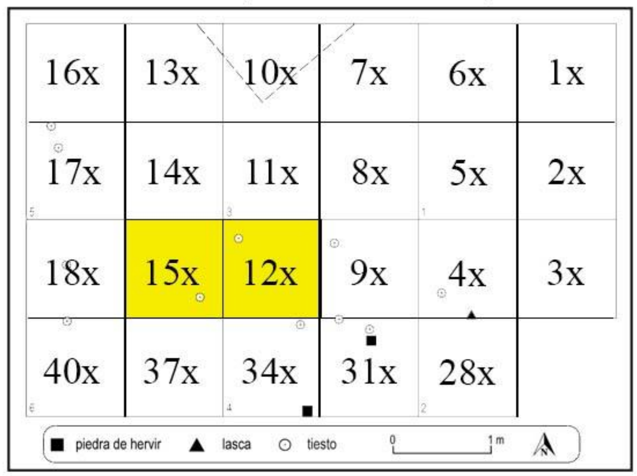
Radial View



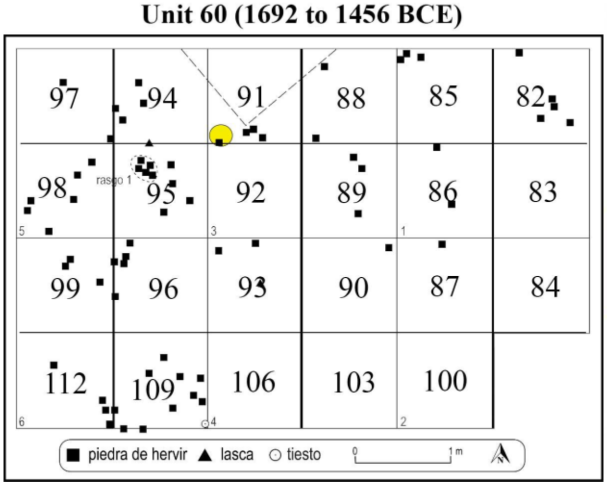
AR 16-15 (100 BCE to 100 CE)



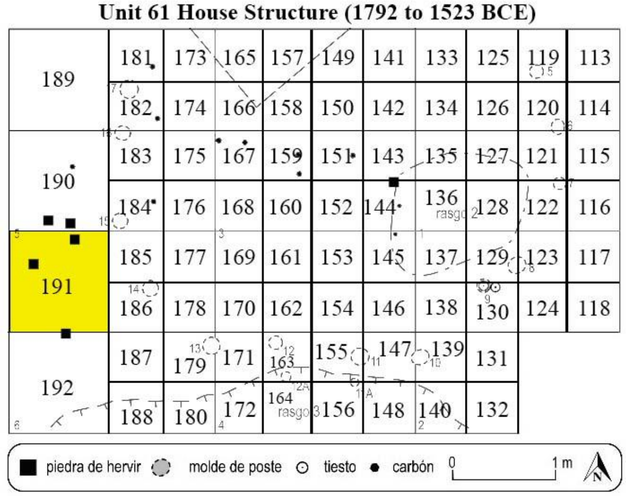
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

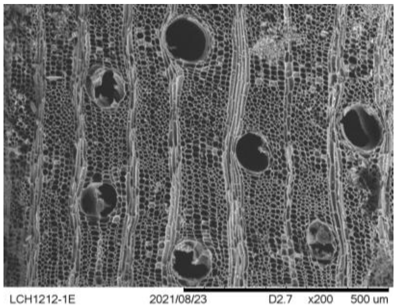


Unit 61 House Structure (1792 to 1523 BCE)

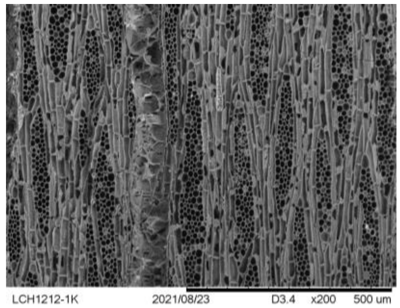


Scientific Name: MORACEAE *Ficus* sp.
Common Name: fig, higuerón

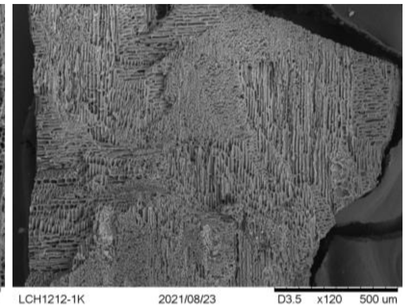
Transverse View



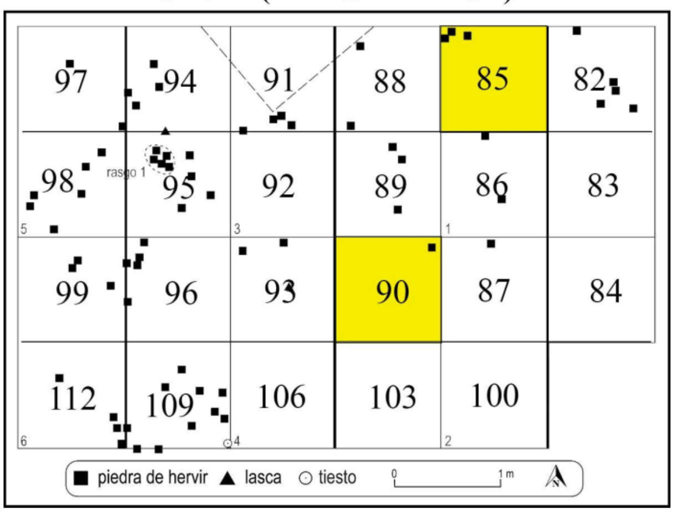
Tangential View



Radial View

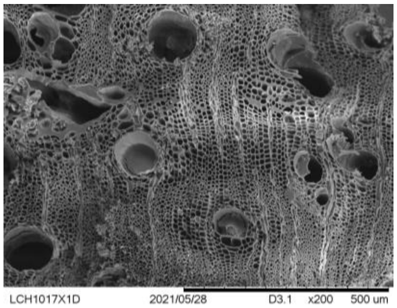


Unit 60 (1692 to 1456 BCE)

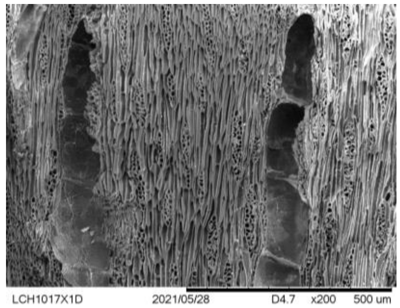


Scientific Name: MORACEAE *Maclura tinctoria* (L.) D. Don ex G. Don
Common Name: moro, mora, amarillo

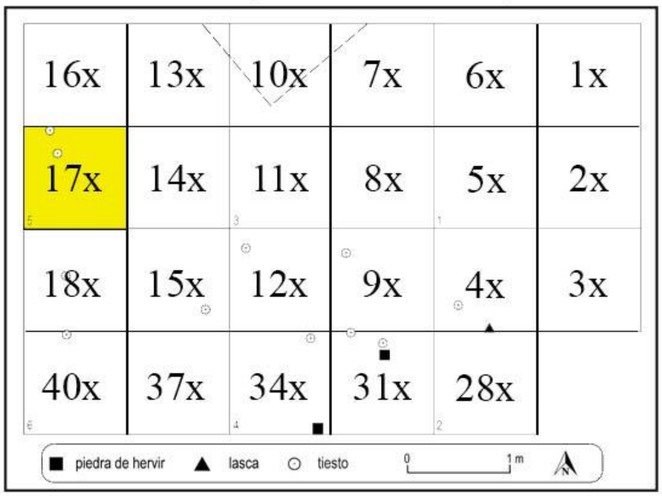
Transverse View



Tangential View

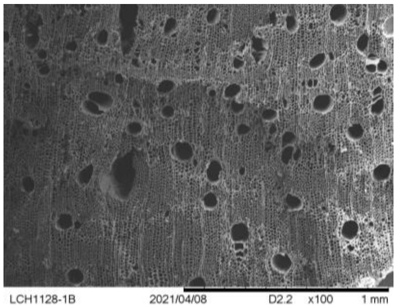


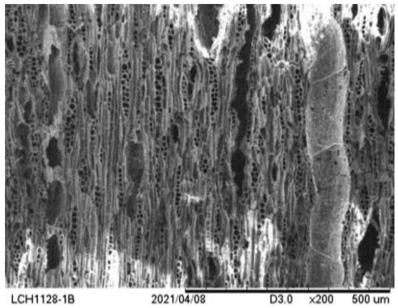
Unit 54 (500 BCE to 100 CE)

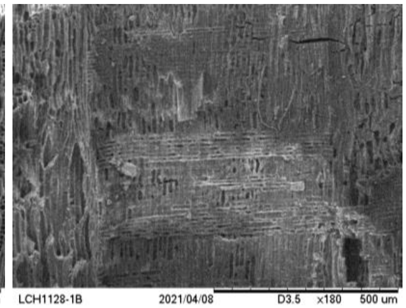


Scientific Name: MORACEAE *Maquira costaricana* (Standl.) C.C. Berg
Common Name: palo de pico

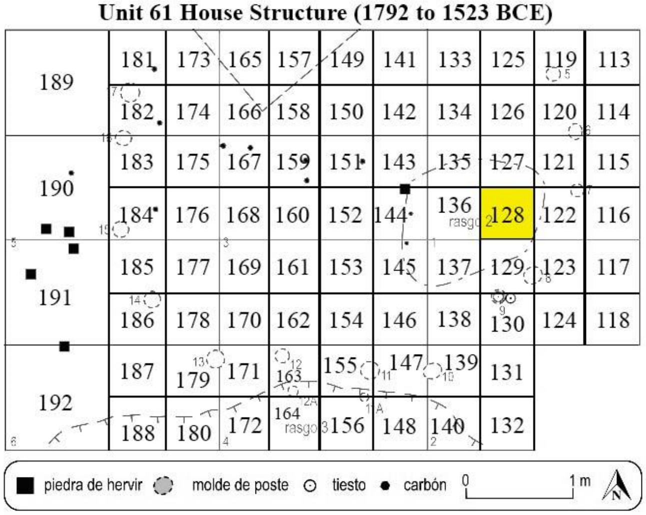
Transverse View / Tangential View / Radial View





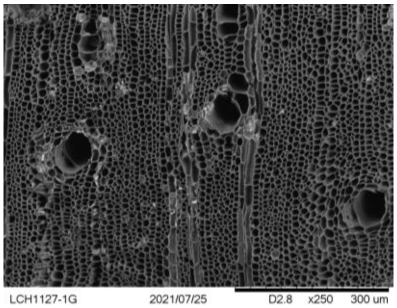


Unit 61 House Structure (1792 to 1523 BCE)

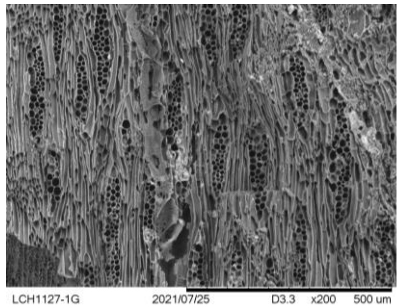


Scientific Name: MORACEAE *Naucleopsis* sp.
Common Name: palo de pico

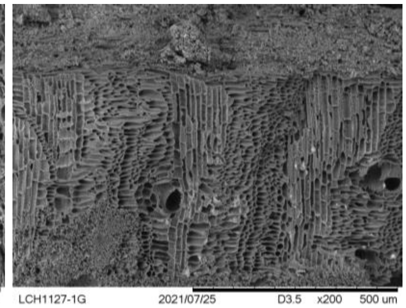
Transverse View



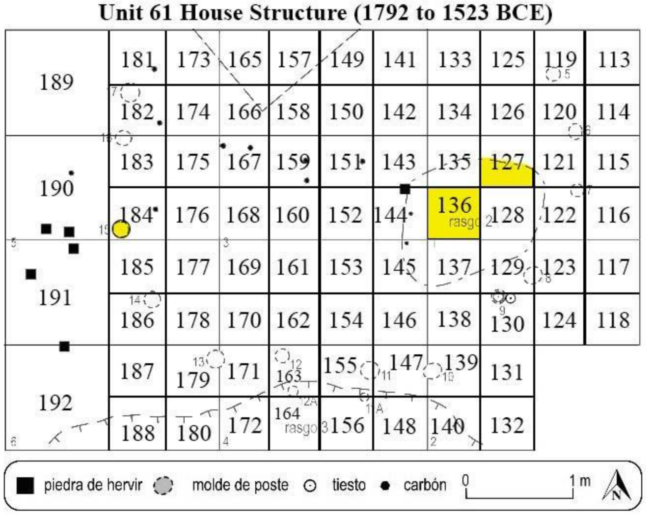
Tangential View



Radial View

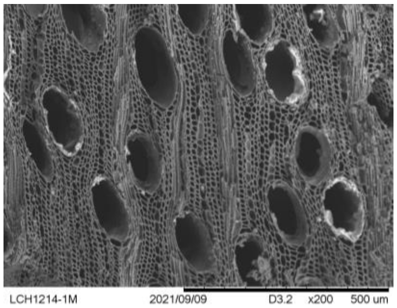


Unit 61 House Structure (1792 to 1523 BCE)

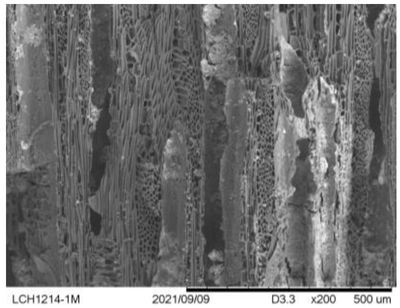


Scientific Name: MORACEAE *Poulsenia armata* (Miq.) Standl.
Common Name: chilamate, chanchama, cucua, mastate

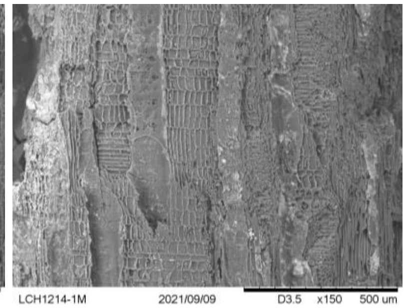
Transverse View



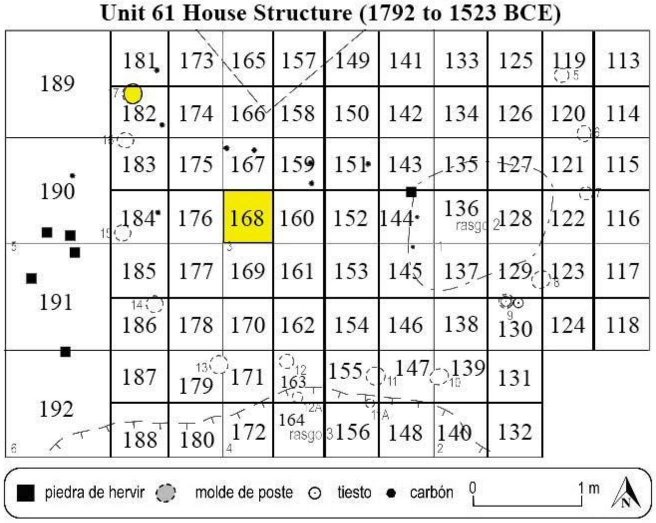
Tangential View



Radial View

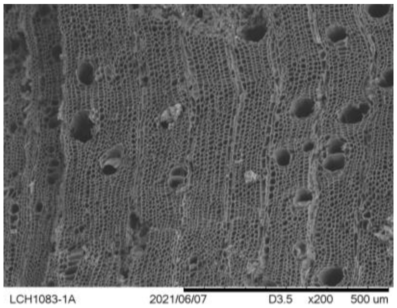


Unit 61 House Structure (1792 to 1523 BCE)

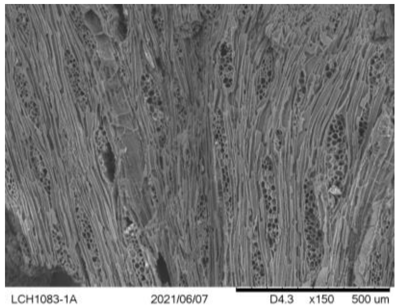


Scientific Name: MORACEAE *Trophis* sp.
Common Name: lija

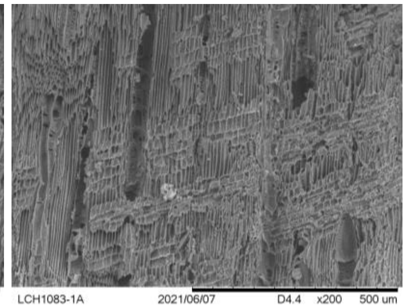
Transverse View



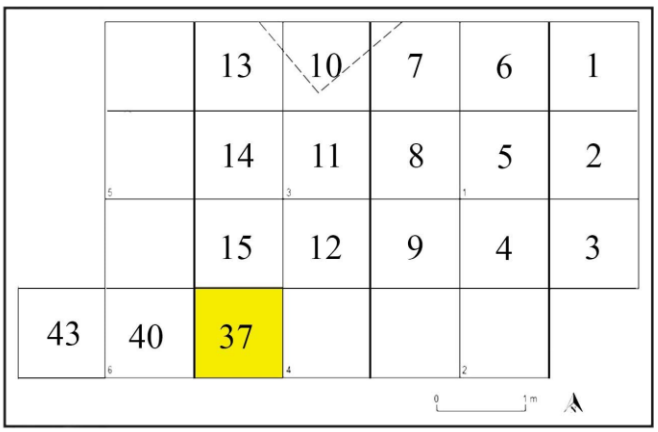
Tangential View



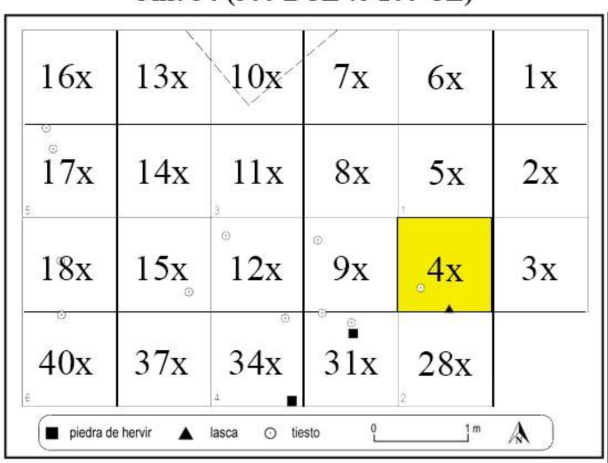
Radial View



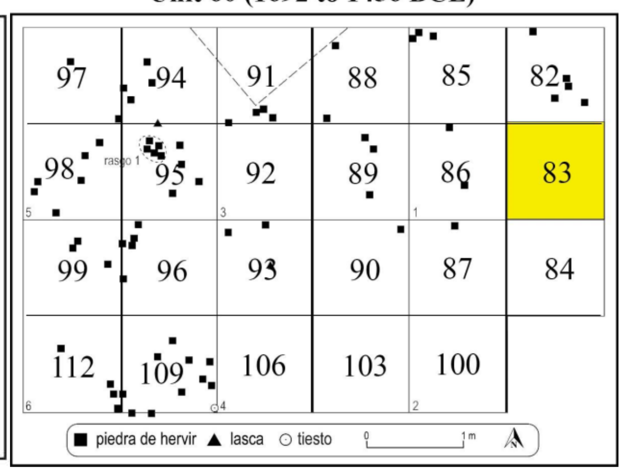
AR 16-15 (100 BCE to 100 CE)



Unit 54 (500 BCE to 100 CE)

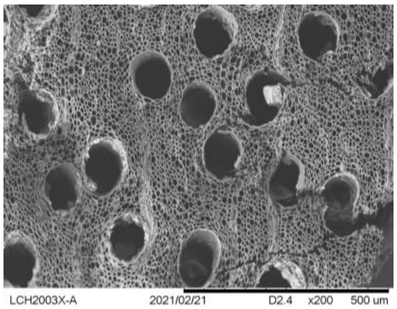


Unit 60 (1692 to 1456 BCE)

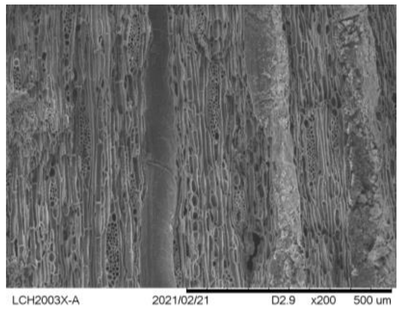


Scientific Name: MUNTINGIACEAE *Muntingia calabura* L.
Common Name: capulin, jamaican cherry

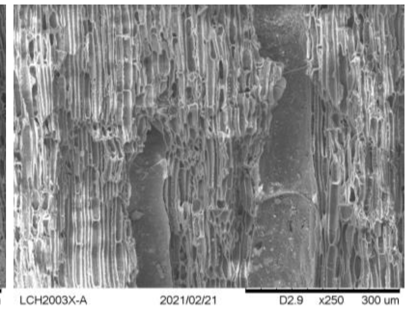
Transverse View



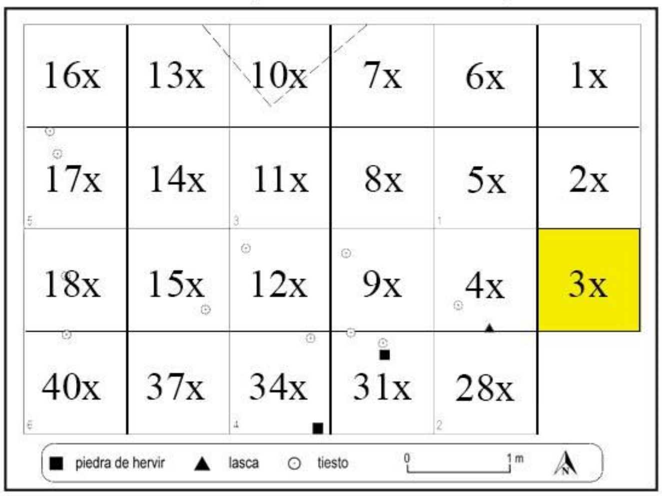
Tangential View



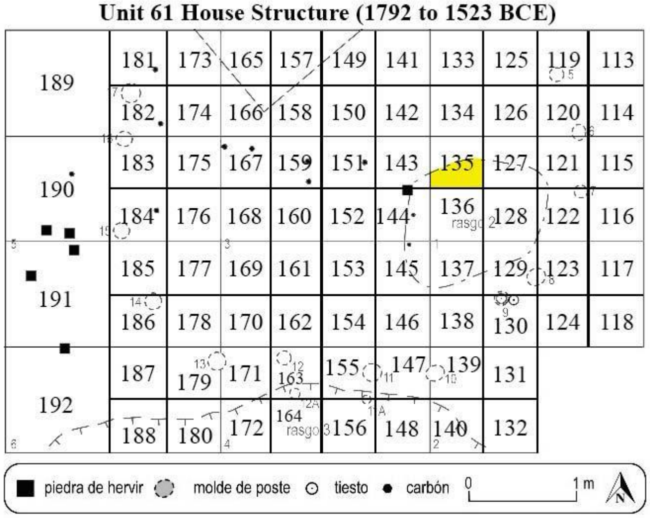
Radial View



Unit 54 (500 BCE to 100 CE)

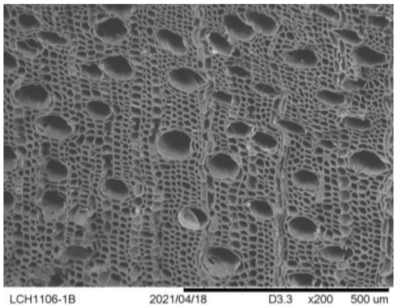


Unit 61 House Structure (1792 to 1523 BCE)

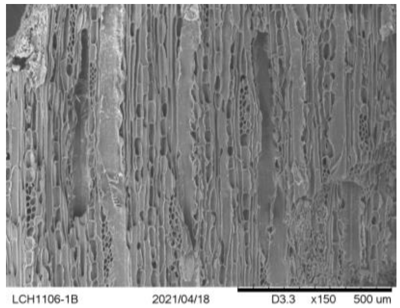


Scientific Name: MYRICACEAE *Morella* sp.
Common Name: bayberry

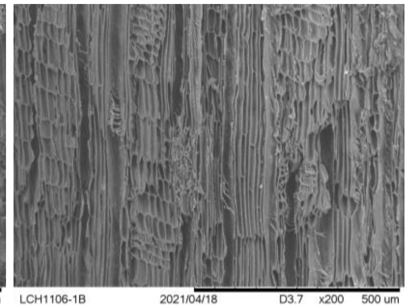
Transverse View



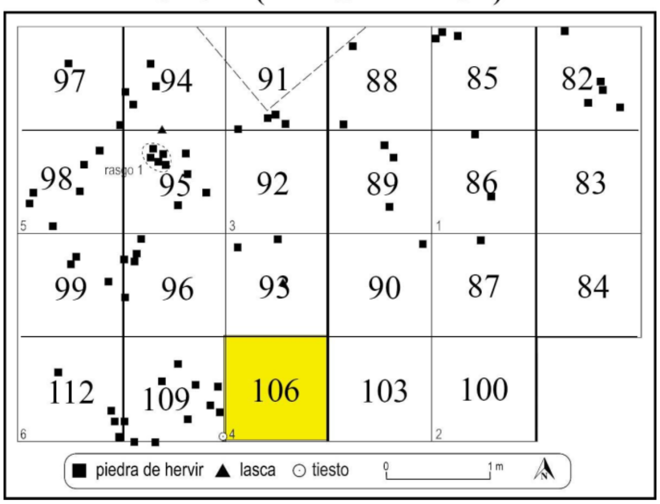
Tangential View



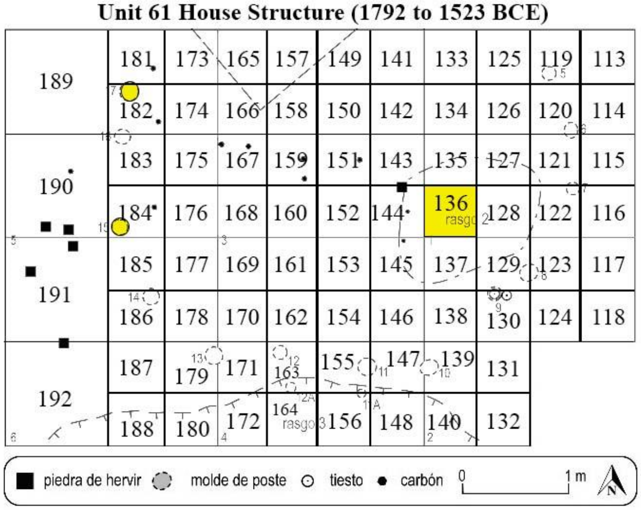
Radial View



Unit 60 (1692 to 1456 BCE)

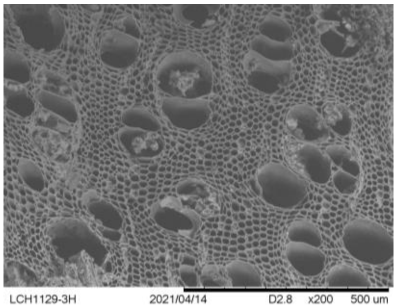


Unit 61 House Structure (1792 to 1523 BCE)

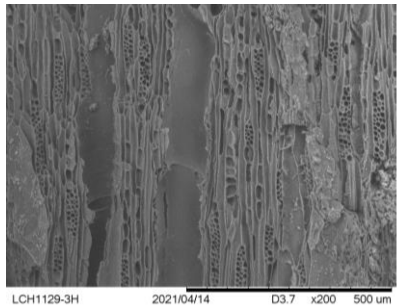


Scientific Name: MYRISTICACEAE *Virola* sp.
Common Name: baboonwood, ucuhuba

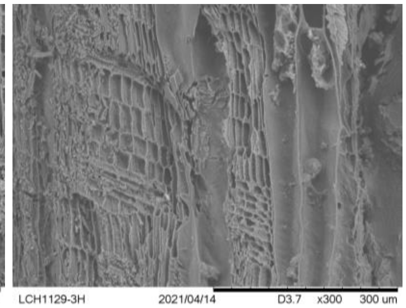
Transverse View



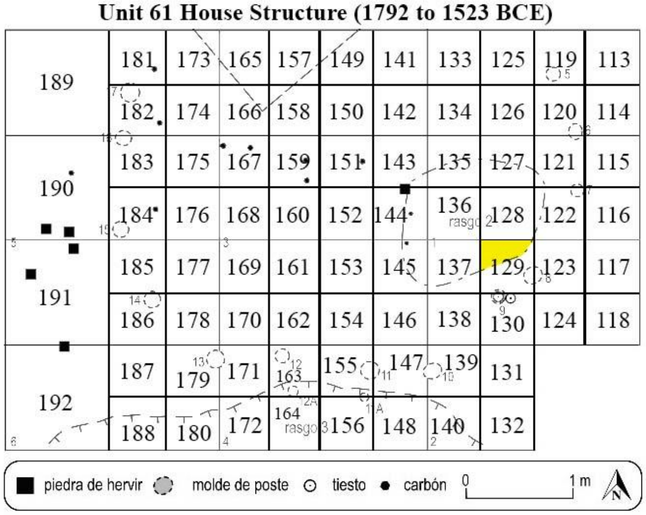
Tangential View



Radial View

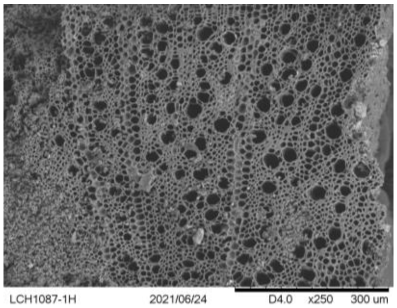


Unit 61 House Structure (1792 to 1523 BCE)

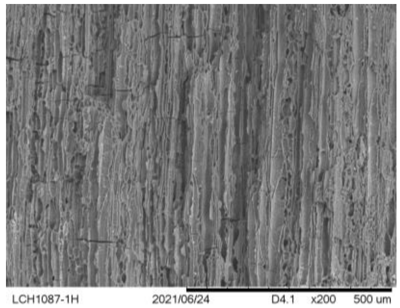


Scientific Name: MYRSINACEAE *Ardisia* sp.
Common Name: coralberry

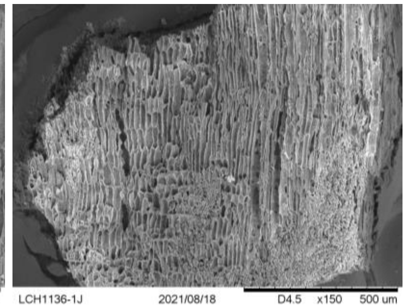
Transverse View



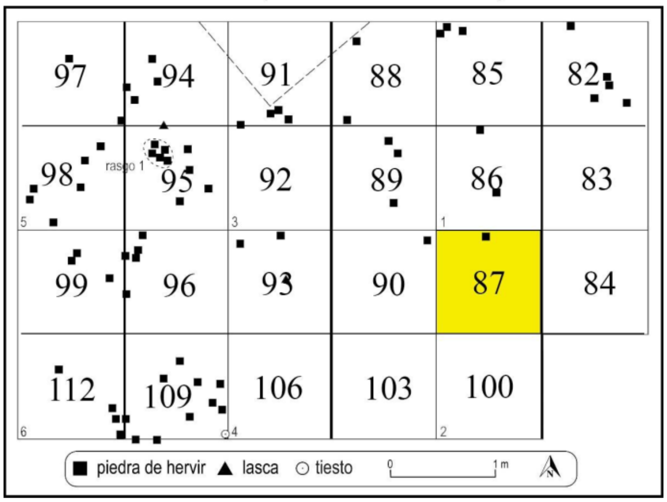
Tangential View



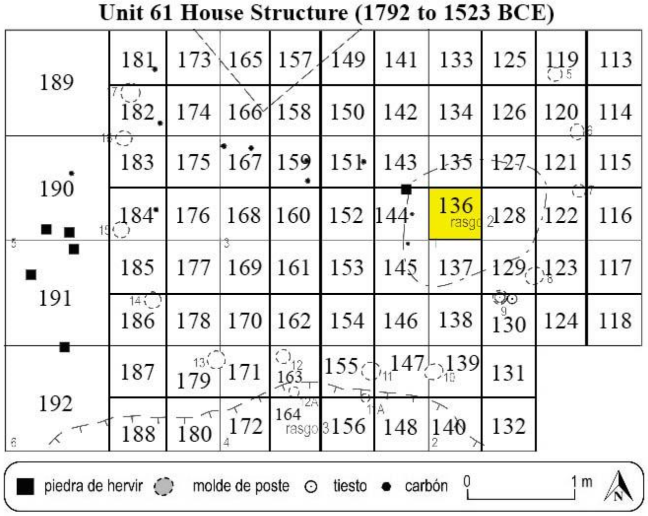
Radial View



Unit 60 (1692 to 1456 BCE)

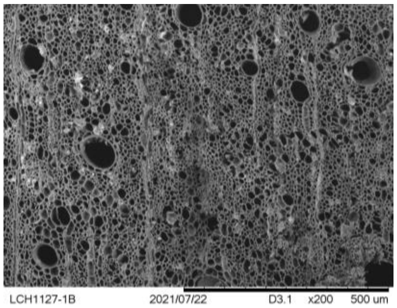


Unit 61 House Structure (1792 to 1523 BCE)

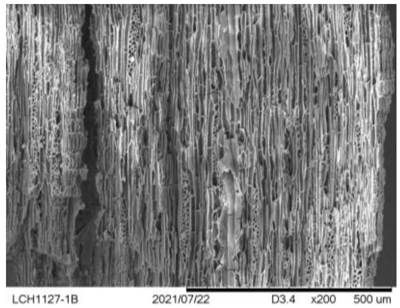


Scientific Name: MYRTACEAE *Eugenia* sp.
Common Name: pitanga, escobillo blanco

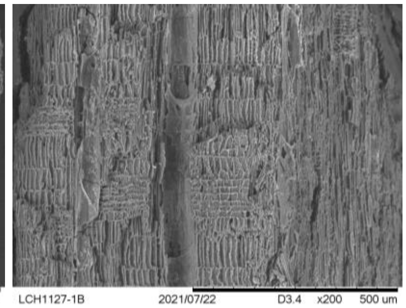
Transverse View



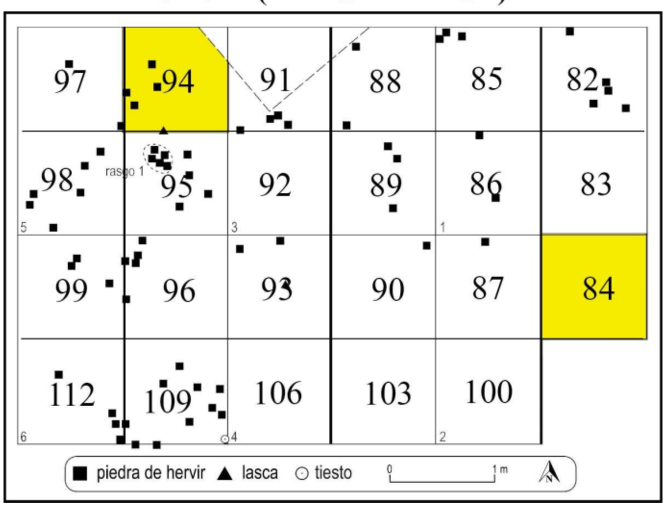
Tangential View



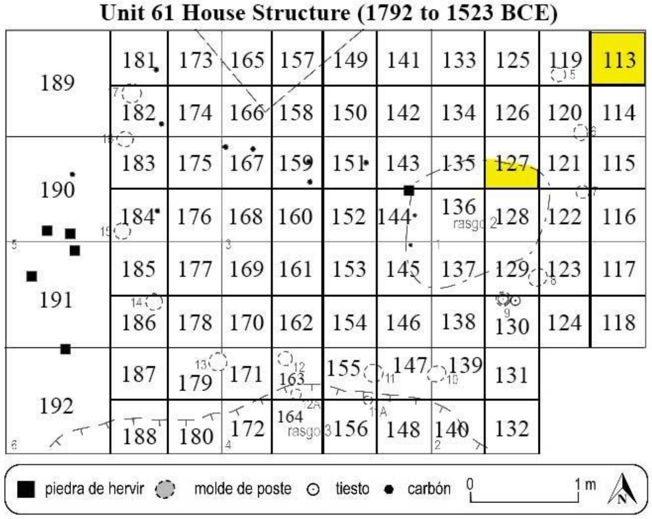
Radial View



Unit 60 (1692 to 1456 BCE)

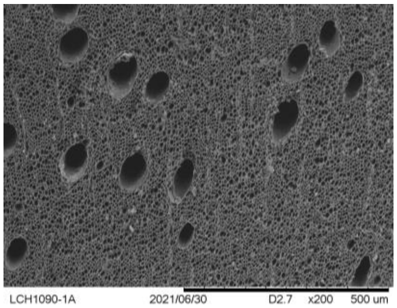


Unit 61 House Structure (1792 to 1523 BCE)

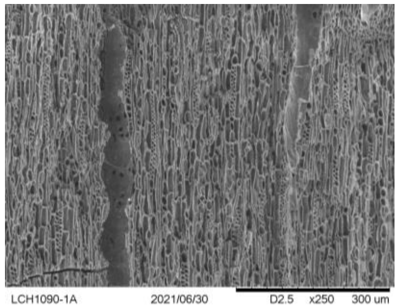


Scientific Name: MYRTACEAE *Psidium* sp.
Common Name: guava, guayaba

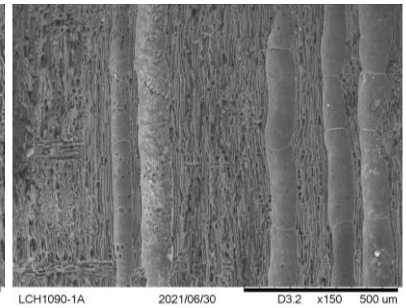
Transverse View



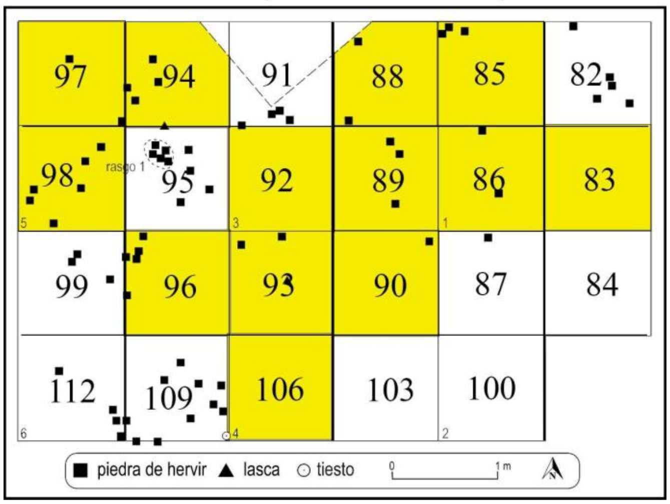
Tangential View



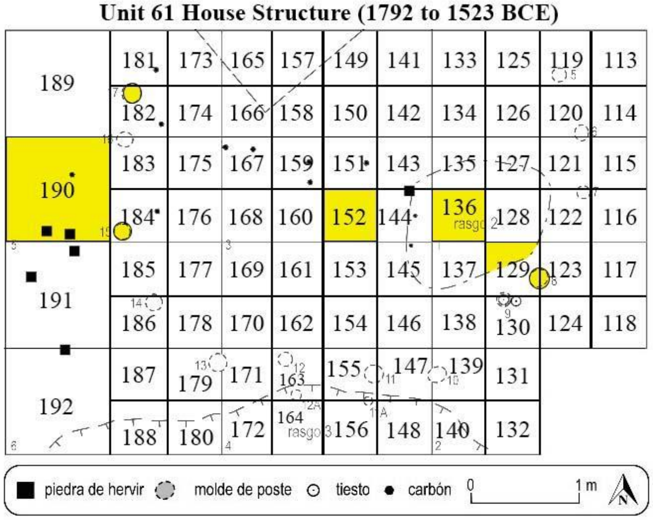
Radial View



Unit 60 (1692 to 1456 BCE)

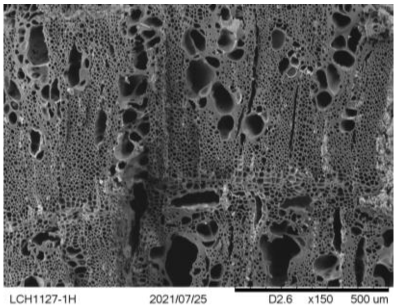


Unit 61 House Structure (1792 to 1523 BCE)

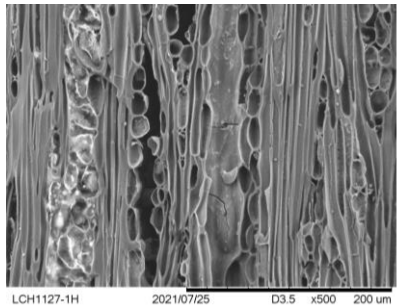


Scientific Name: NYCTAGINACEAE *cf. Neea* sp.
Common Name: canela, canelito

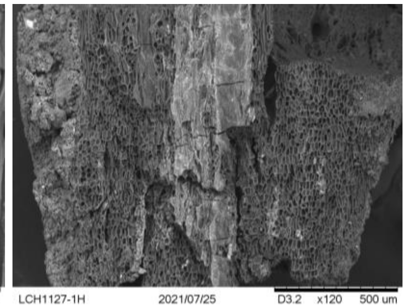
Transverse View



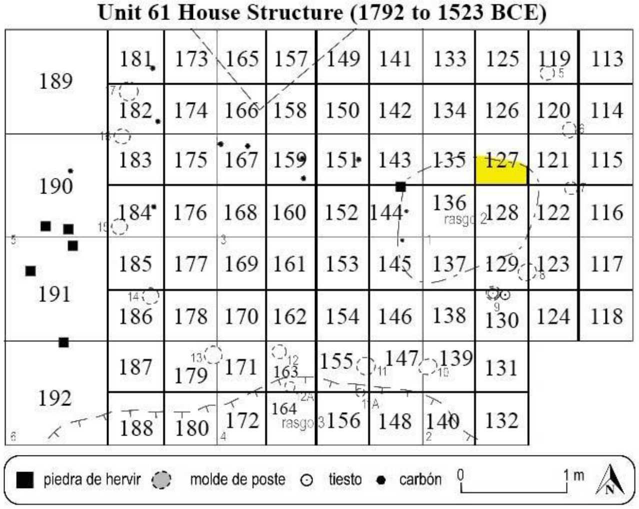
Tangential View



Radial View

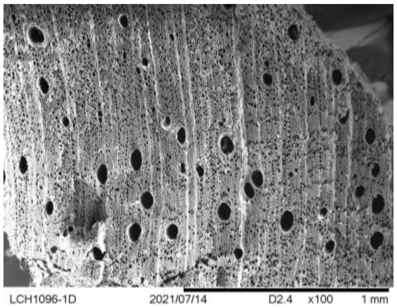


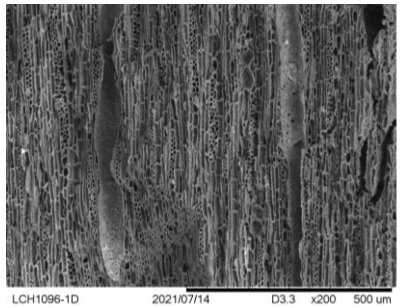
Unit 61 House Structure (1792 to 1523 BCE)

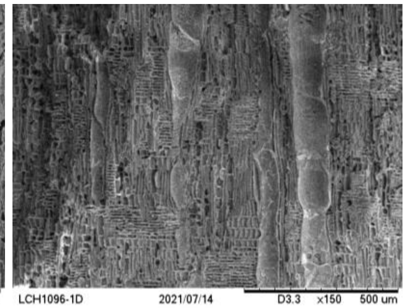


Scientific Name: OCHNACEAE *Ouratea* sp.
Common Name: unknown

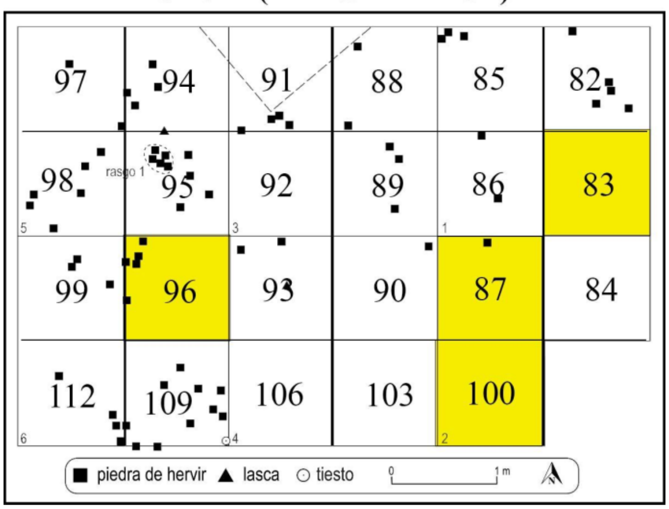
Transverse View | Tangential View | Radial View



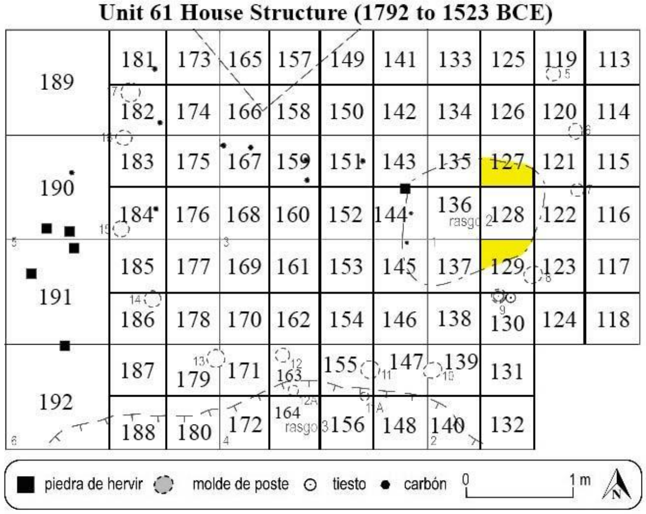




Unit 60 (1692 to 1456 BCE)

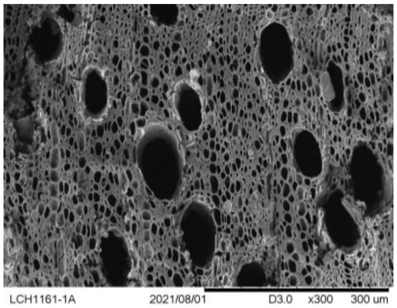


Unit 61 House Structure (1792 to 1523 BCE)

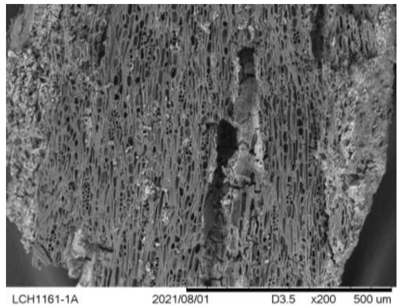


Scientific Name: OLACACEAE *Heisteria* sp.
Common Name: sombrerito, ajicillo, chorola

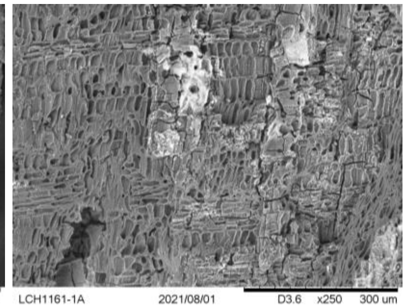
Transverse View



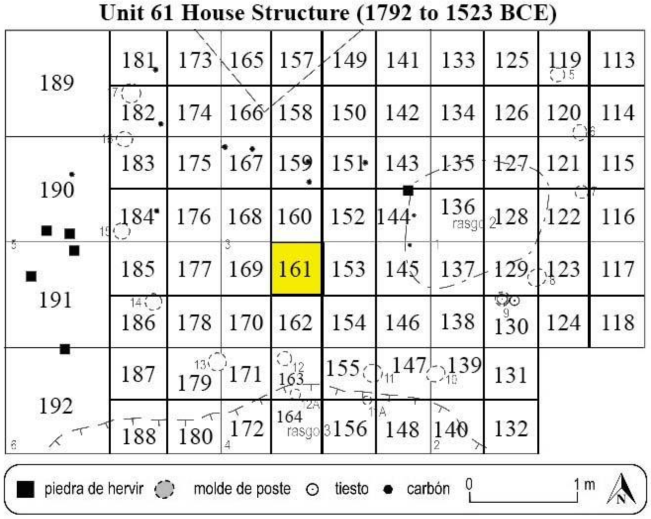
Tangential View



Radial View

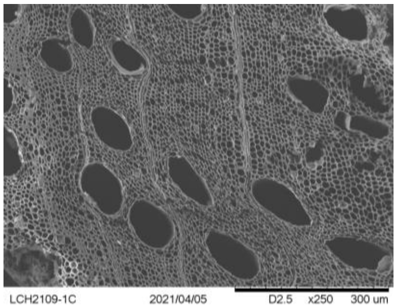


Unit 61 House Structure (1792 to 1523 BCE)

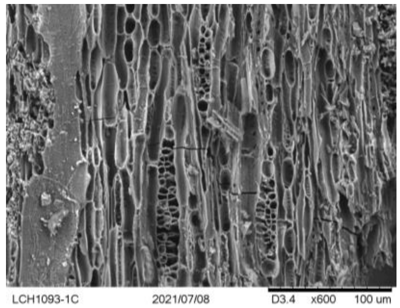


Scientific Name: PHYLLANTHACEAE *Hieronyma alchorneoides* Allemão
Common Name: zapatero, pilón, palo chancho, piedro

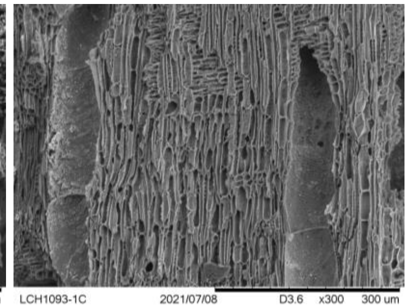
Transverse View



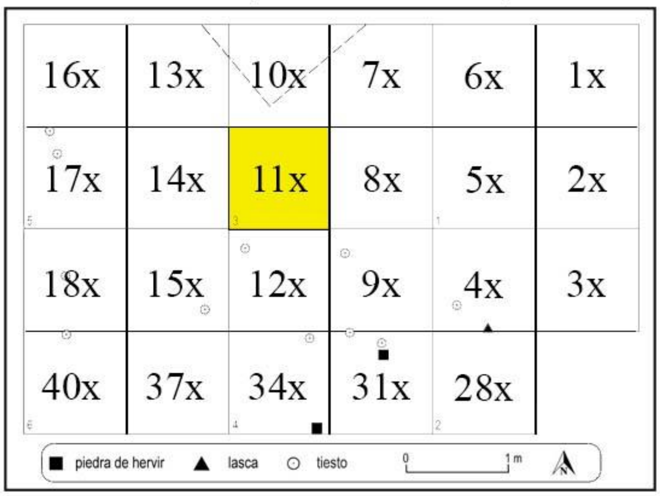
Tangential View



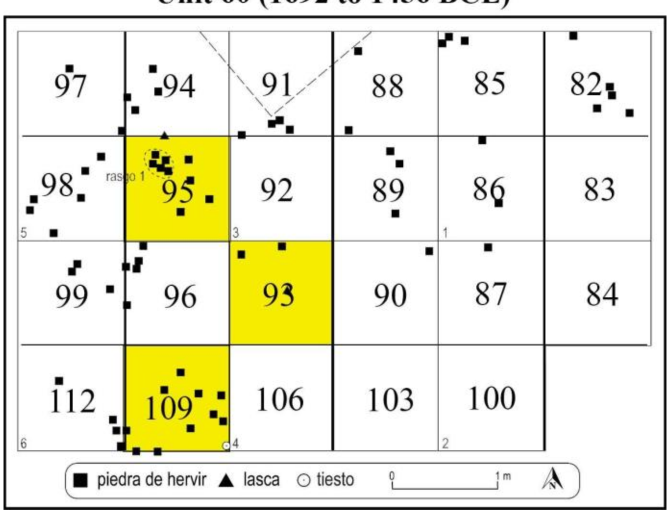
Radial View



Unit 54 (500 BCE to 100 CE)

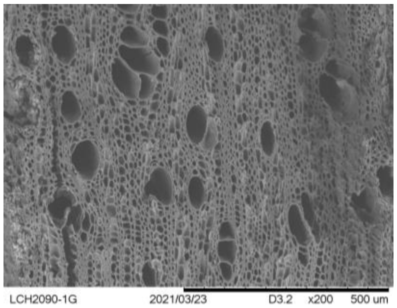


Unit 60 (1692 to 1456 BCE)

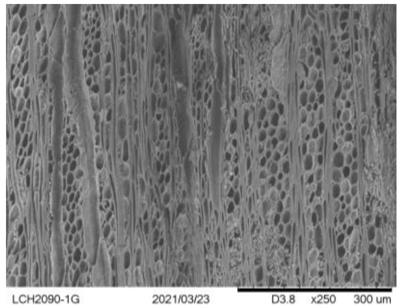


Scientific Name: PHYLLANTHACEAE *Margaritaria nobilis* L. f.
Common Name: clavito

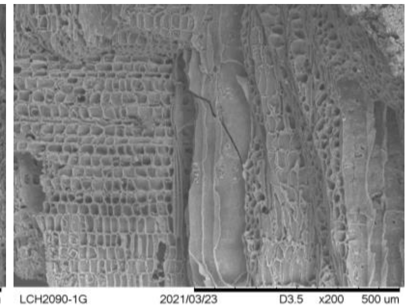
Transverse View



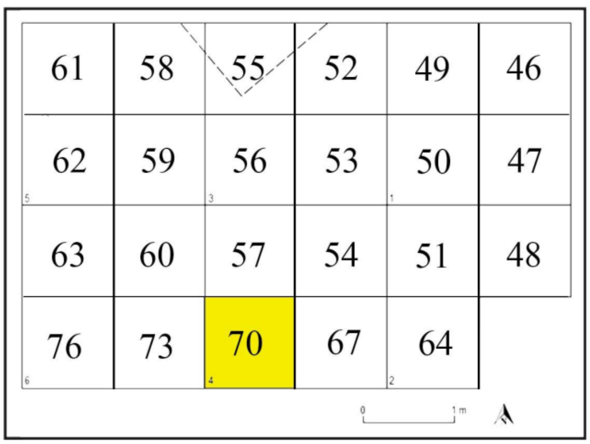
Tangential View



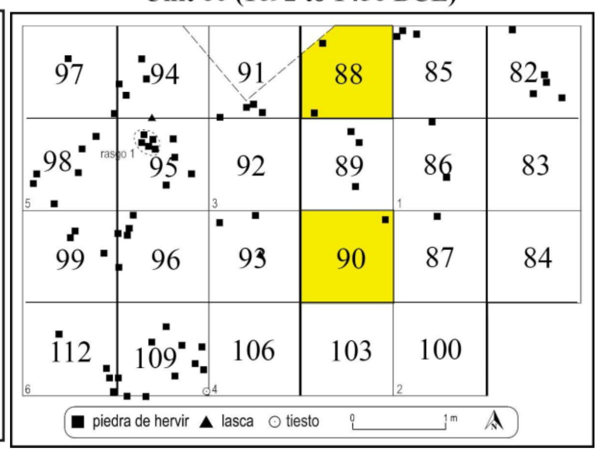
Radial View



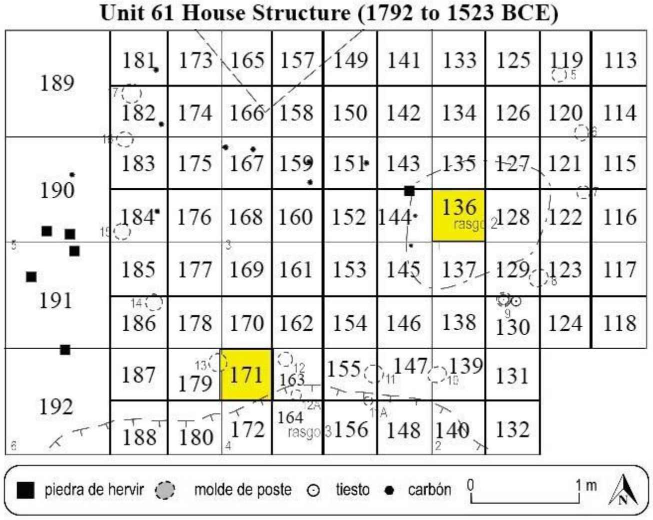
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

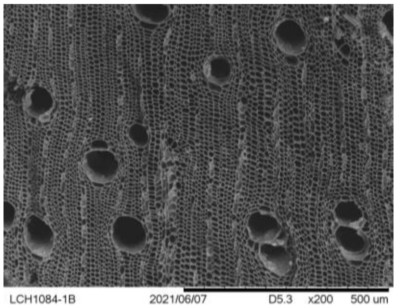


Unit 61 House Structure (1792 to 1523 BCE)

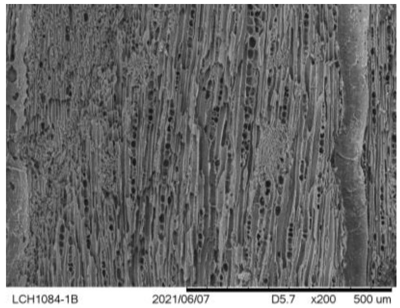


Scientific Name: POLYGONACEAE *Coccoloba* sp.
Common Name: uvito, sea grape, uvero

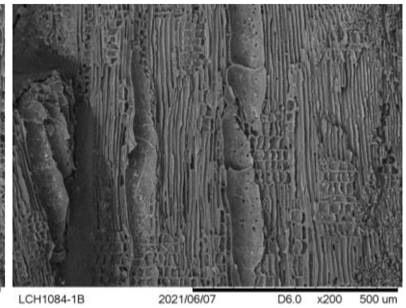
Transverse View



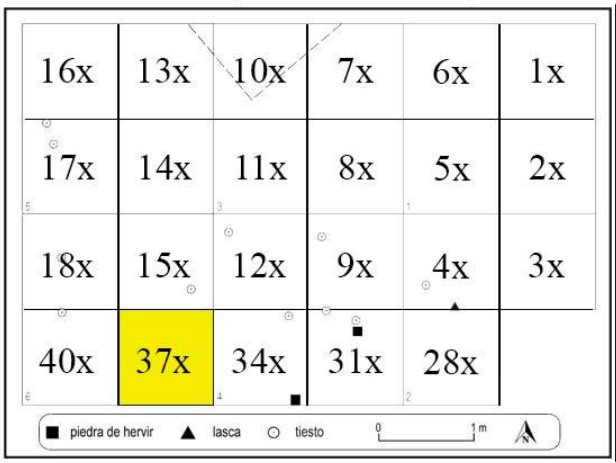
Tangential View



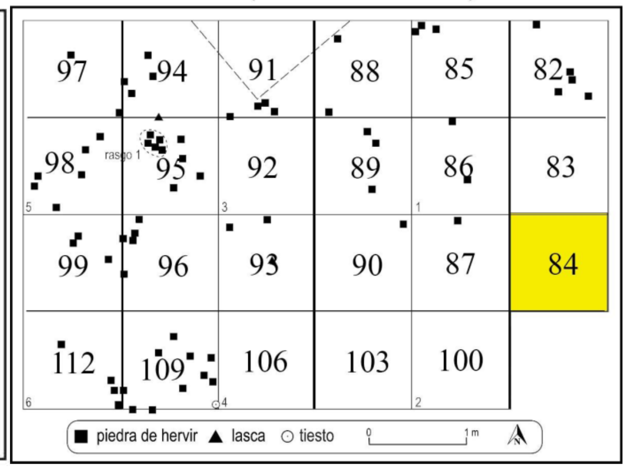
Radial View



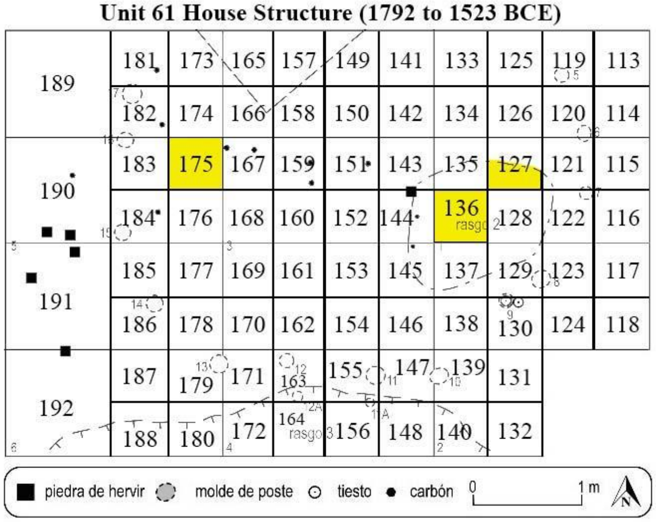
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

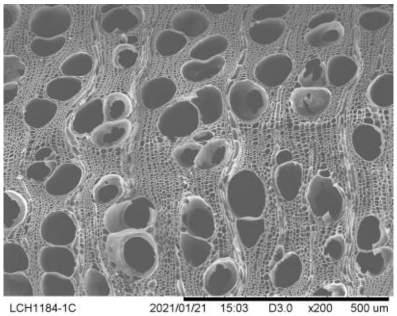


Unit 61 House Structure (1792 to 1523 BCE)

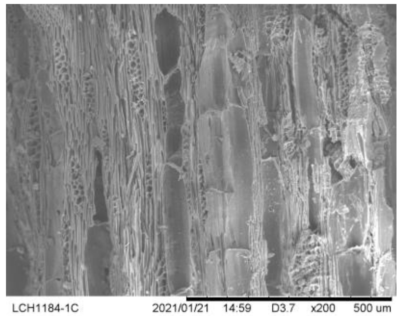


Scientific Name: ROSACEAE *Prunus* cf. *serotina* Ehrh.
Common Name: cherry

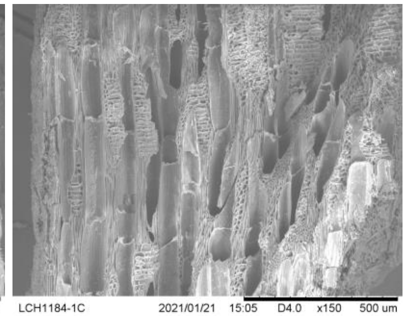
Transverse View



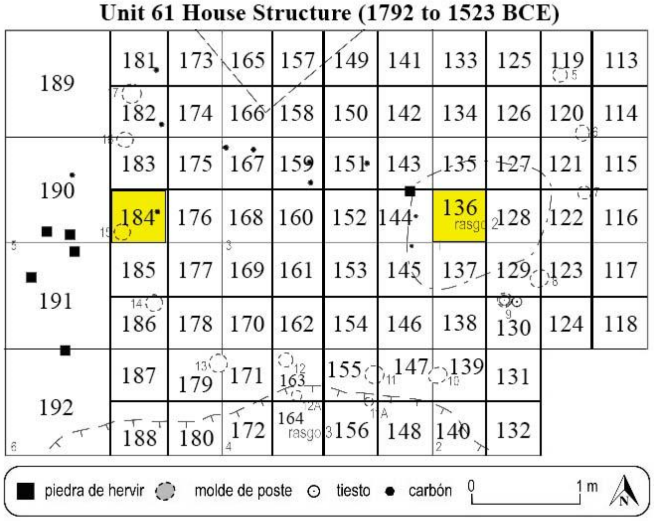
Tangential View



Radial View

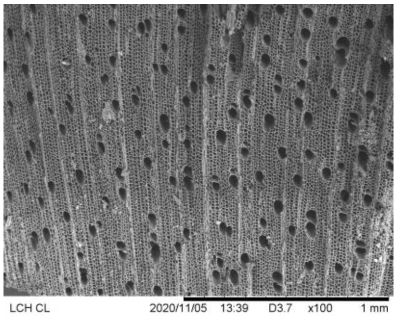


Unit 61 House Structure (1792 to 1523 BCE)

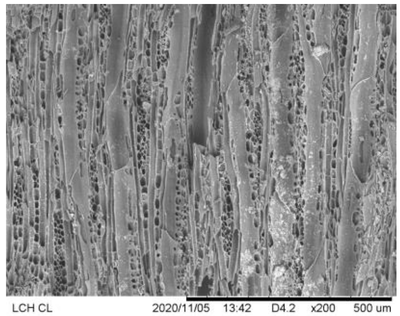


Scientific Name: RUBIACEAE *Calycophyllum candidissium* (Vahl) D.C.
Common Name: madroño, alazano, lluvia de plato, degame, lemonwood

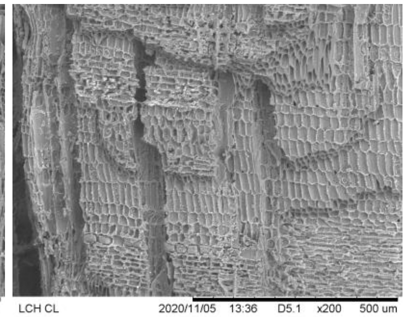
Transverse View



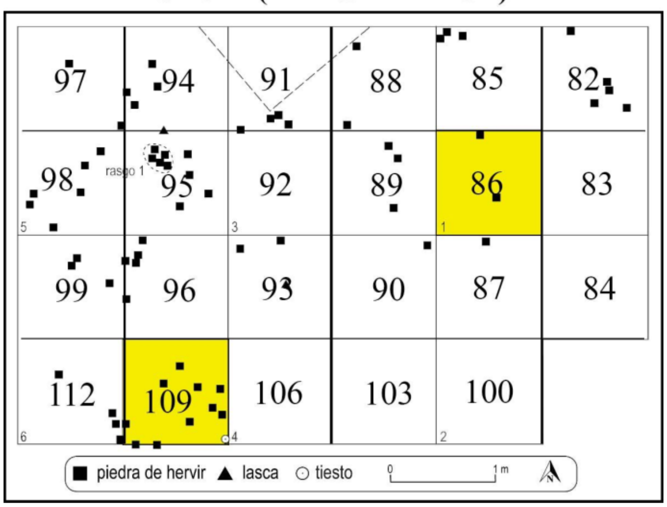
Tangential View



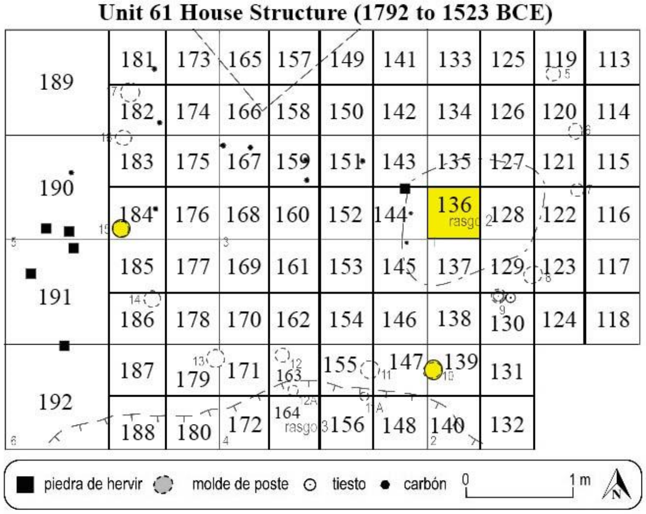
Radial View



Unit 60 (1692 to 1456 BCE)

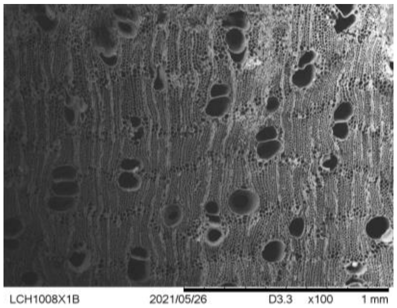


Unit 61 House Structure (1792 to 1523 BCE)

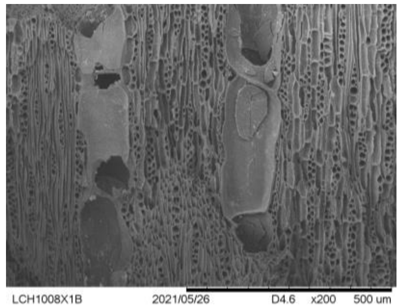


Scientific Name: RUBIACEAE *Cosmibuena sp.*
Common Name: tabaquillo

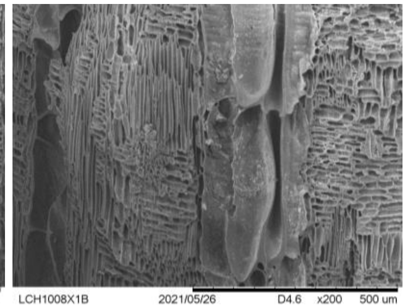
Transverse View



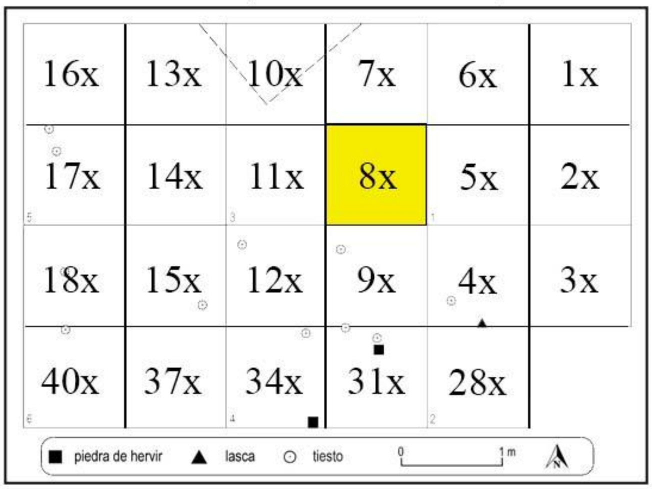
Tangential View



Radial View

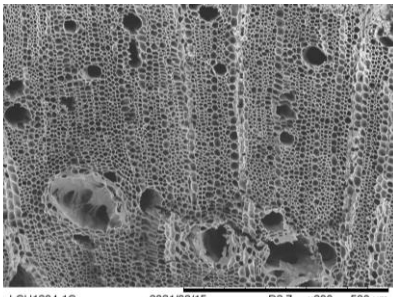


Unit 54 (500 BCE to 100 CE)

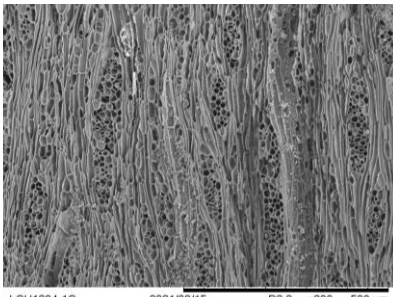


Scientific Name: RUBIACEAE *Coussarea sp.*
Common Name: huesito

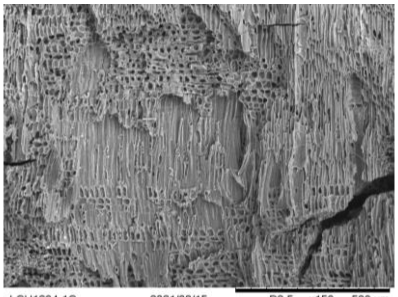
Transverse View



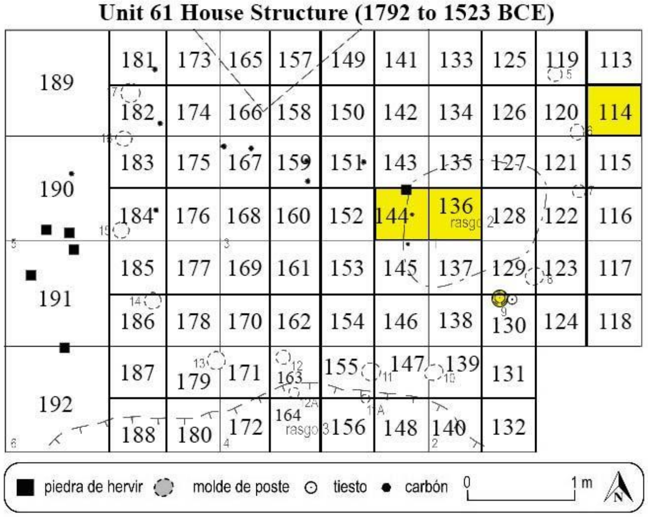
Tangential View



Radial View

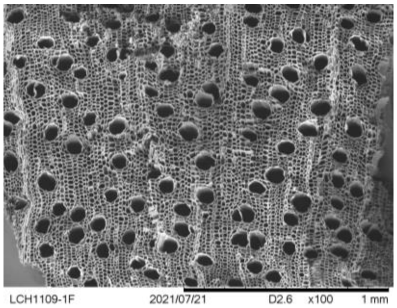


Unit 61 House Structure (1792 to 1523 BCE)

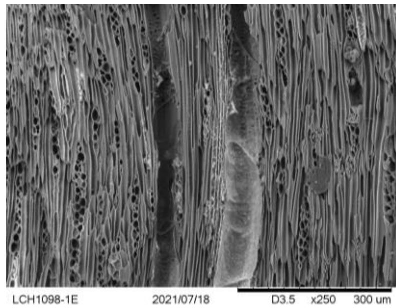


Scientific Name: RUBIACEAE *Coutarea/Exostema*
Common Name: azulejo, quina

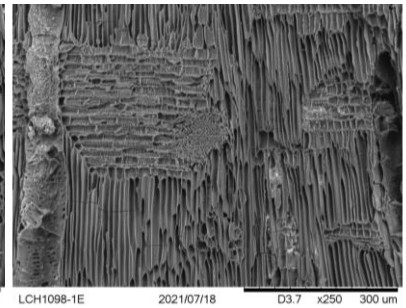
Transverse View



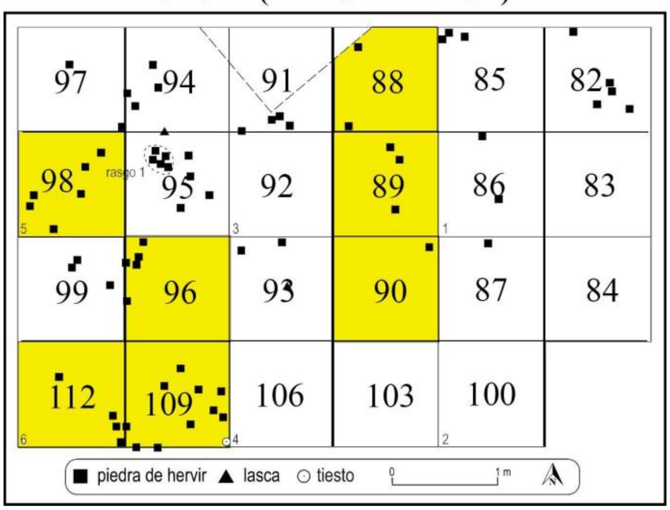
Tangential View



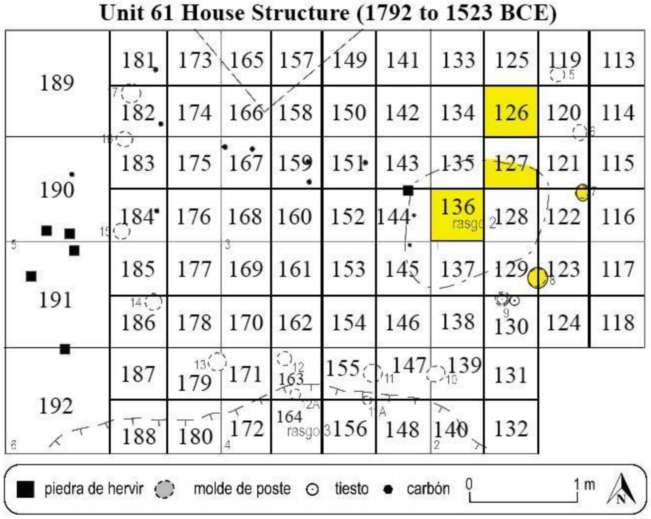
Radial View



Unit 60 (1692 to 1456 BCE)

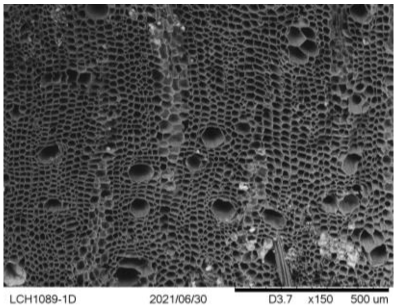


Unit 61 House Structure (1792 to 1523 BCE)

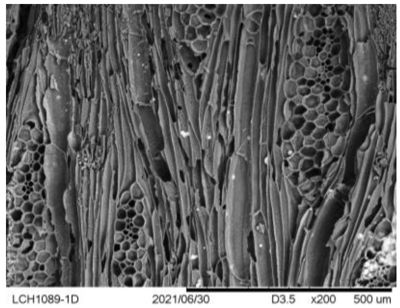


Scientific Name: RUBIACEAE *Faramea* sp.
Common Name: huesito, benjamín, garrotillo, jazmín

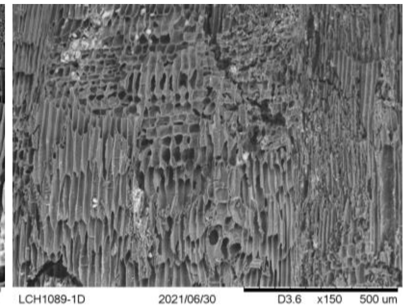
Transverse View



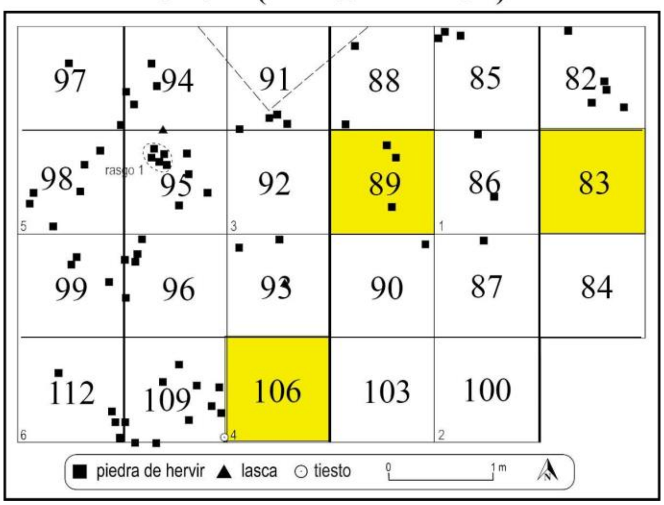
Tangential View



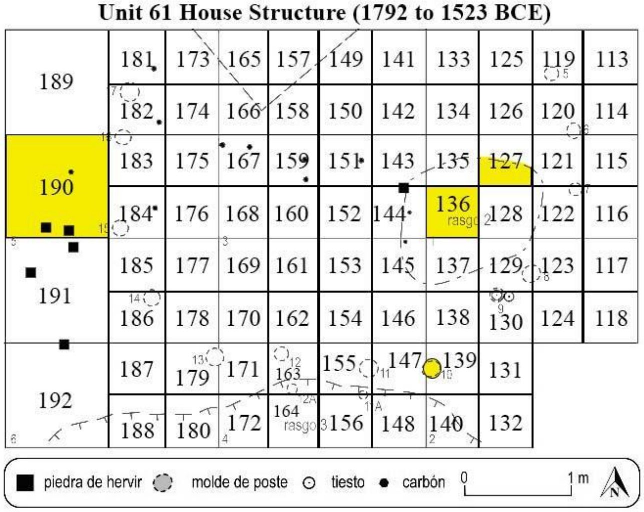
Radial View



Unit 60 (1692 to 1456 BCE)

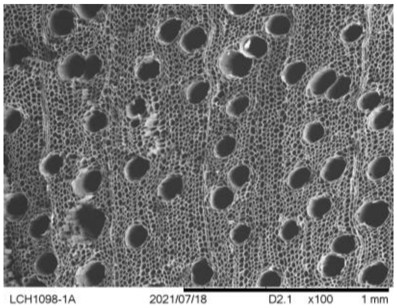


Unit 61 House Structure (1792 to 1523 BCE)

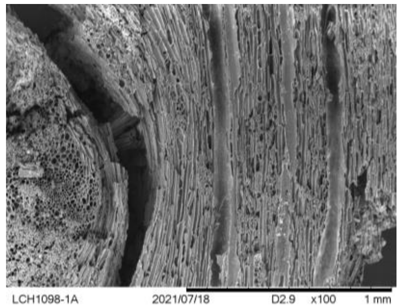


Scientific Name: RUBIACEAE cf. *Genipa americana* L.
Common Name: jagua

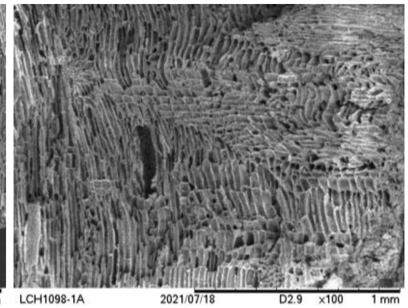
Transverse View



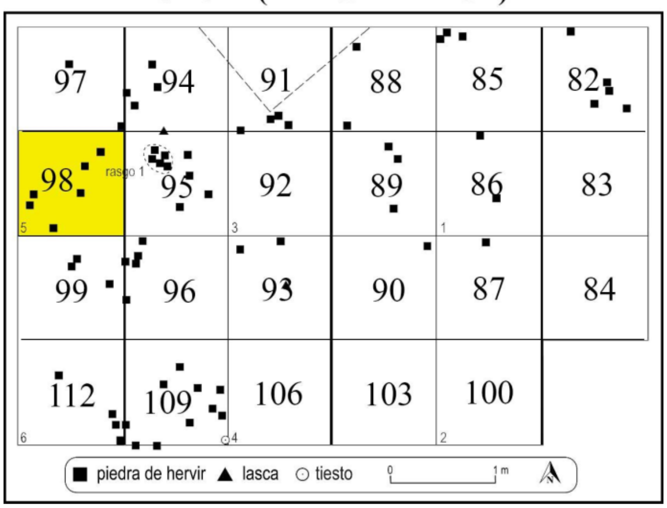
Tangential View



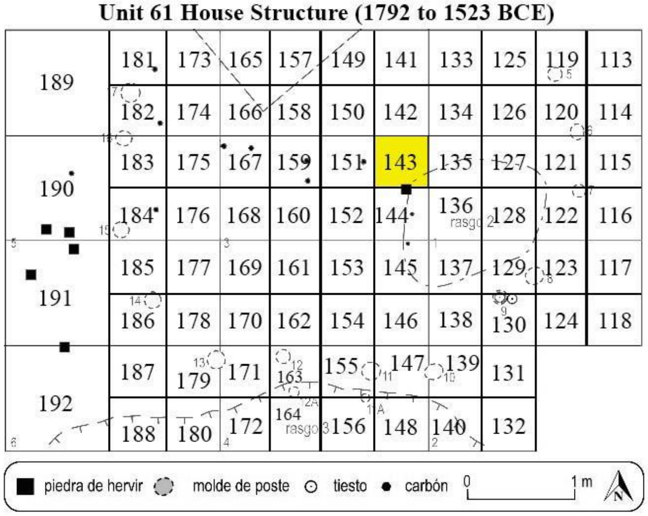
Radial View



Unit 60 (1692 to 1456 BCE)

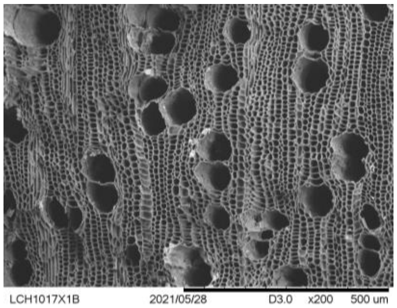


Unit 61 House Structure (1792 to 1523 BCE)

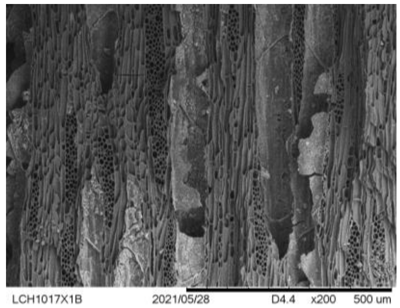


Scientific Name: RUBIACEAE *Hamelia* sp.
Common Name: firebush, guayabo negro, canelito

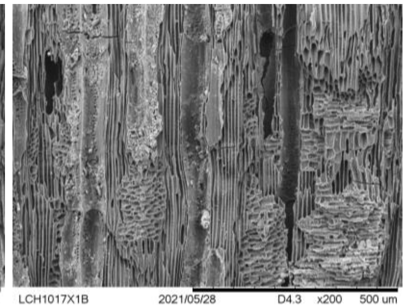
Transverse View



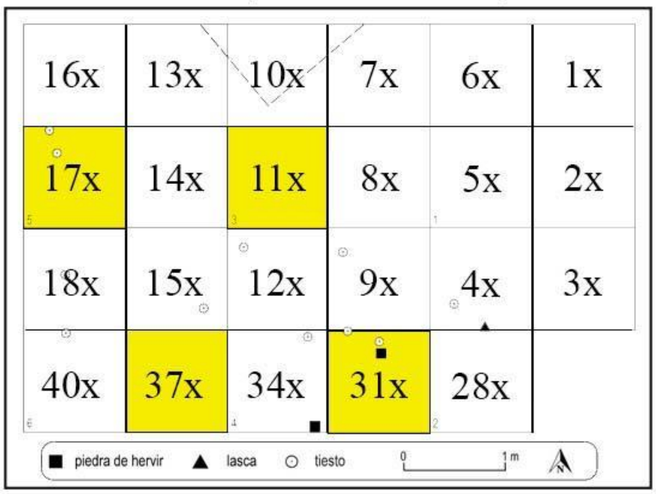
Tangential View



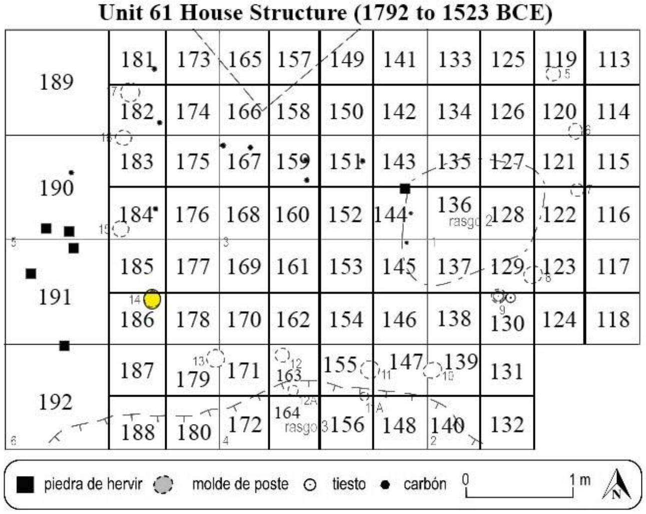
Radial View



Unit 54 (500 BCE to 100 CE)

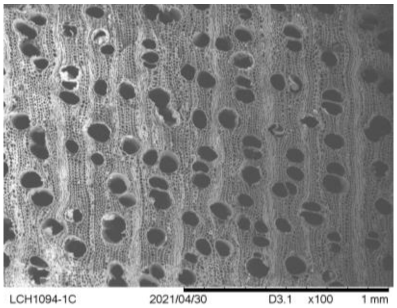


Unit 61 House Structure (1792 to 1523 BCE)

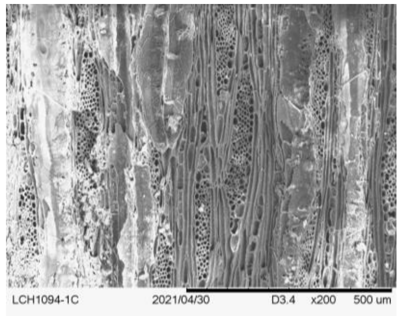


Scientific Name: RUBIACEAE *Macrocnemum roseum* (Ruiz & Pav.) Wedd.
Common Name: palo cuadrado, madroño, canaleto

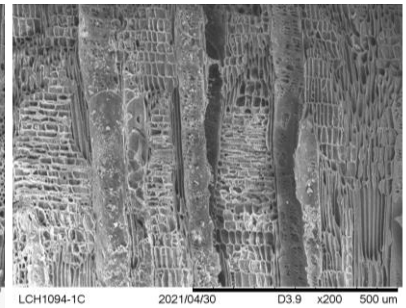
Transverse View



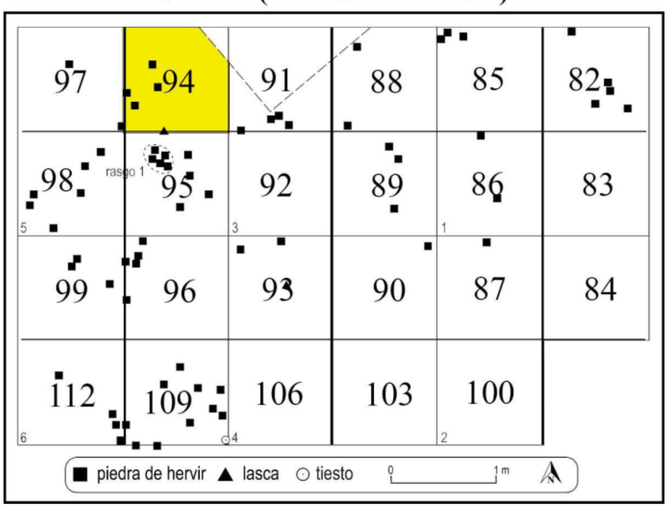
Tangential View



Radial View

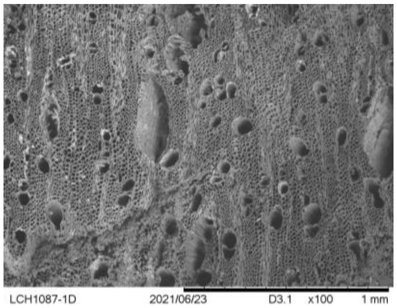


Unit 60 (1692 to 1456 BCE)

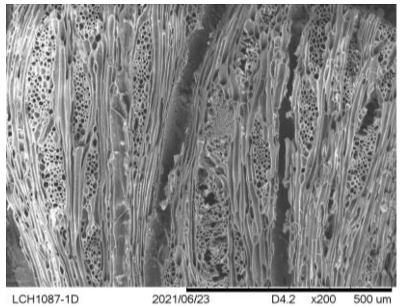


Scientific Name: RUBIACEAE *Palicourea* sp.
Common Name: recadito

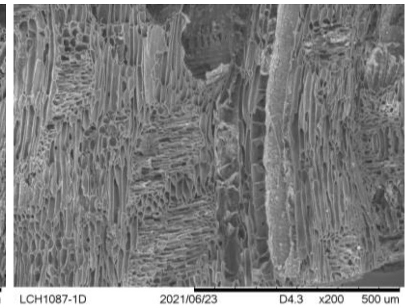
Transverse View



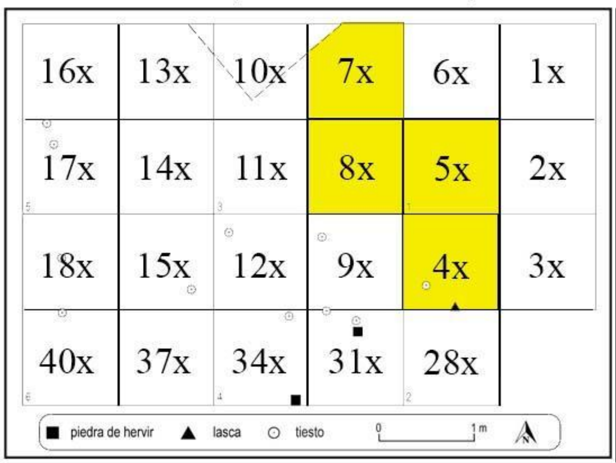
Tangential View



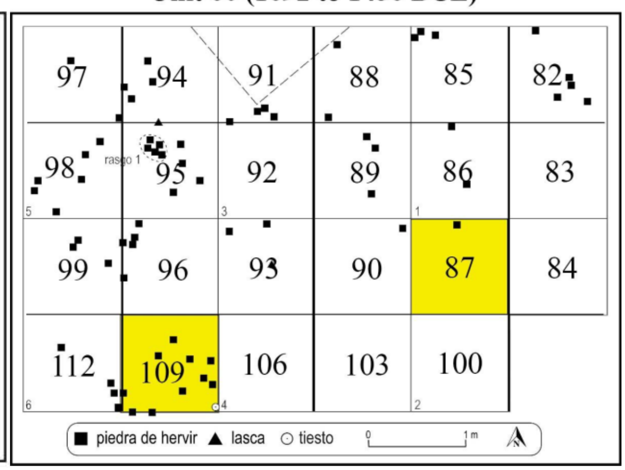
Radial View



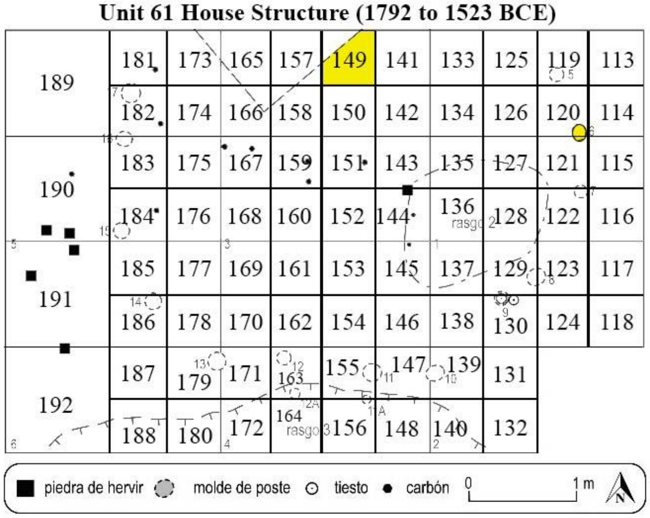
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

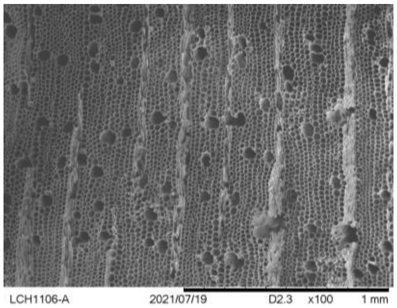


Unit 61 House Structure (1792 to 1523 BCE)

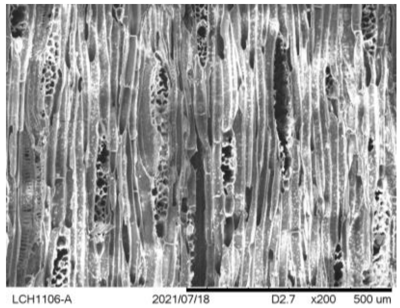


Scientific Name: RUBIACEAE *Psychotria* sp.
Common Name: cafecillo, hot lips, sombrerito de diablo

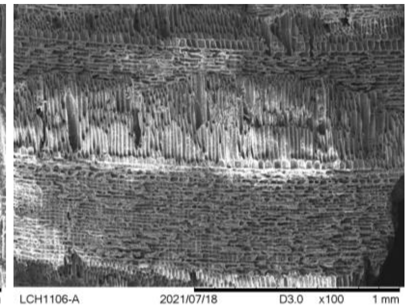
Transverse View



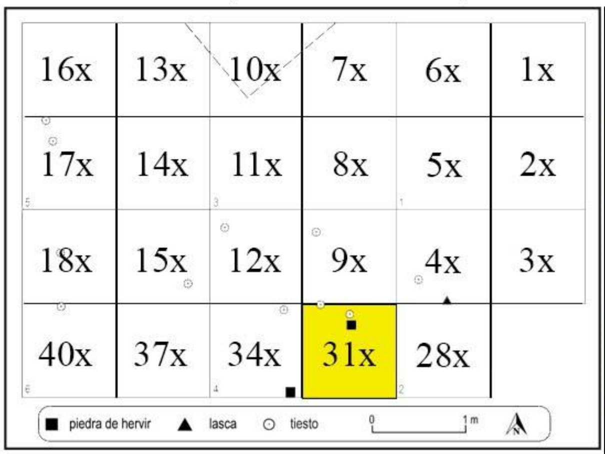
Tangential View



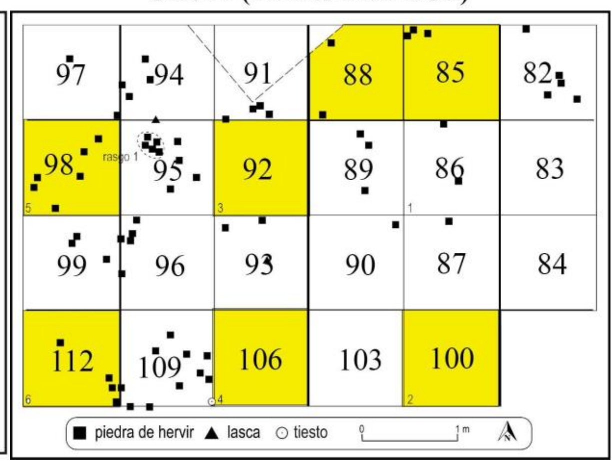
Radial View



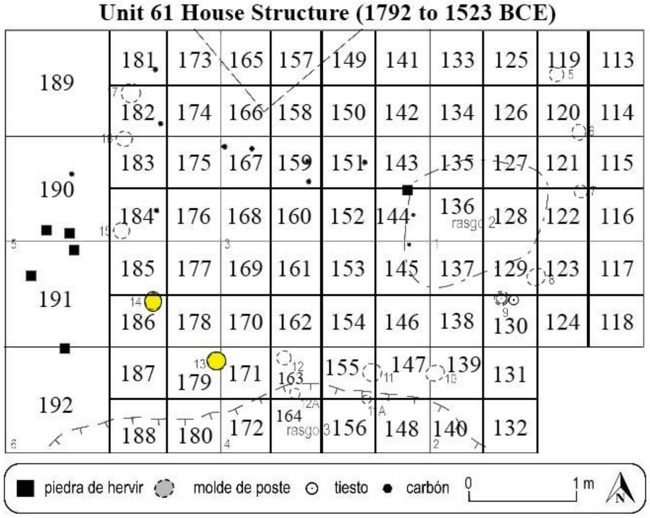
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

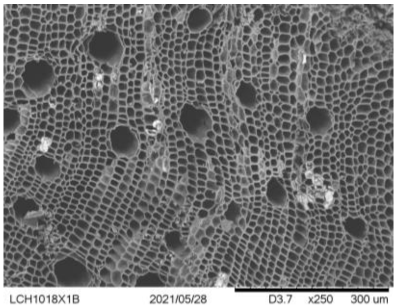


Unit 61 House Structure (1792 to 1523 BCE)

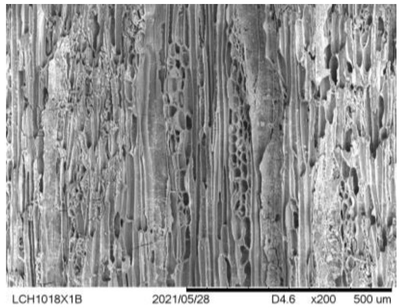


Scientific Name: RUBIACEAE *Randia* sp.
Common Name: rosetillo, jagua macho, mostrenco, tres chucitos

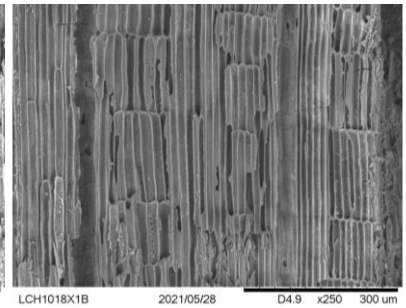
Transverse View



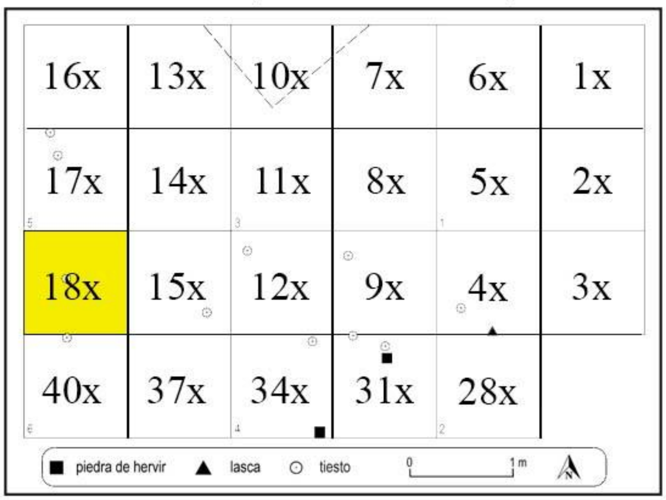
Tangential View



Radial View

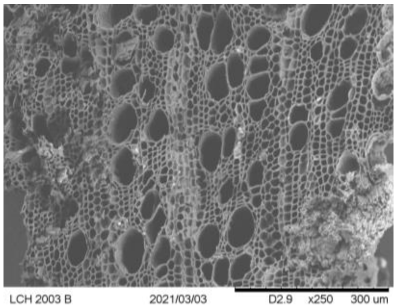


Unit 54 (500 BCE to 100 CE)

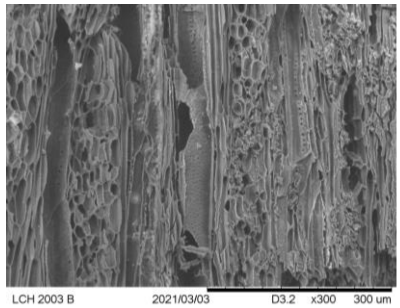


Scientific Name: RUBIACEAE *Warszewiczia* sp.
Common Name: wakamy, sanguinaria, cresta de gallo, orinera

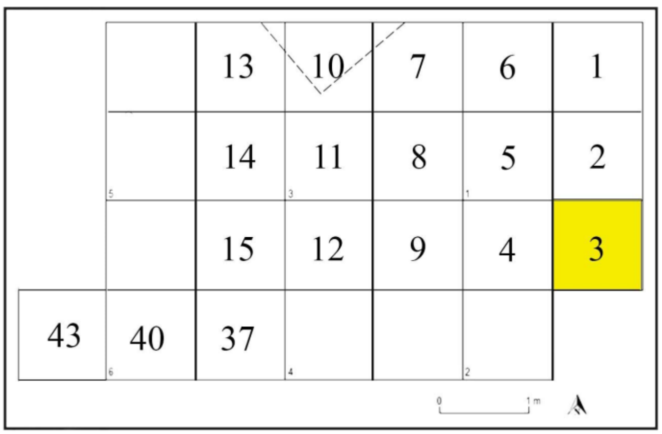
Transverse View



Tangential View

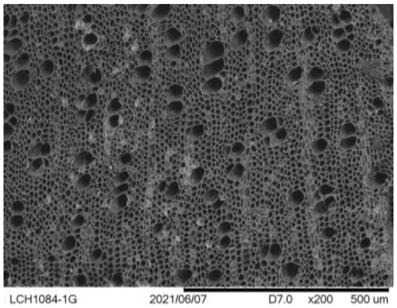


AR 16-15 **(100 BCE to 100 CE)**

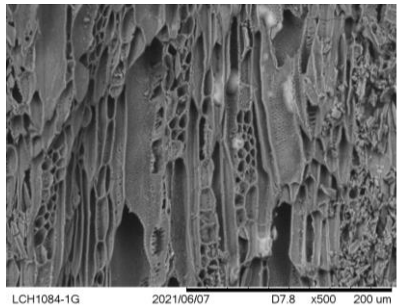


Scientific Name: RUTACEAE *Erythrochiton* sp.
Common Name: unknown

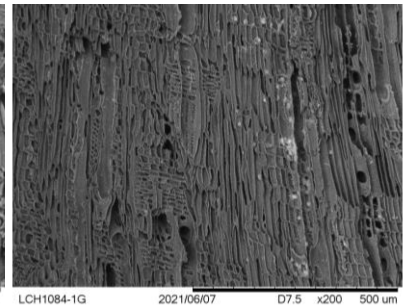
Transverse View



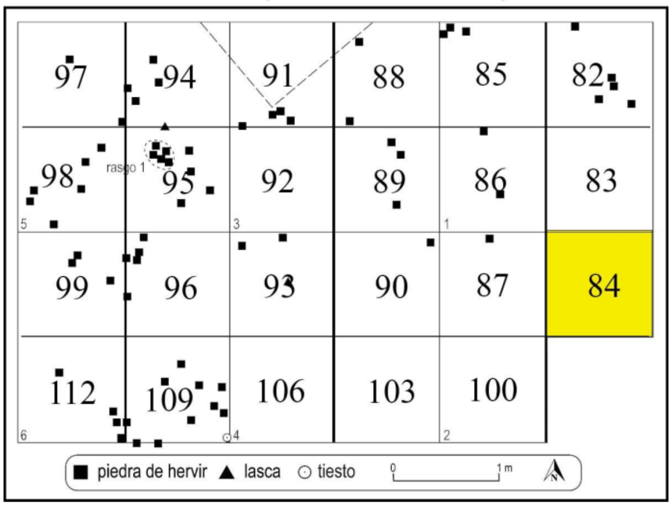
Tangential View



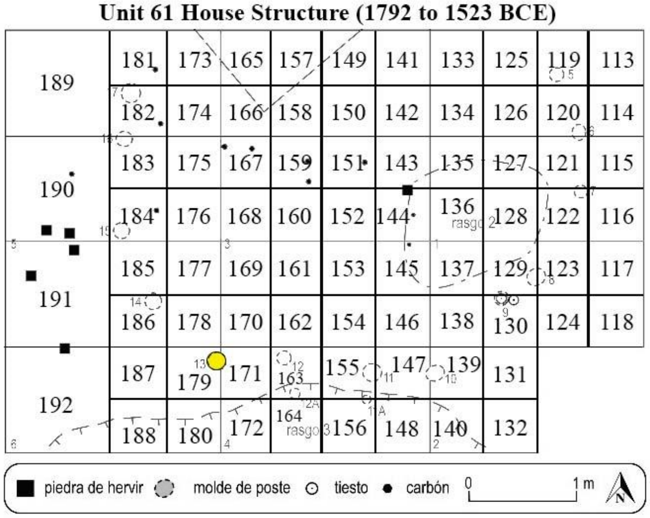
Radial View



Unit 60 (1692 to 1456 BCE)

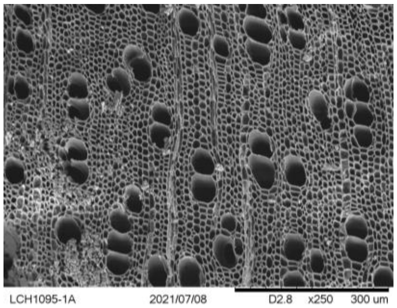


Unit 61 House Structure (1792 to 1523 BCE)

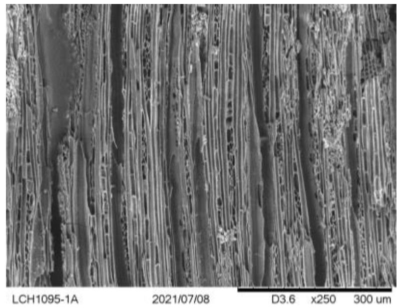


Scientific Name: RUTACEAE *Zanthoxylum* sp.
Common Name: arcabú, tachuelo, pricklyash

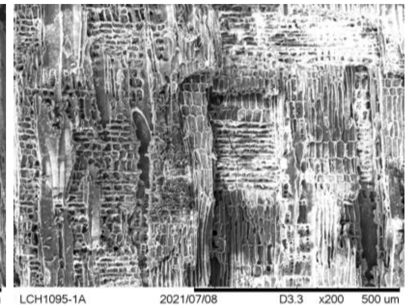
Transverse View



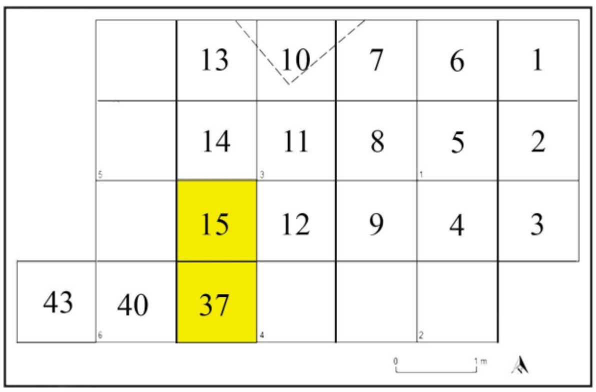
Tangential View



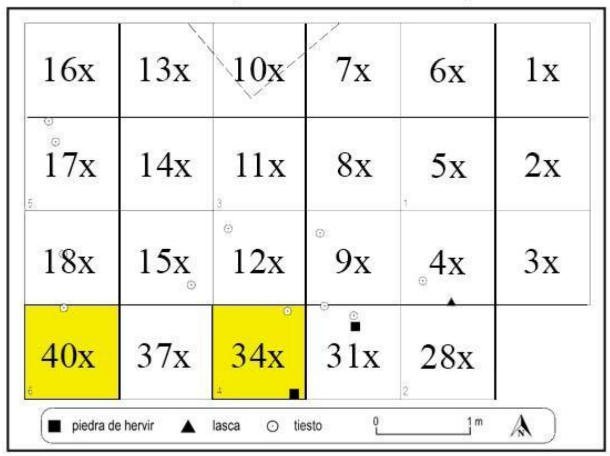
Radial View



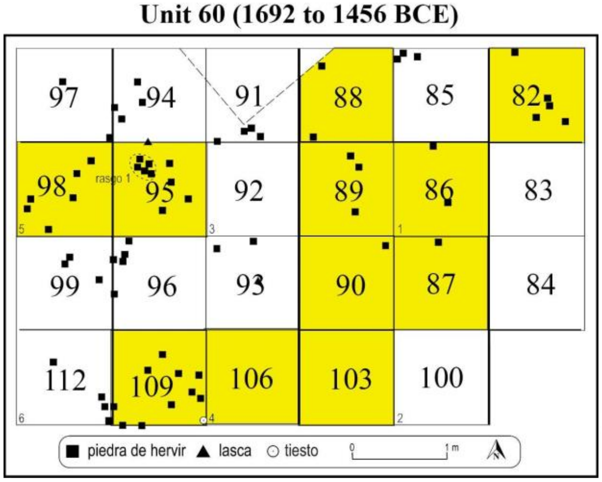
AR 16-15 (100 BCE to 100 CE)



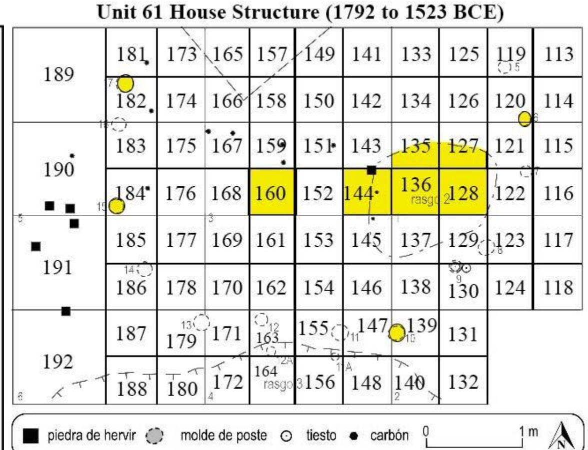
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

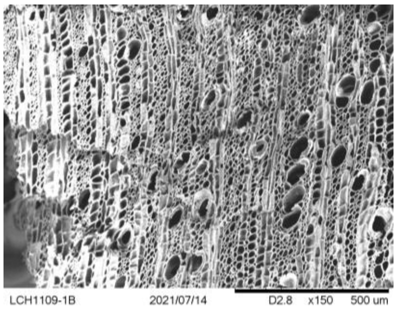


Unit 61 House Structure (1792 to 1523 BCE)

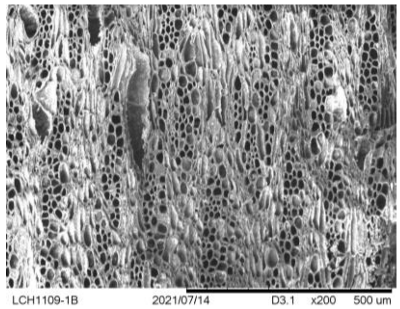


Scientific Name: SABIACEAE *Meliosma* sp.
Common Name: worm head tree

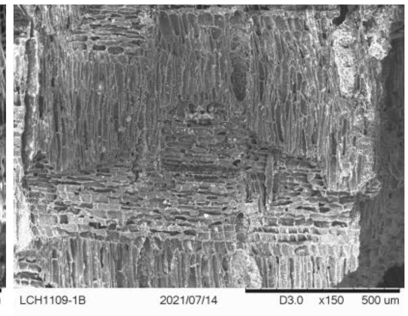
Transverse View



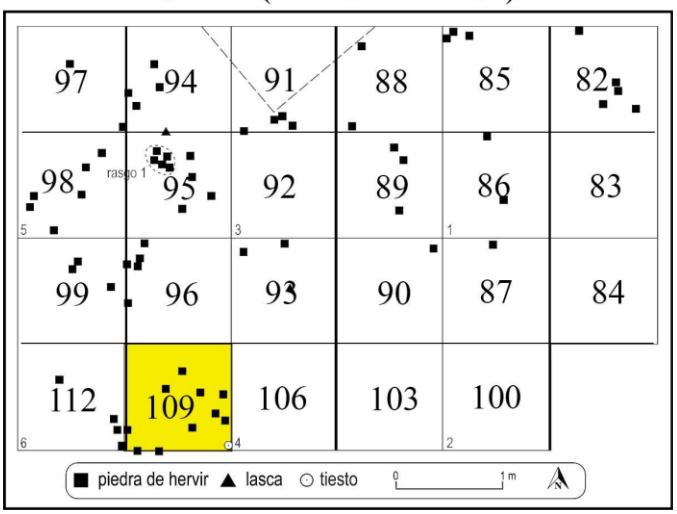
Tangential View



Radial View

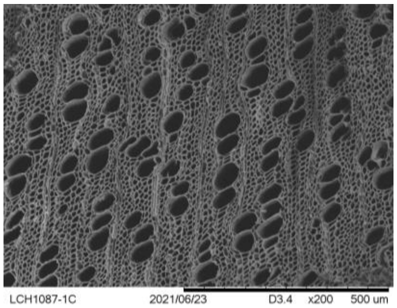


Unit 60 (1692 to 1456 BCE)

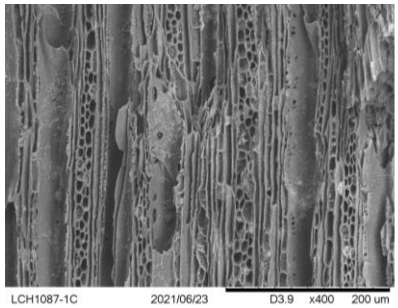


Scientific Name: SALICACEAE *Casearia* sp.
Common Name: corta lengua, pica lengua, manga larga, mauro

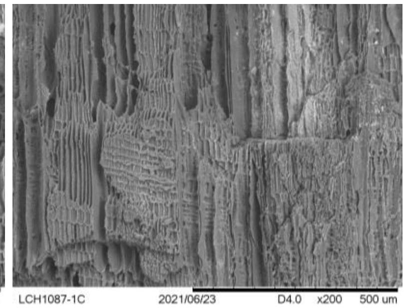
Transverse View



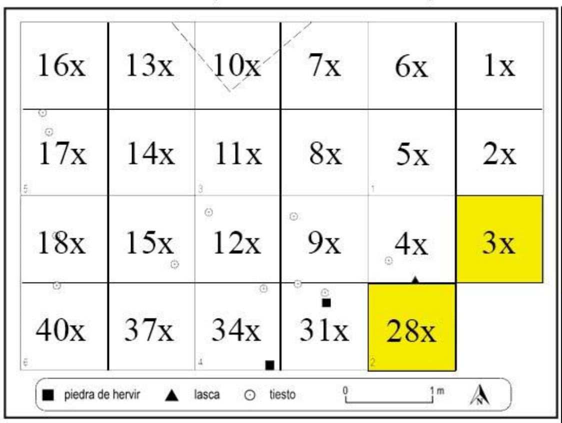
Tangential View



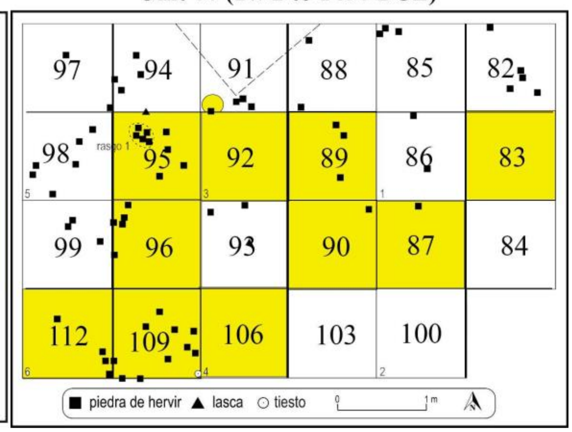
Radial View



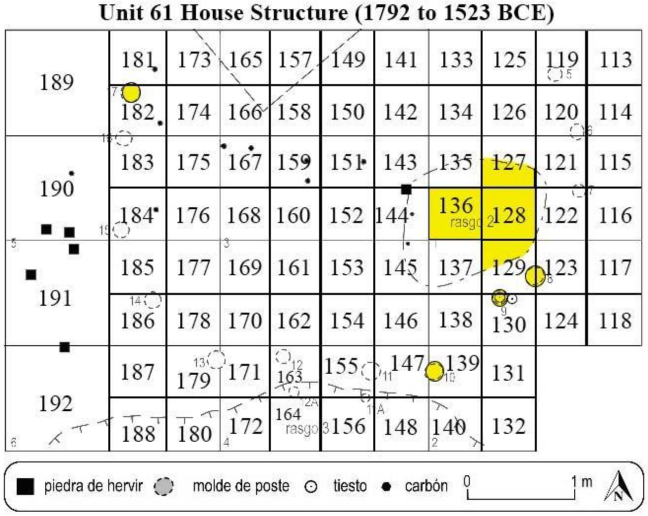
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

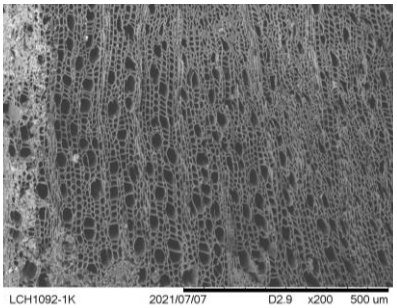


Unit 61 House Structure (1792 to 1523 BCE)

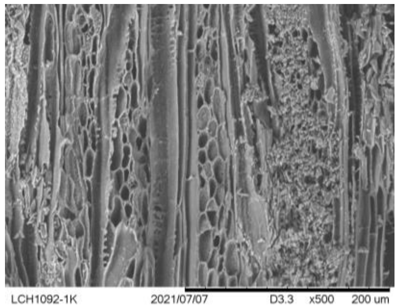


Scientific Name: SALICACEAE *Hasseltia* sp.
Common Name: parimontón, corta lengua, raspa lengua

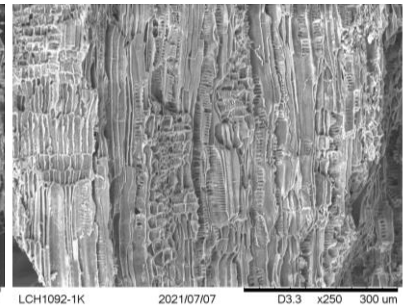
Transverse View



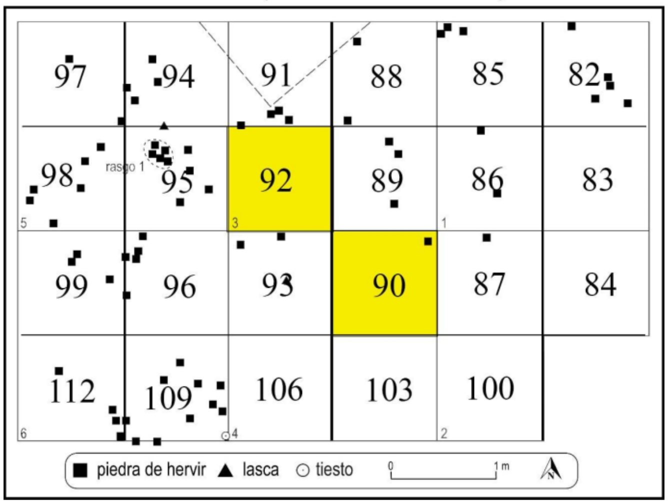
Tangential View



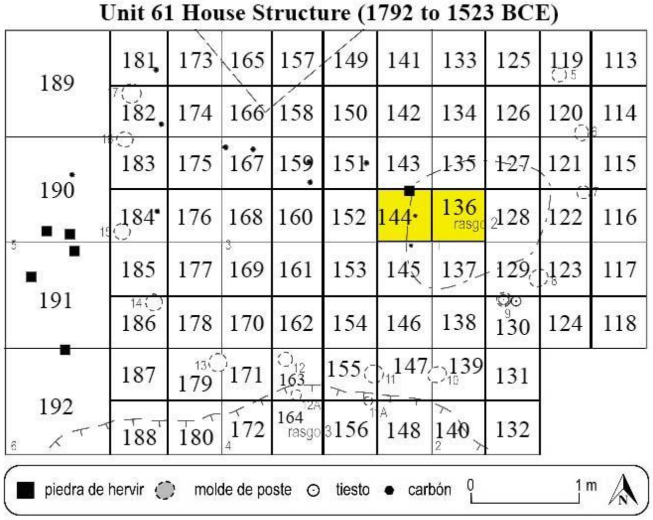
Radial View



Unit 60 (1692 to 1456 BCE)

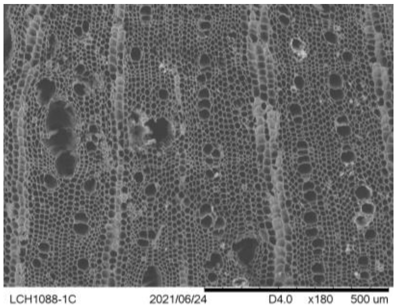


Unit 61 House Structure (1792 to 1523 BCE)

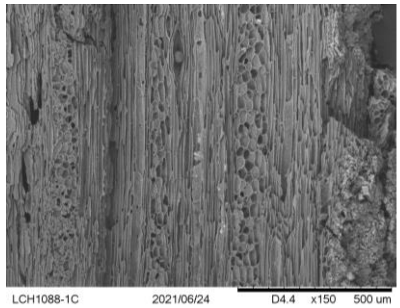


Scientific Name: SALICACEAE *Ryania speciosa* Vahl
Common Name: corta lengua

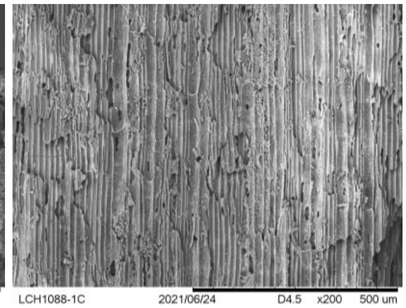
Transverse View



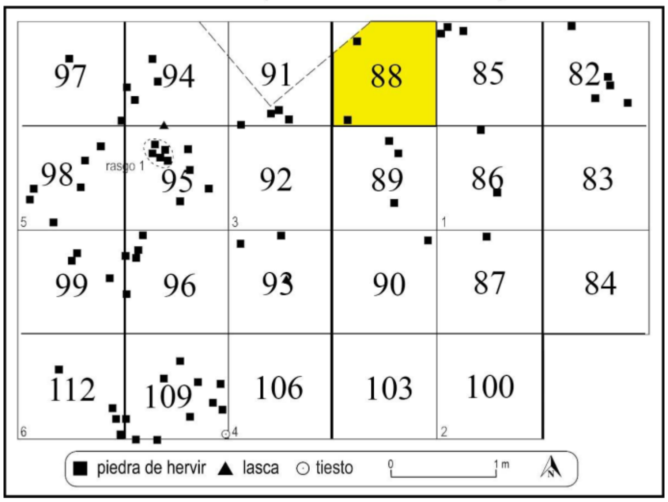
Tangential View



Radial View

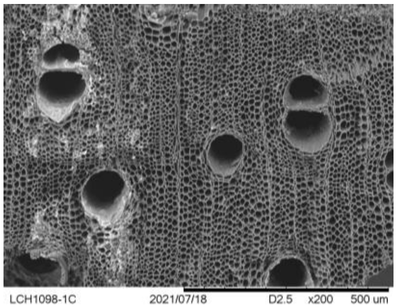


Unit 60 (1692 to 1456 BCE)

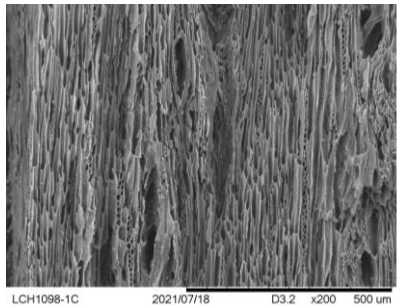


Scientific Name: SAPINDACEAE *Allophylus* sp.
Common Name: esquitillo

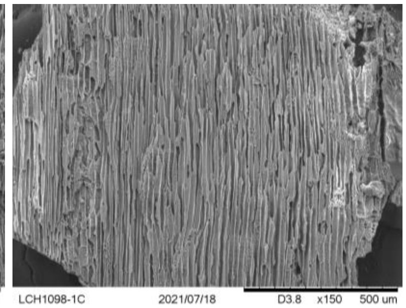
Transverse View



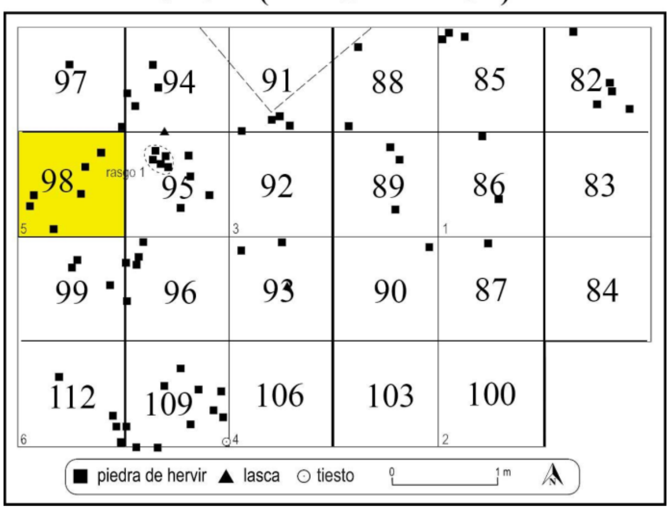
Tangential View



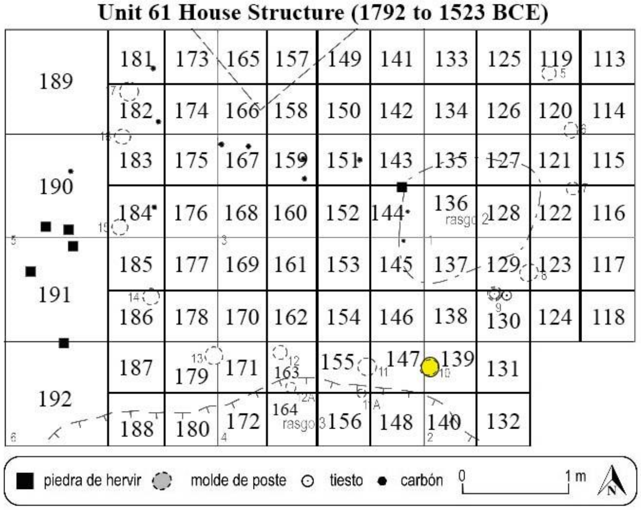
Radial View



Unit 60 (1692 to 1456 BCE)

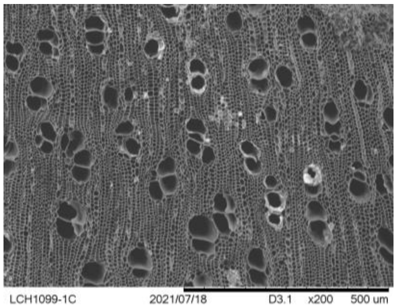


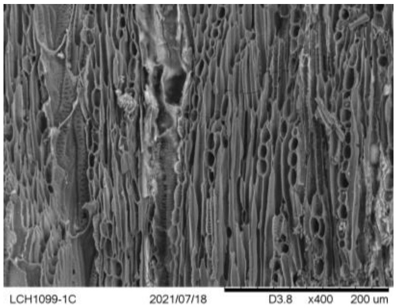
Unit 61 House Structure (1792 to 1523 BCE)

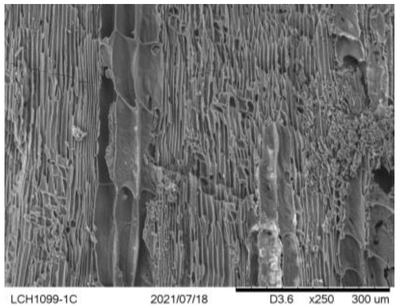


Scientific Name: SAPINDACEAE *Cupania* sp.
Common Name: candelillo, gorgojero, gorgojo, pava

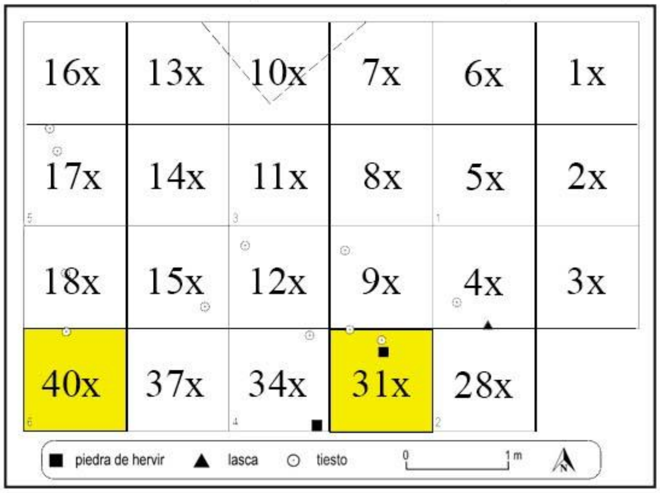
Transverse View | Tangential View | Radial View



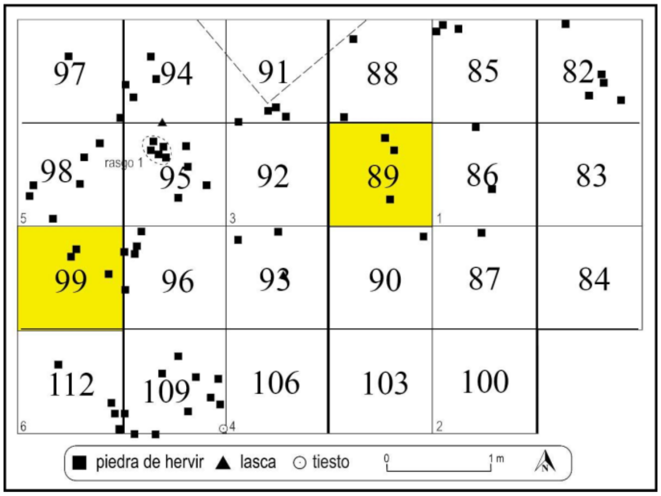




Unit 54 (500 BCE to 100 CE)

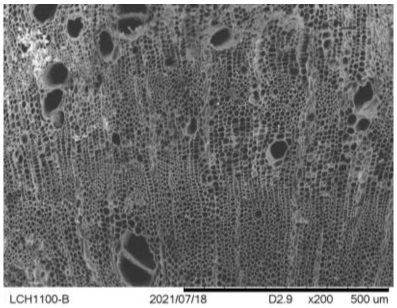


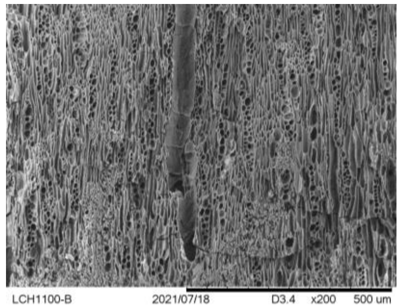
Unit 60 (1692 to 1456 BCE)

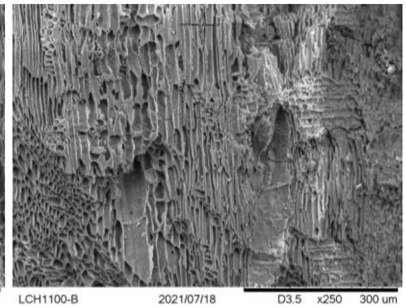


Scientific Name: SAPINDACEAE cf. *Sapindus saponaria* L.
Common Name: jaboncillo, soapberry, yequiti

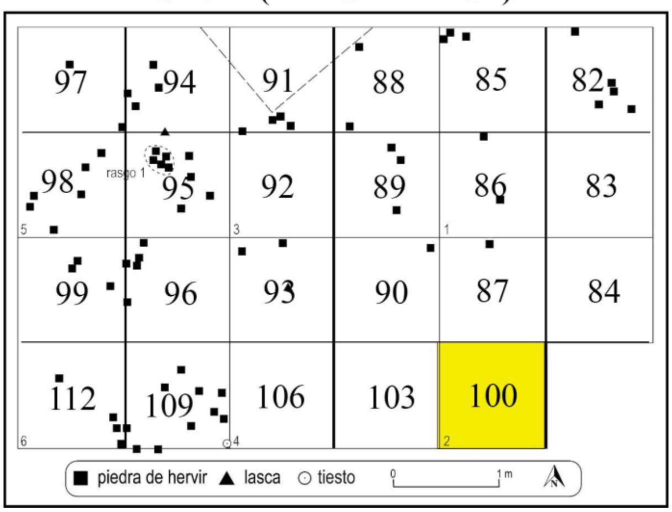
Transverse View | Tangential View | Radial View



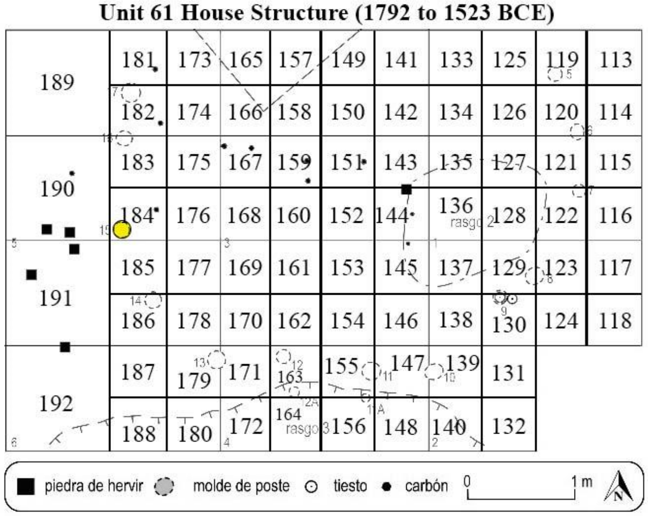




Unit 60 (1692 to 1456 BCE)

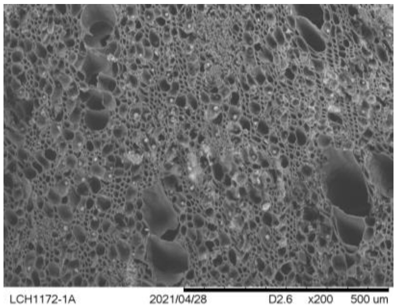


Unit 61 House Structure (1792 to 1523 BCE)

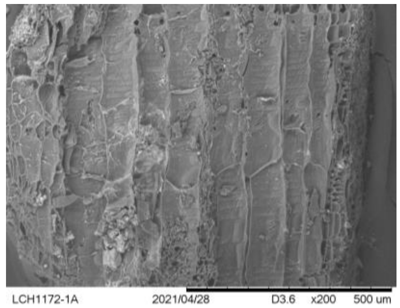


Scientific Name: SAPOTACEAE *Manilkara* sp.
Common Name: mamey, sapodilla, níspero

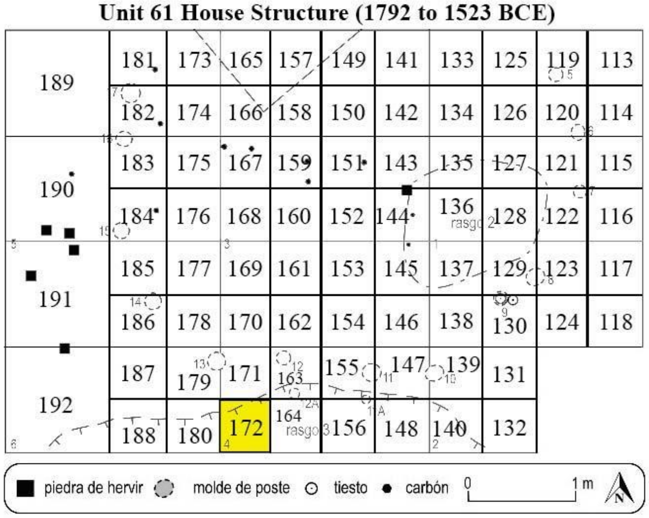
Transverse View



Tangential View

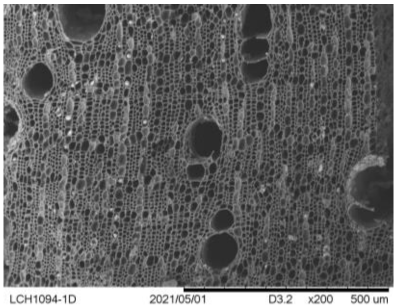


Unit 61 House Structure (1792 to 1523 BCE)

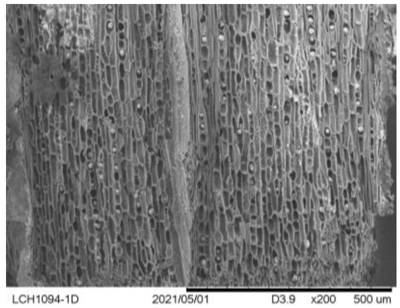


Scientific Name: SAPOTACEAE *Pouteria* sp.
Common Name: mamey, nisperillo, mameicillo, canistel

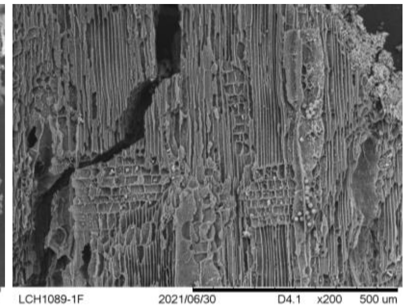
Transverse View



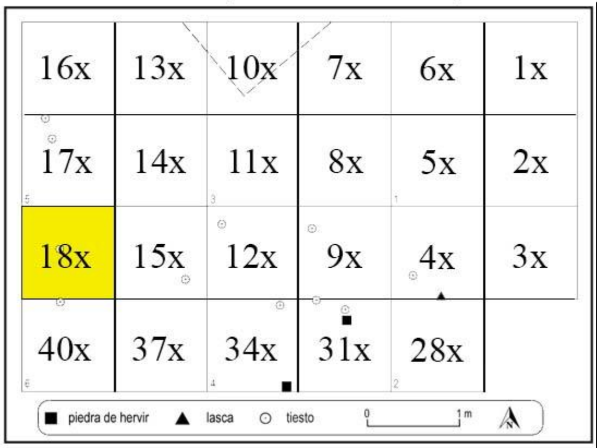
Tangential View



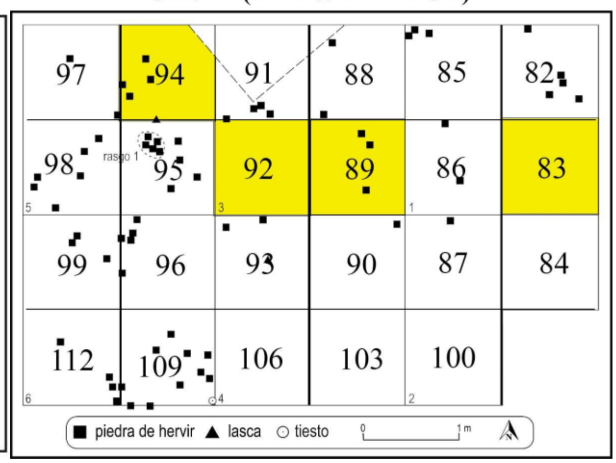
Radial View



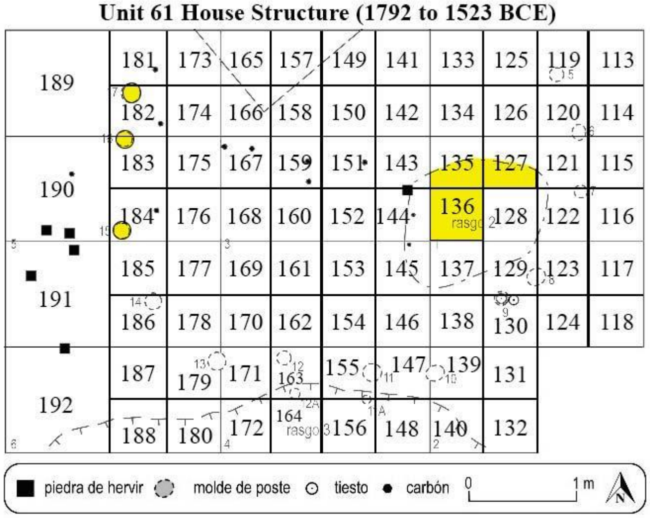
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

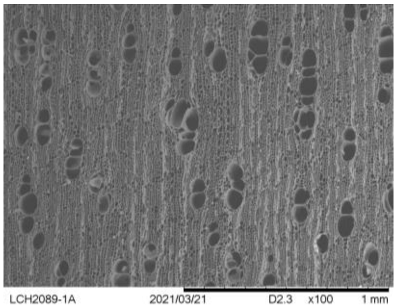


Unit 61 House Structure (1792 to 1523 BCE)

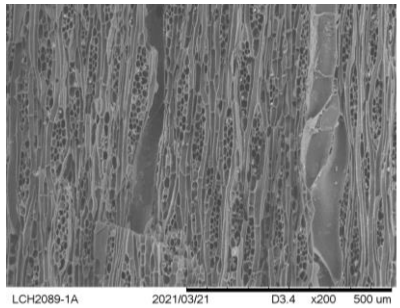


Scientific Name: SAPOTACEAE *Sideroxylon* sp.
Common Name: espino rico

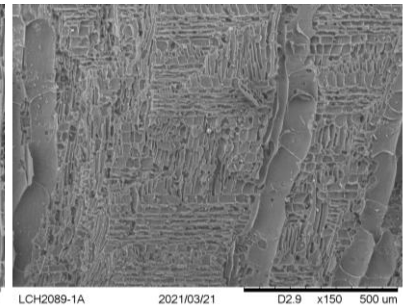
Transverse View



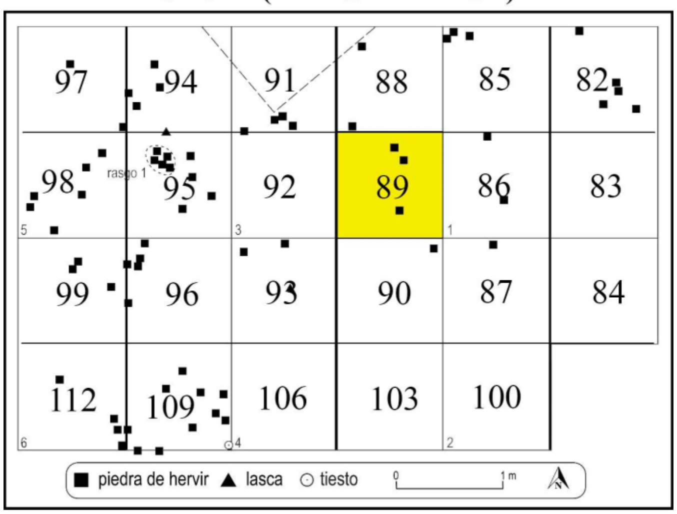
Tangential View



Radial View

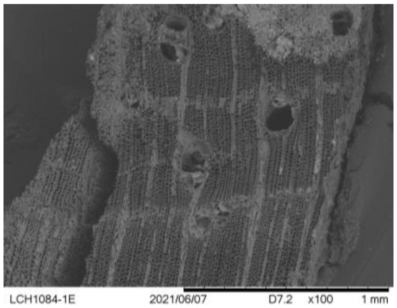


Unit 60 (1692 to 1456 BCE)

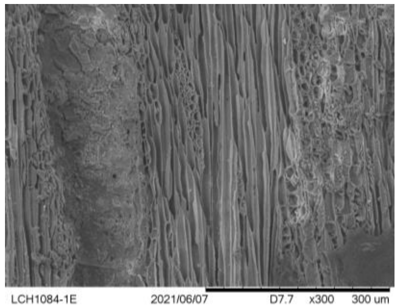


Scientific Name: SIMAROUBACEAE *Simaba* cf. *cedron* Planch.
Common Name: cedron

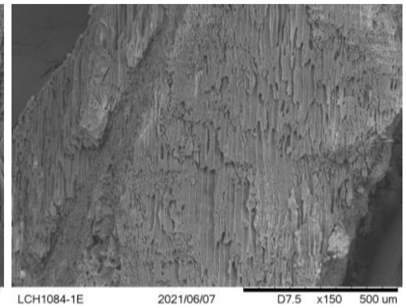
Transverse View



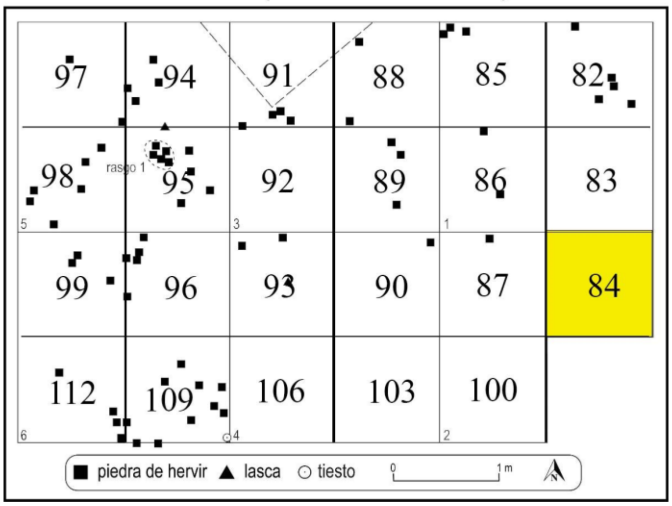
Tangential View



Radial View

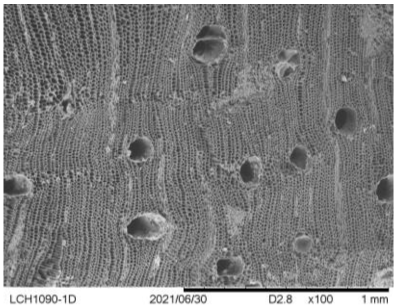


Unit 60 (1692 to 1456 BCE)

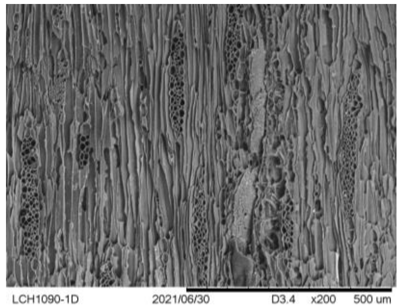


Scientific Name: SIMAROUBACEAE *Simarouba amara* Aubl.
Common Name: aceituno, olivo

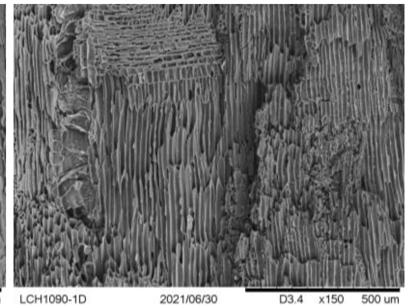
Transverse View



Tangential View

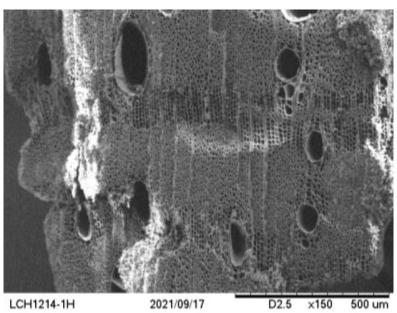


Radial View

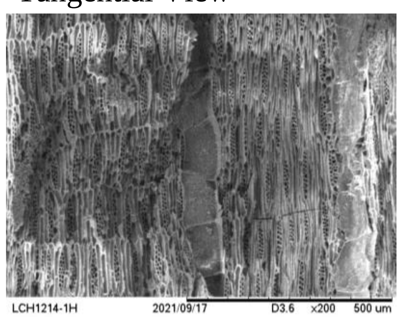


Scientific Name: SIMAROUBACEAE *Simarouba glauca* DC.
Common Name: marupa, paradise tree

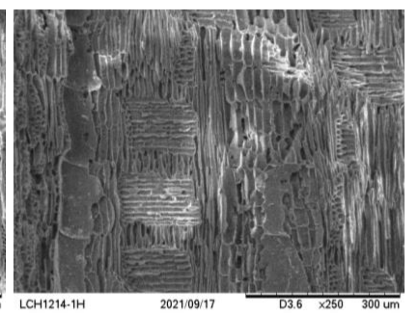
Transverse View

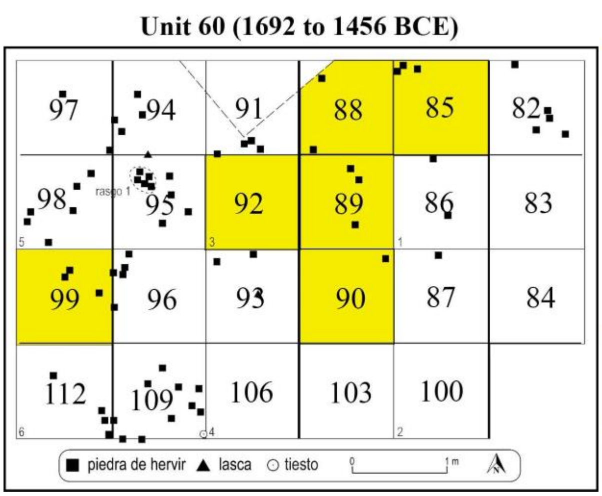


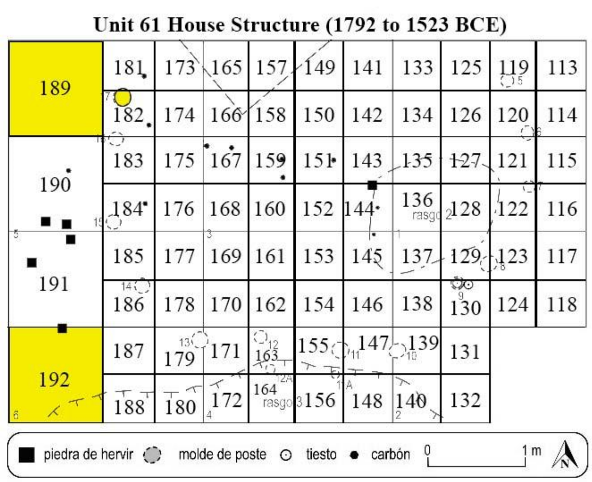
Tangential View



Radial View



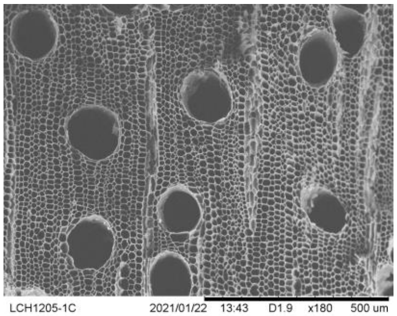


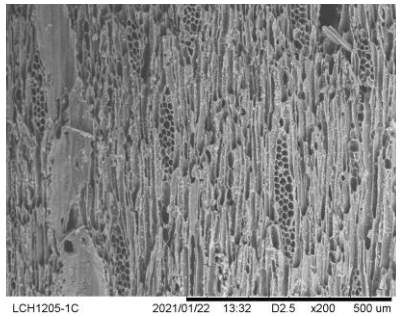


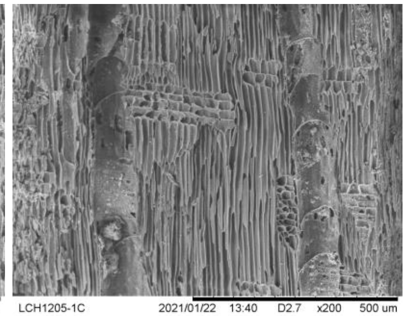
* All *Simarouba* spp. are combined in the maps

Scientific Name: URTICACEAE *Cecropia* sp.
Common Name: guarumo, trumpet tree

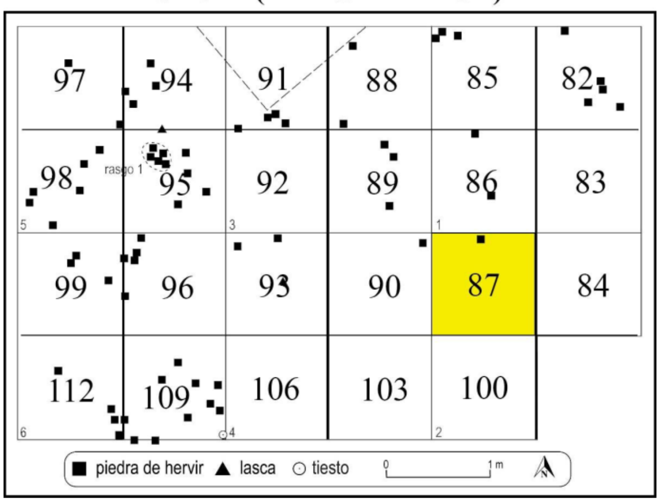
Transverse View | Tangential View | Radial View



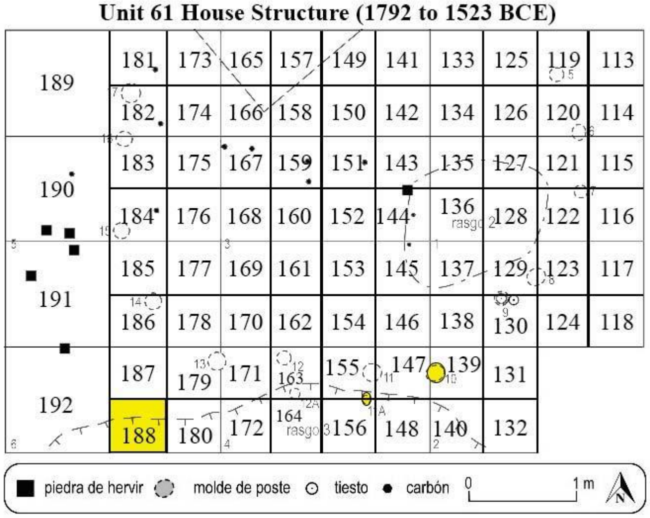




Unit 60 (1692 to 1456 BCE)

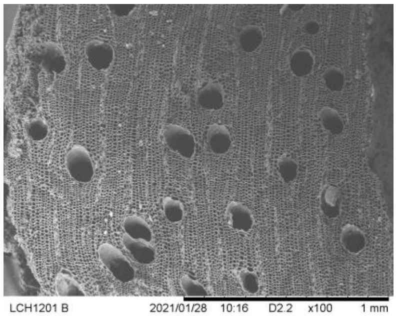


Unit 61 House Structure (1792 to 1523 BCE)

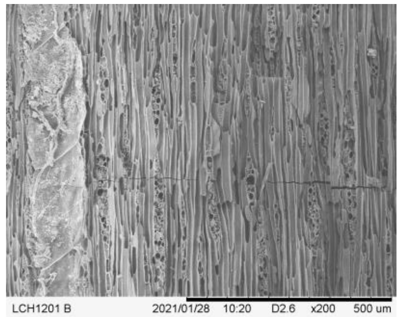


Scientific Name: URTICACEAE *Pourouma* sp.
Common Name: uvito, magabe, guarumo macho

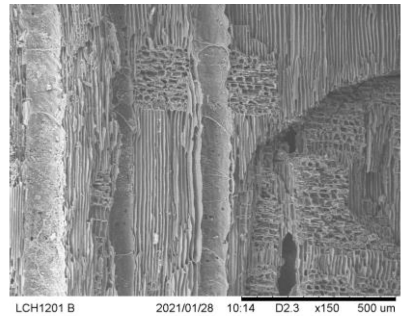
Transverse View



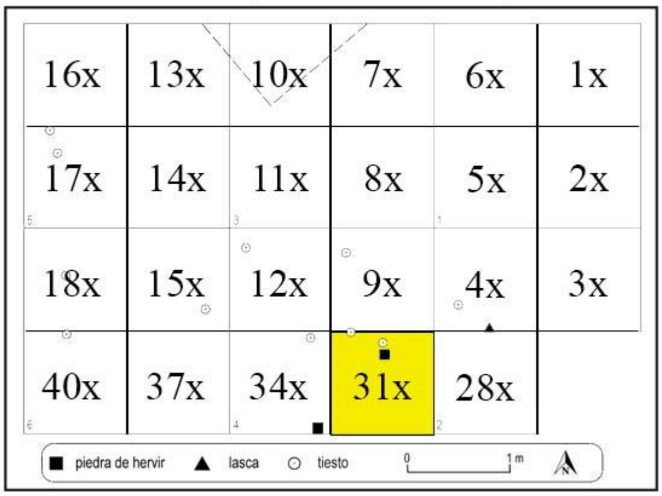
Tangential View



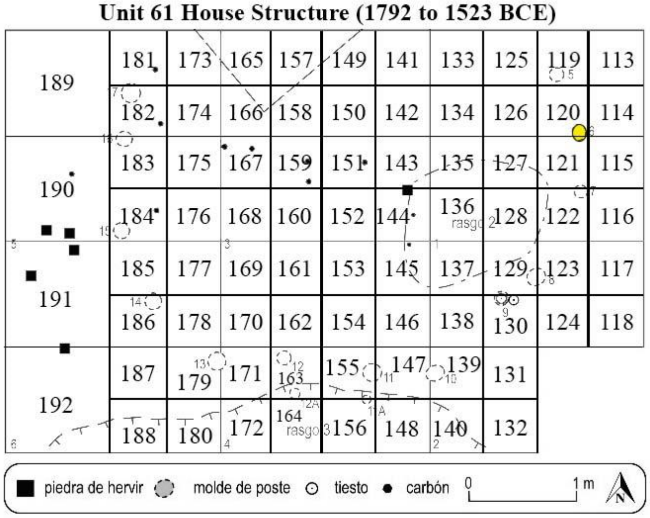
Radial View



Unit 54 (500 BCE to 100 CE)

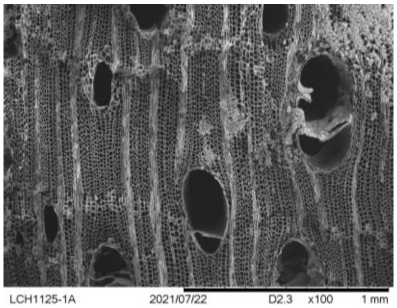


Unit 61 House Structure (1792 to 1523 BCE)

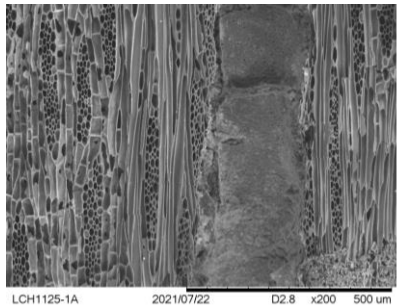


Scientific Name: VOCHYSIACEAE *Vochysia* sp.
Common Name: mayo, flor de mayo, botarrama, tecla

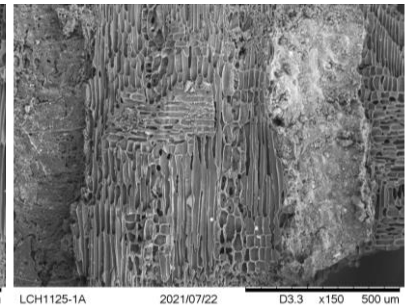
Transverse View



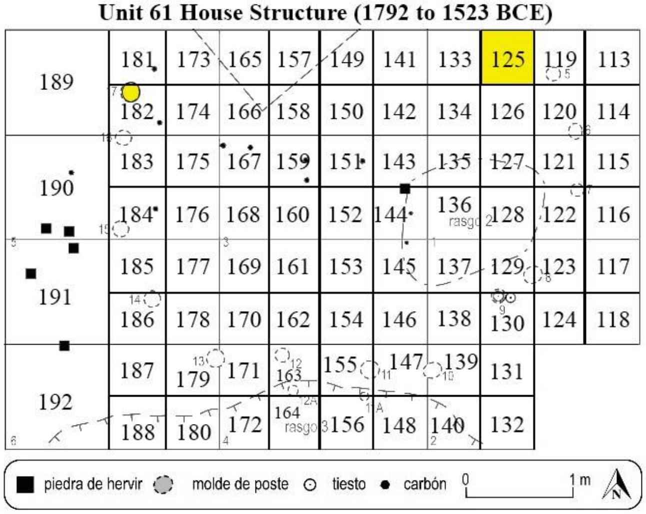
Tangential View



Radial View



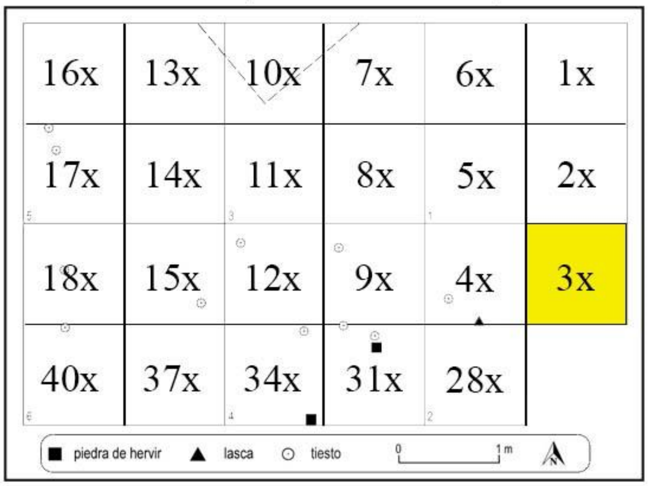
Unit 61 House Structure (1792 to 1523 BCE)

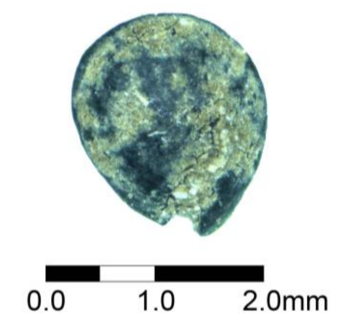


Appendix G: G995 La Chiripa Identified Seeds, Fruits, and Geophytes Images and Context Maps

Scientific Name: AMARANTHACEAE *Chenopodium* sp.
Common Name: quinoa
Plant Part: seed

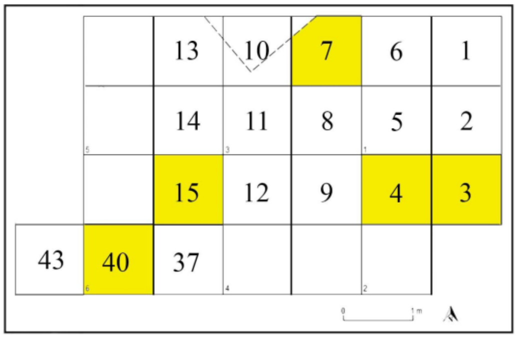
Unit 54 (500 BCE to 100 CE)



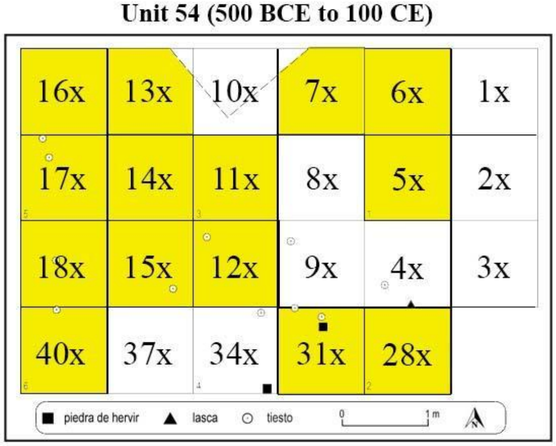


Scientific Name: ASTERACEAE
Common Name: composite family
Plant Part: achene

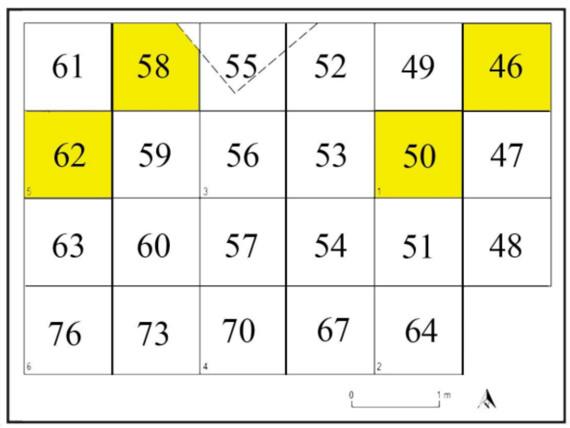
AR 16-15 (100 BCE to 100 CE)



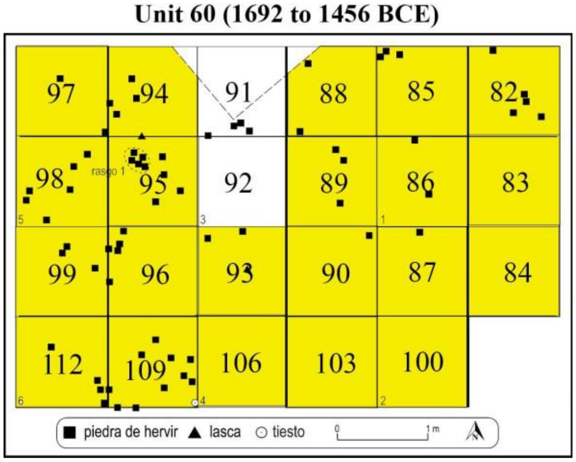
Unit 54 (500 BCE to 100 CE)



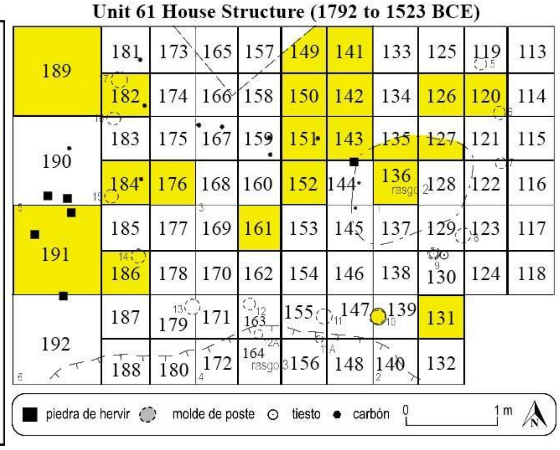
AR 14-9 (1456 to 500 BCE)



Unit 60 (1692 to 1456 BCE)

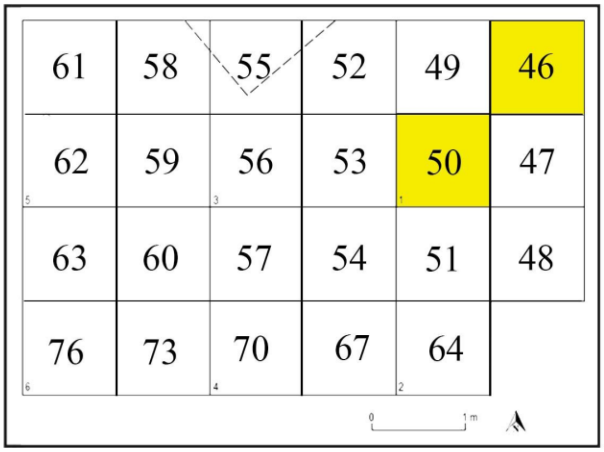


Unit 61 House Structure (1792 to 1523 BCE)

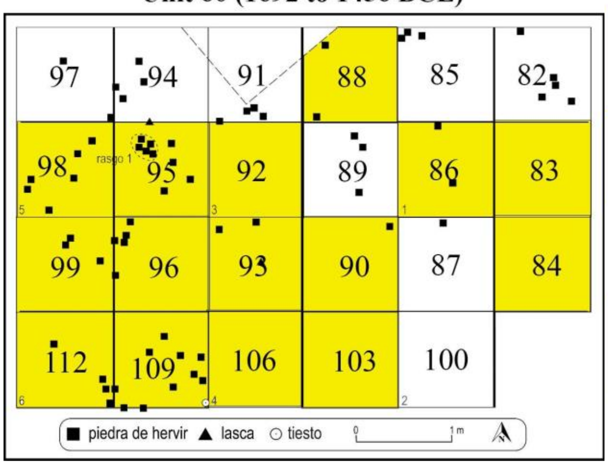


Scientific Name: ASTERACEAE *Acmella* sp.
Common Name: toothache plant, paracress
Plant Part: achene

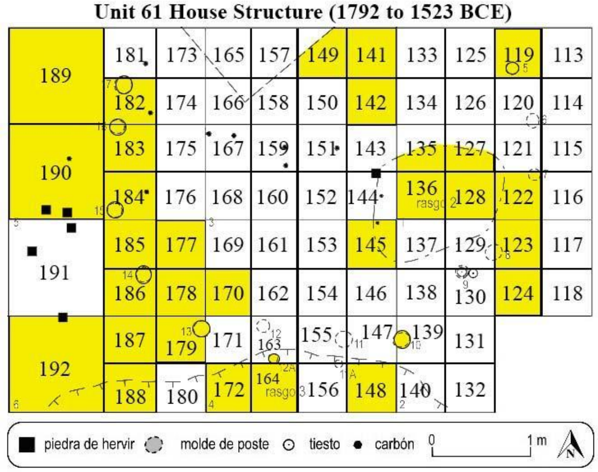
AR 14-9 (1456 to 500 BCE)



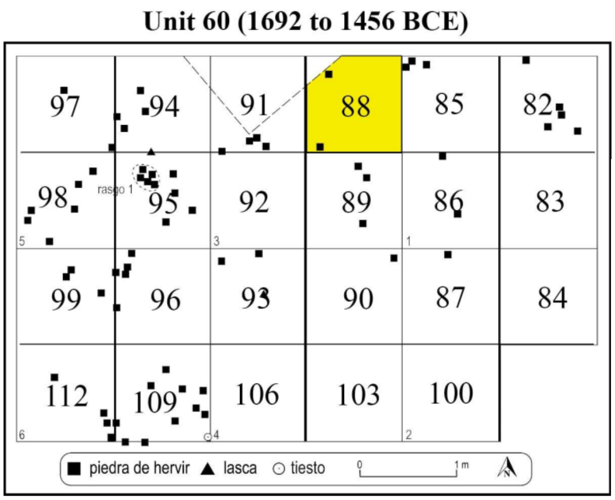
Unit 60 (1692 to 1456 BCE)



Unit 61 House Structure (1792 to 1523 BCE)

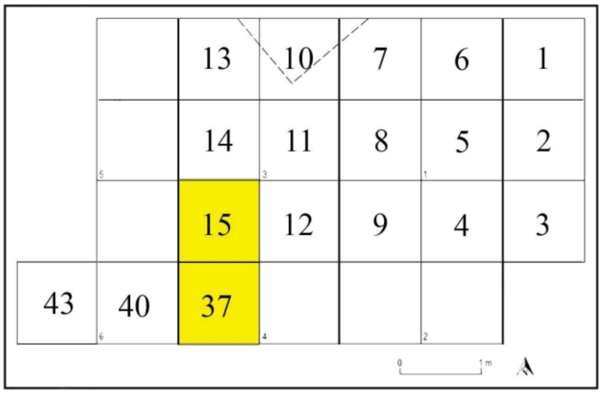


Scientific Name: ASTERACEAE *Melampodium* sp.
Common Name: blackfoot daisy, butter daisy
Plant Part: achene



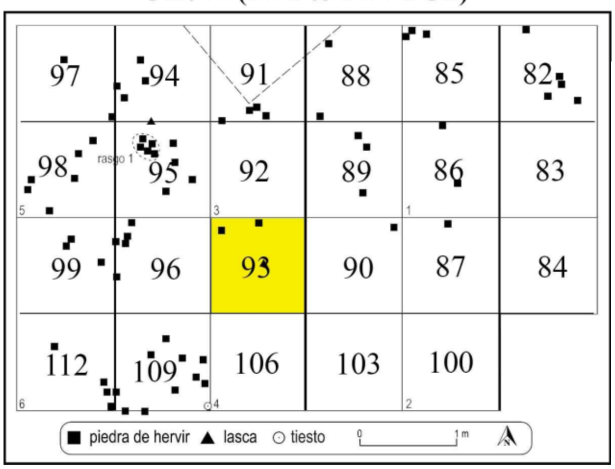
Scientific Name: CARYOPHYLLACEAE *Drymaria cordata*
Common Name: chickweed
Plant Part: seed

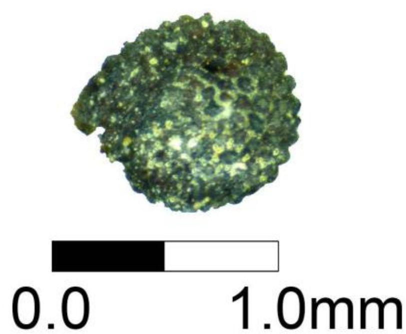
AR 16-15 (100 BCE to 100 CE)



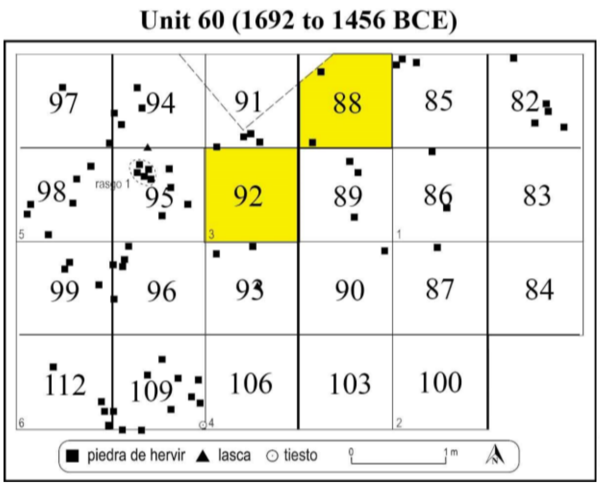
Unit 54 (500 BCE to 100 CE)

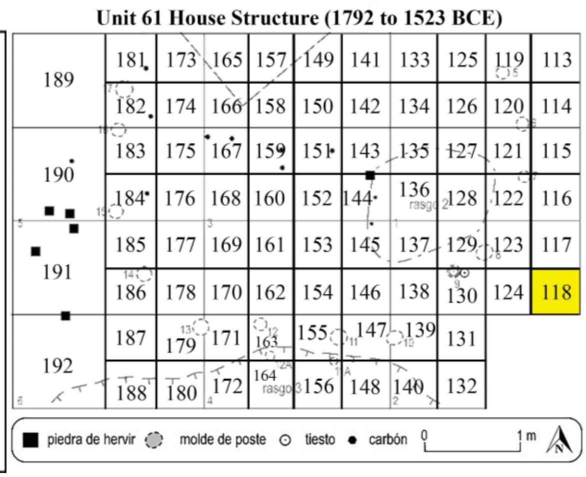
Unit 60 (1692 to 1456 BCE)

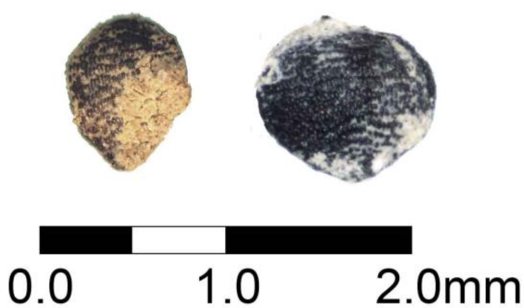




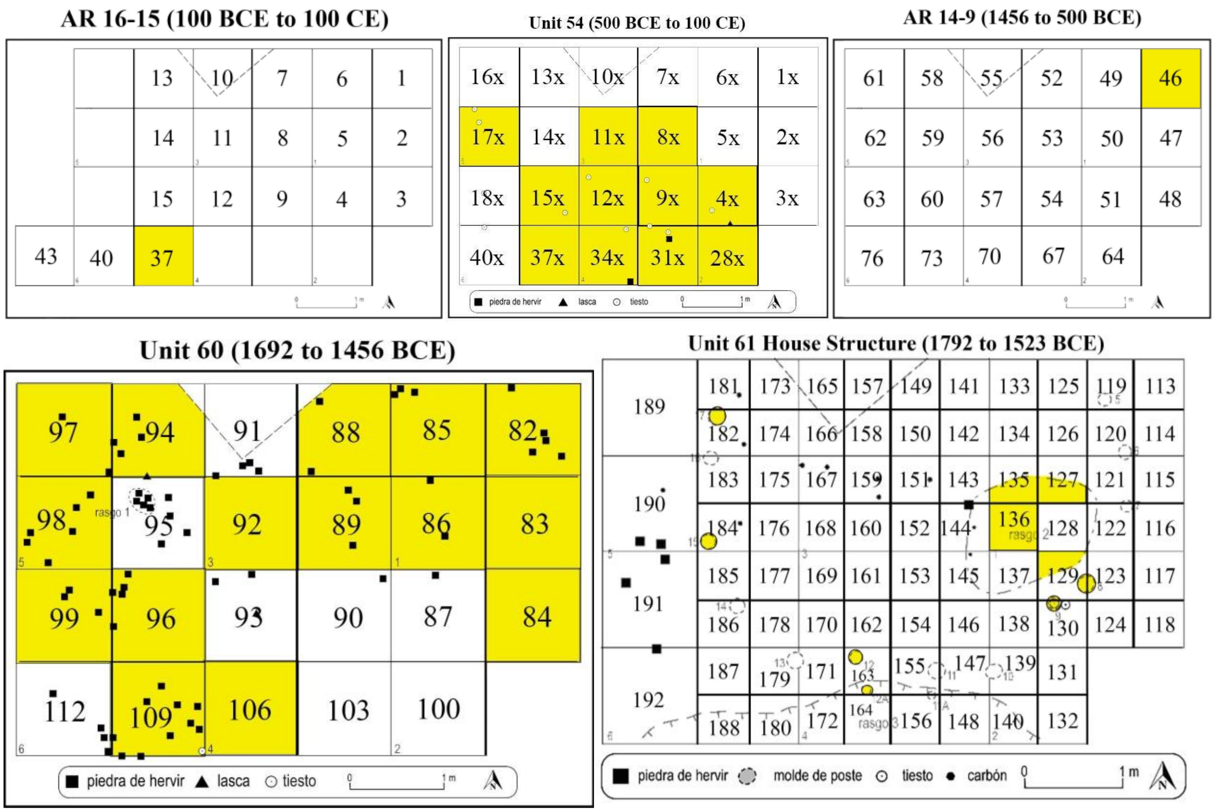
Scientific Name: CARYOPHYLLACEAE
Common Name: carnation family
Plant Part: seed





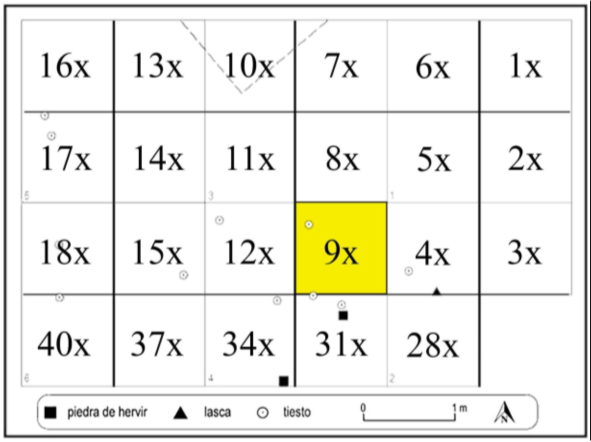


Scientific Name: COMBRETACEAE *Terminalia* sp. (fruits - wood in Appendix F)
Common Name: tropical almond, black olive, guayabo de montaña, guayabillo, guayabón, amarillo, roble amarillo, carabazuelo
Plant Part: fruit

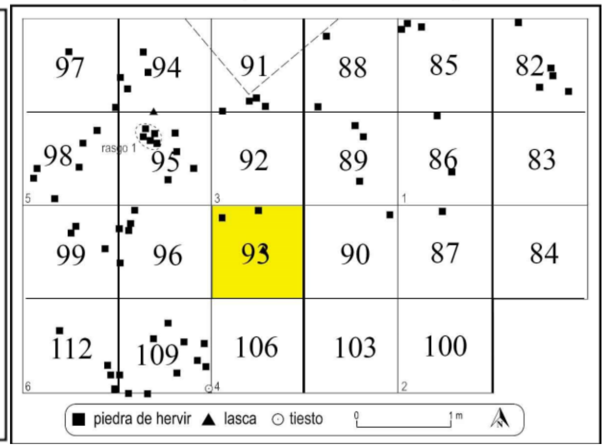


Scientific Name: EUPHORBIACEAE *Sapium* sp.
Common Name: milktree
Plant Part: seed

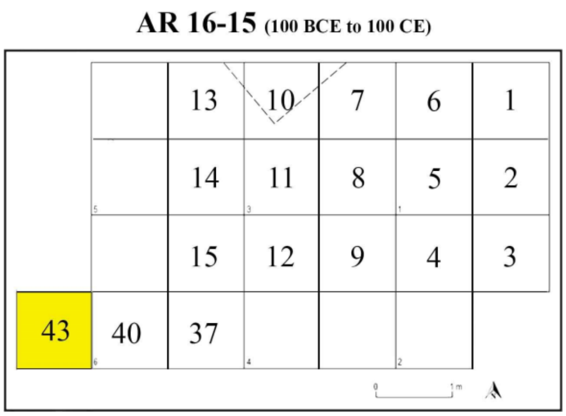
Unit 54 (500 BCE to 100 CE)



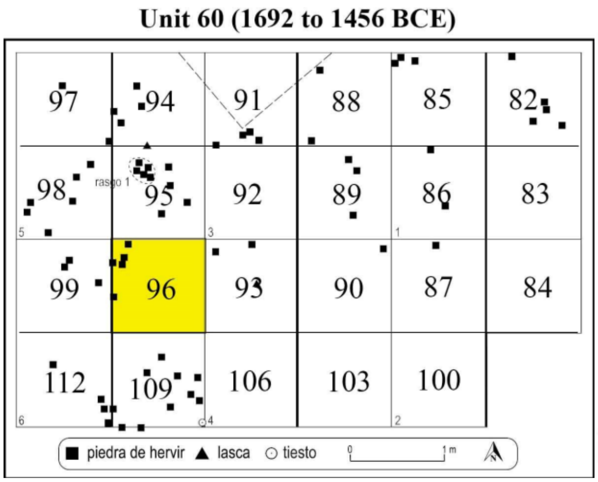
Unit 60 (1692 to 1456 BCE)

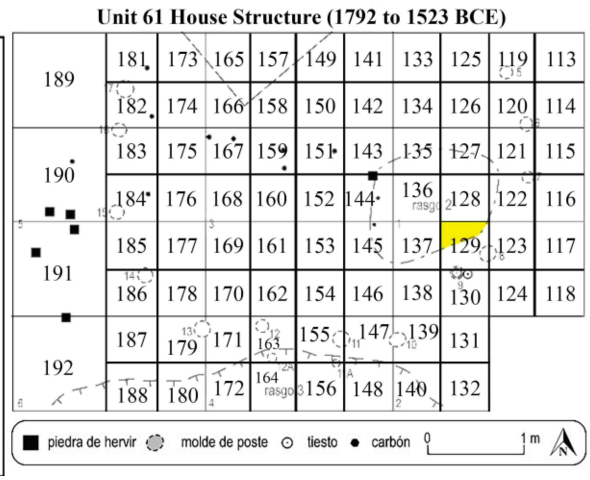


Scientific Name: LEGUMINOSAE *Crotalaria* sp.
Common Name: rattlepod
Plant Part: seed



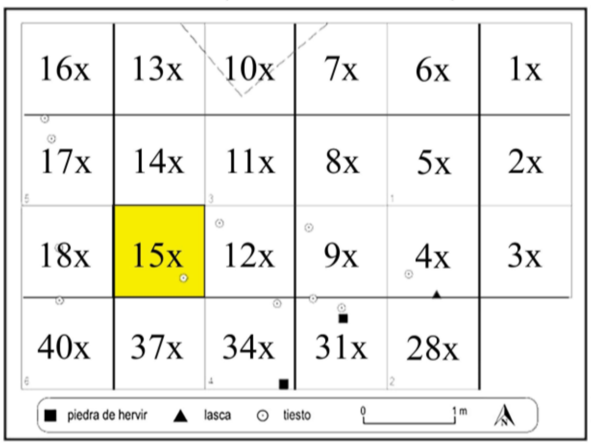
Scientific Name: LEGUMINOSAE *Phaseolus* sp.
Common Name: common bean
Plant Part: cotyledon



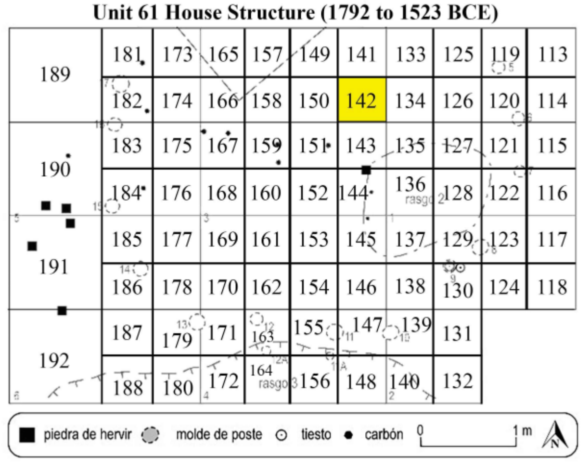


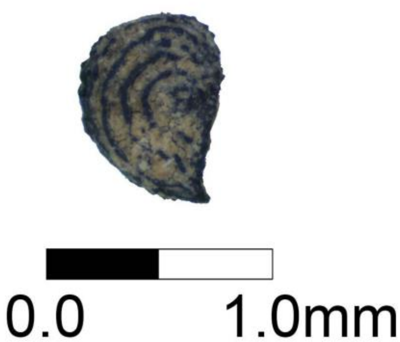
Scientific Name: MOLLUGINACEAE *Mollugo verticillata*
Common Name: carpetweed
Plant Part: seed

Unit 54 (500 BCE to 100 CE)



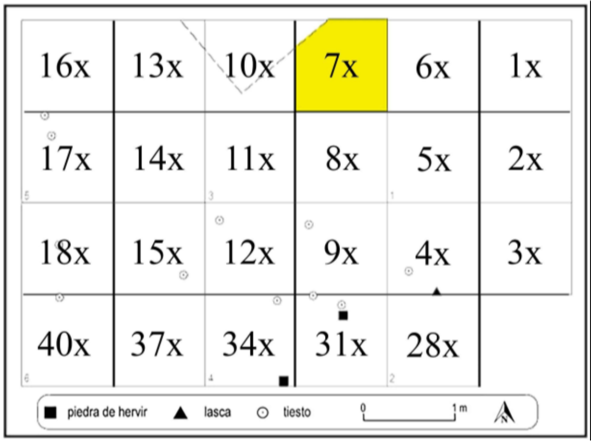
Unit 61 House Structure (1792 to 1523 BCE)



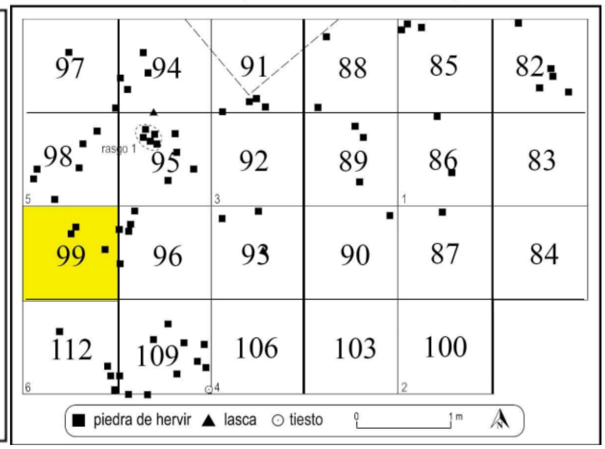


Scientific Name: OXALIDACEAE *Oxalis* sp.
Common Name: wood sorrel
Plant Part: seed

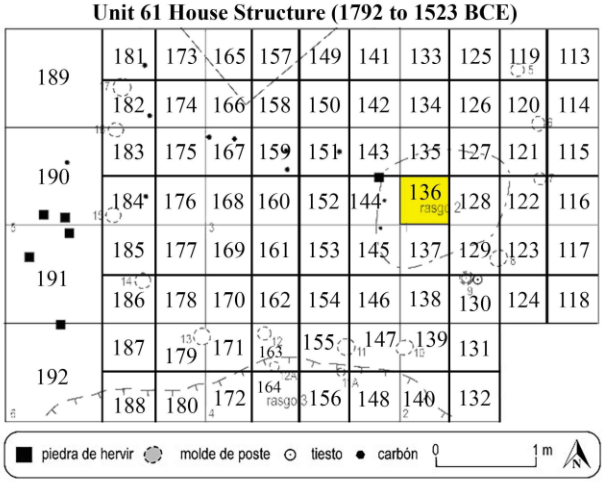
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

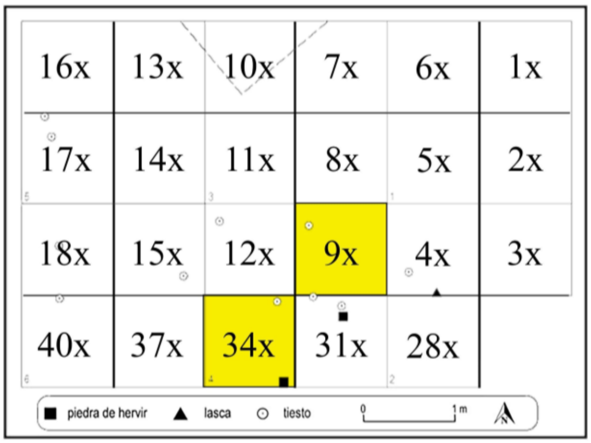


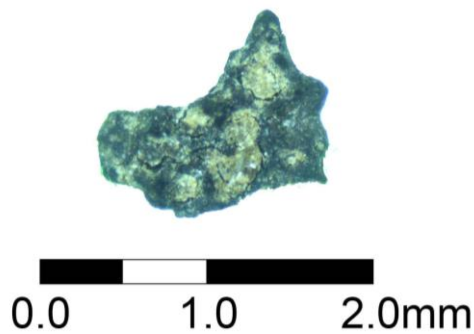
Unit 61 House Structure (1792 to 1523 BCE)



Scientific Name: PASSIFLORACEAE *Passiflora* sp.
Common Name: passion flower
Plant Part: seed

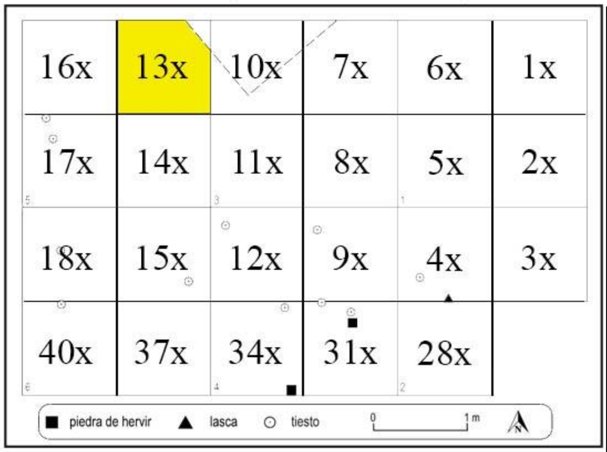
Unit 54 (500 BCE to 100 CE)



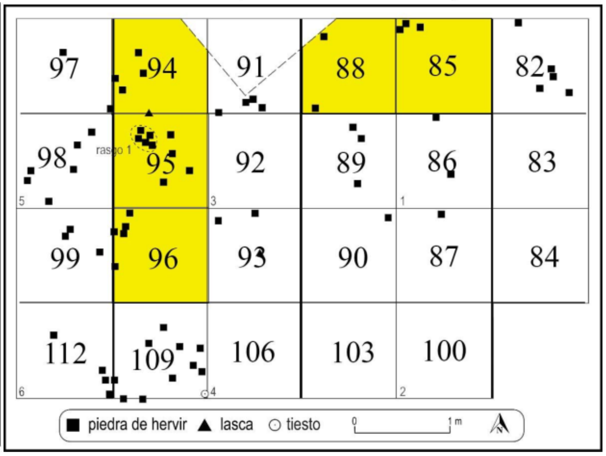


Scientific Name: POACEAE *Zea mays* L.
Common Name: maize
Plant Part: cupule

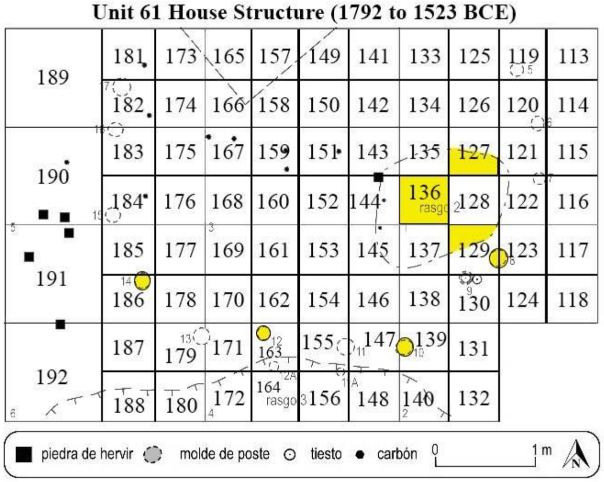
Unit 54 (500 BCE to 100 CE)



Unit 60 (1692 to 1456 BCE)

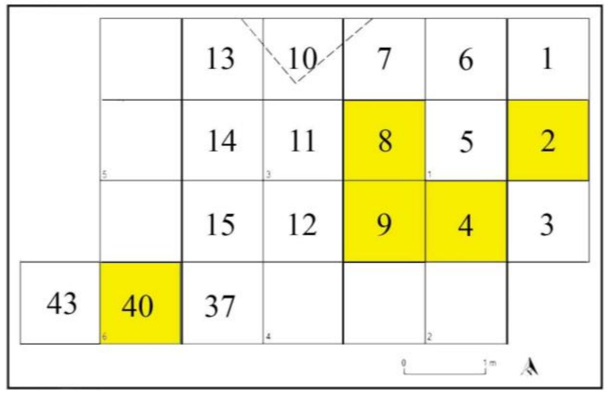


Unit 61 House Structure (1792 to 1523 BCE)

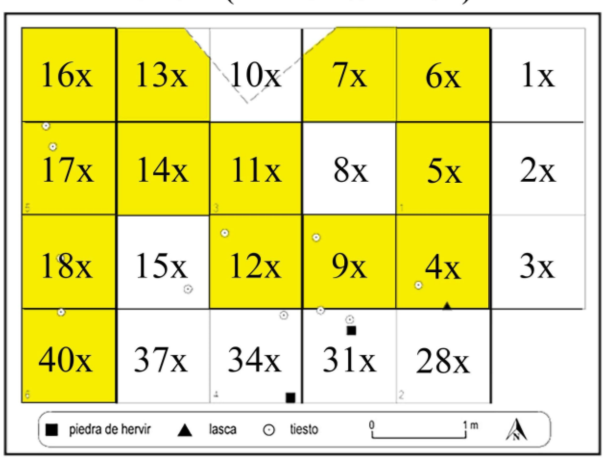


Scientific Name: POACEAE
Common Name: grass
Plant Part: seed

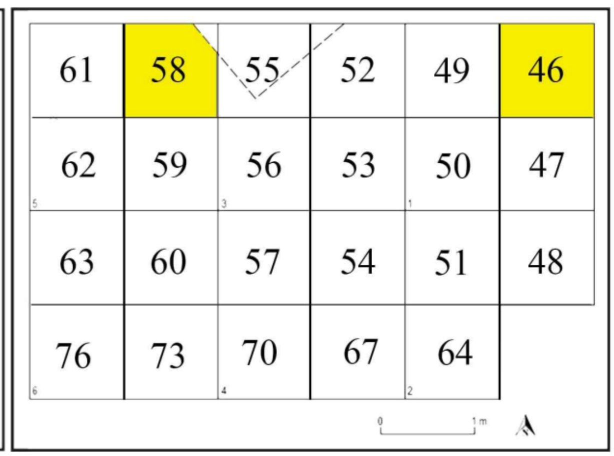
AR 16-15 (100 BCE to 100 CE)



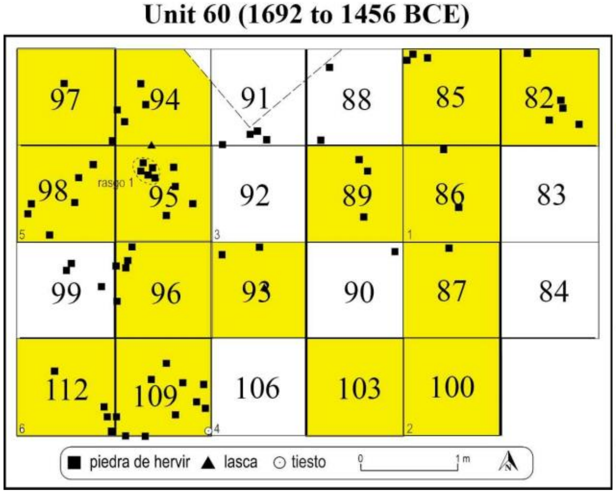
Unit 54 (500 BCE to 100 CE)



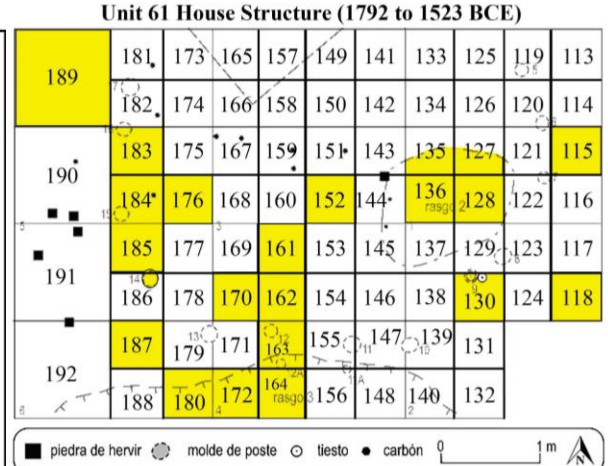
AR 14-9 (1456 to 500 BCE)



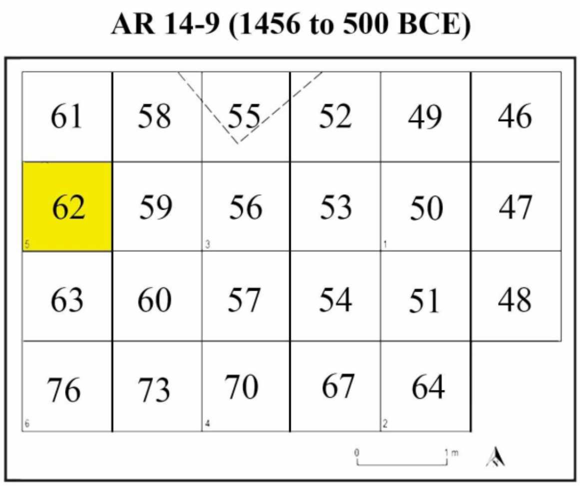
Unit 60 (1692 to 1456 BCE)

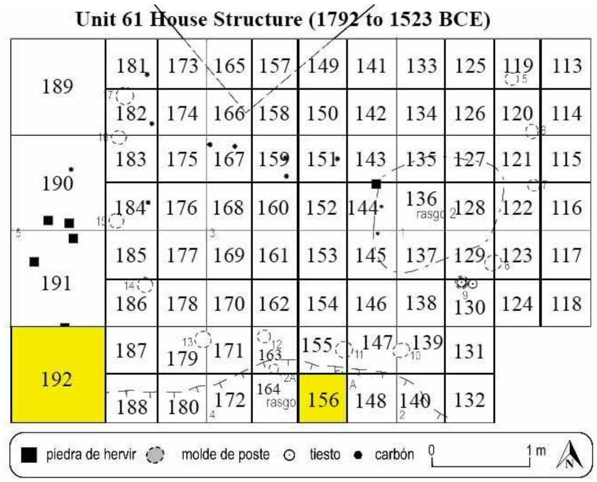


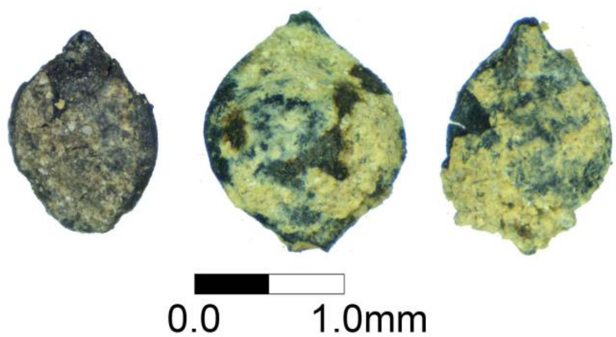
Unit 61 House Structure (1792 to 1523 BCE)



Scientific Name: POLYGONACEAE cf. *Rumex* sp.
Common Name: sorrel
Plant Part: seed

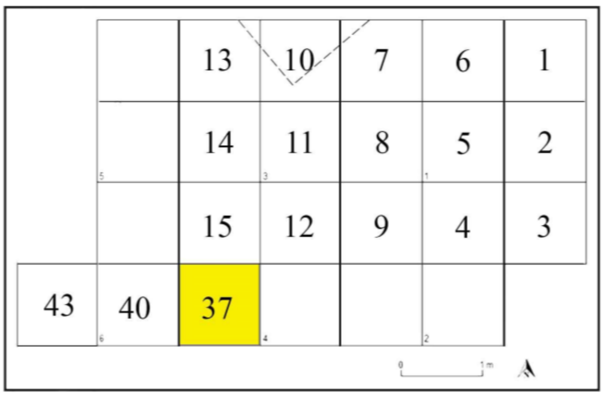


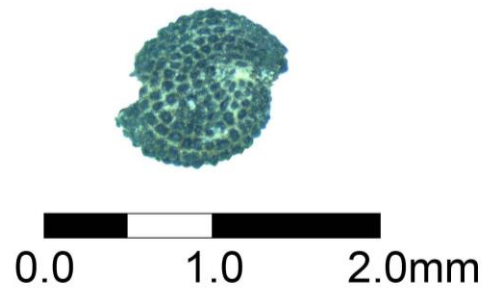




Scientific Name: PORTULACACEAE *Portulaca* cf. *oleracea*
Common Name: purslane
Plant Part: seed

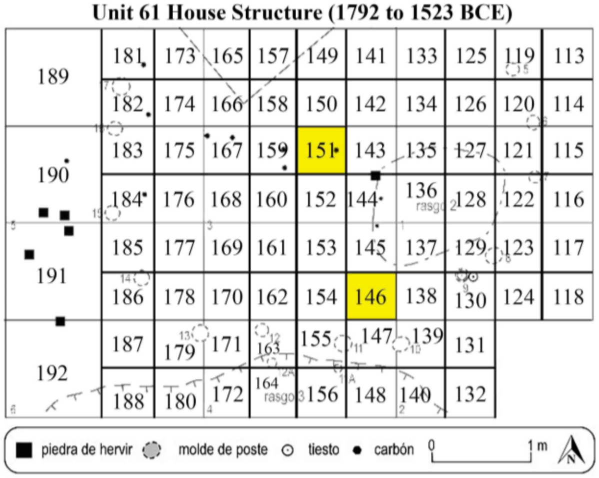
AR 16-15 (100 BCE to 100 CE)

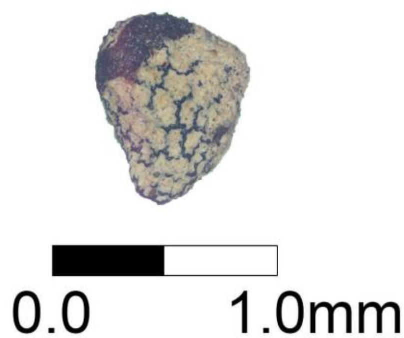




Scientific Name: SOLANACEAE *Nicotiana* sp.
Common Name: tobacco
Plant Part: seed

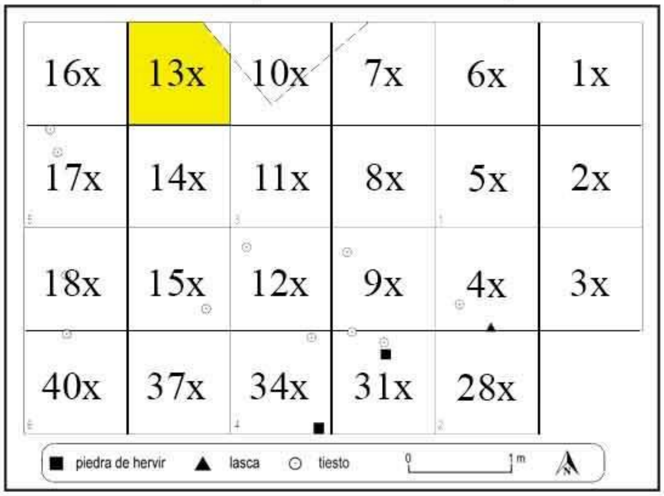
Unit 61 House Structure (1792 to 1523 BCE)



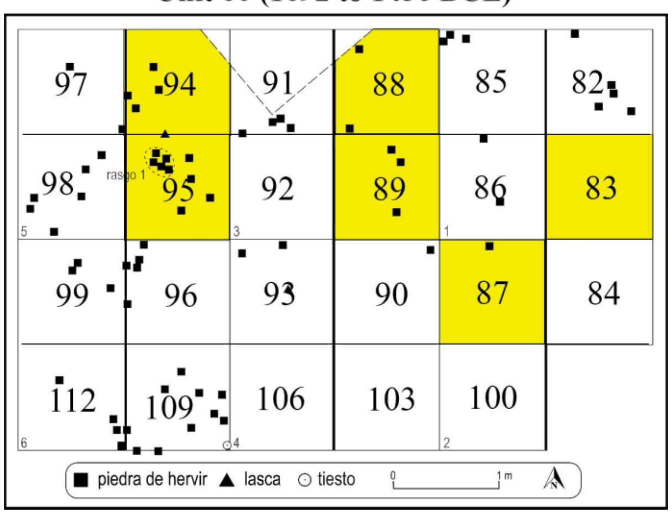


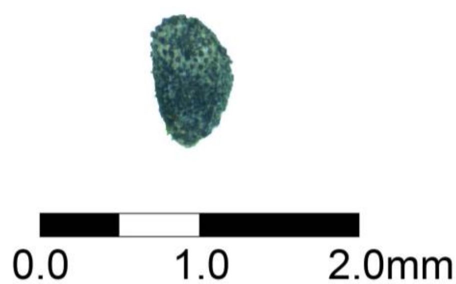
Scientific Name: URTICACEAE *Cecropia* sp.
Common Name: trumpet tree
Plant Part: seed

Unit 54 (500 BCE to 100 CE)

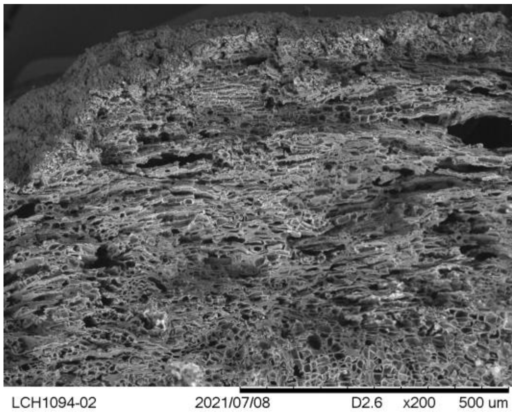


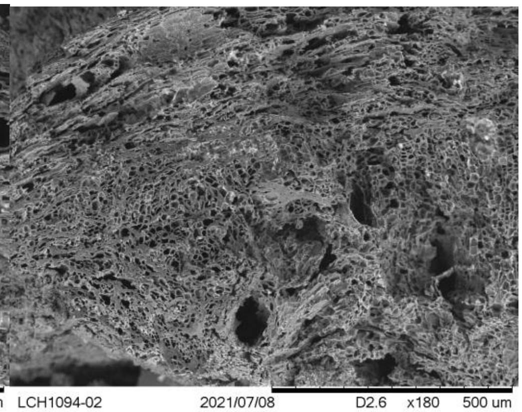
Unit 60 (1692 to 1456 BCE)

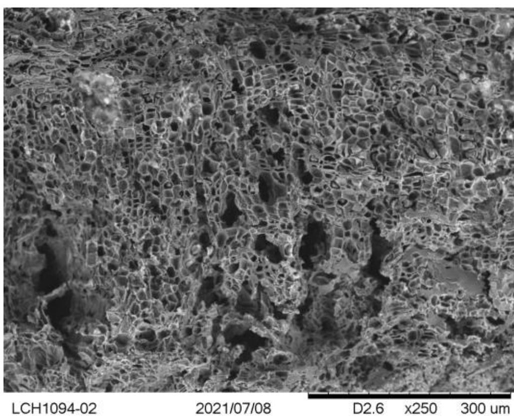


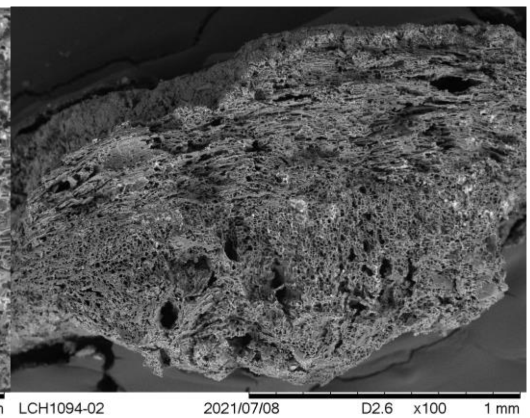


Scientific Name: EUPHORBIACEAE *Manihot* sp.
Common Name: manioc
Plant Part: geophyte

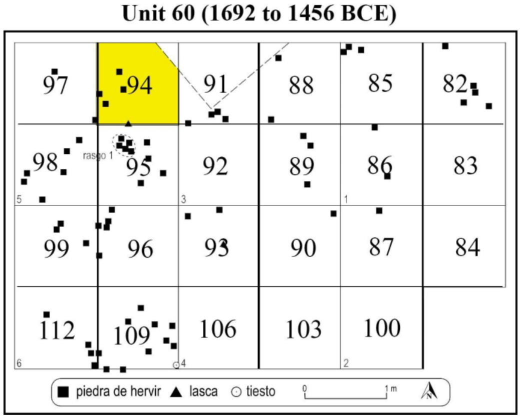






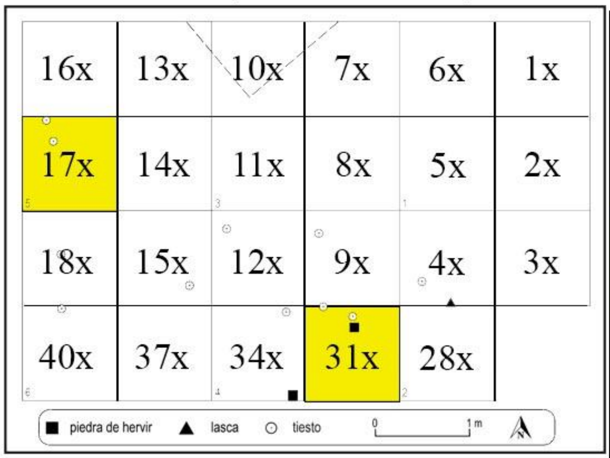


Unit 60 (1692 to 1456 BCE)

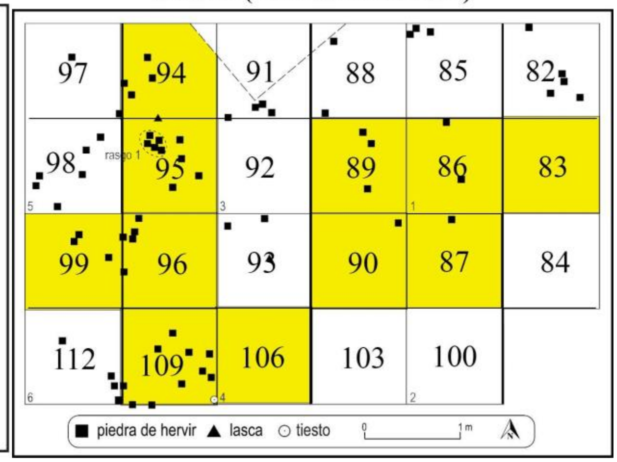


Scientific Name: unidentified
Common Name: geophyte
Plant Part: root or stem

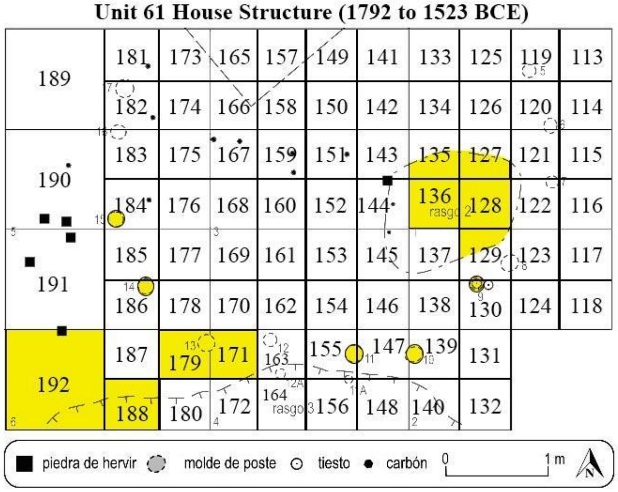
Unit 54 (500 BCE to 100 CE)



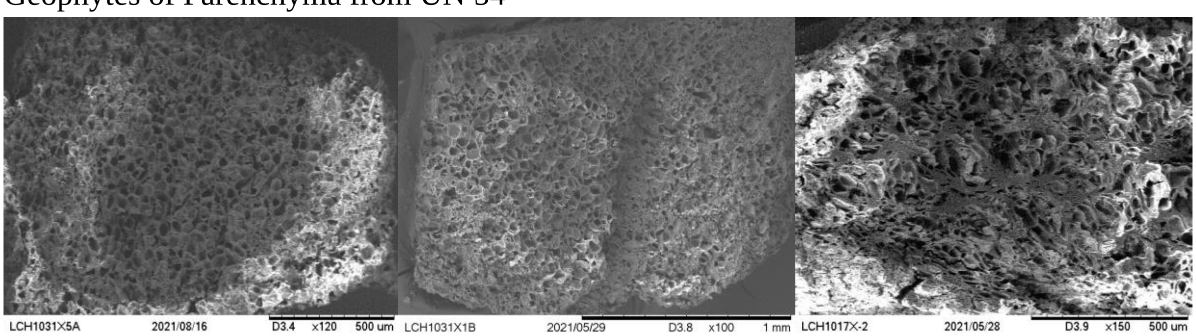
Unit 60 (1692 to 1456 BCE)



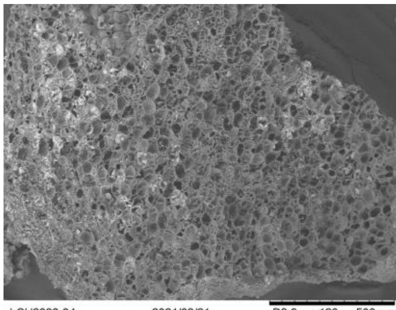
Unit 61 House Structure (1792 to 1523 BCE)

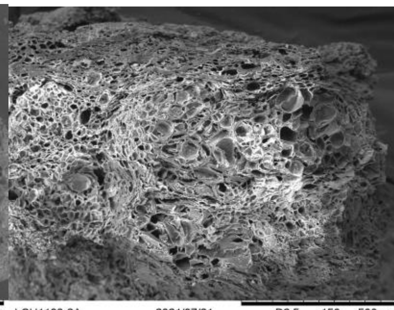


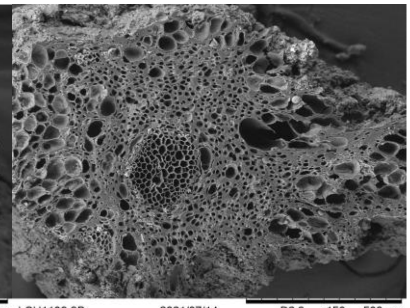
Geophytes of Parenchyma from UN 54

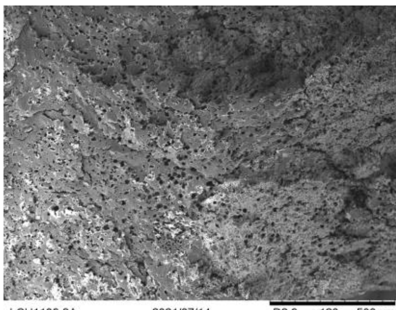


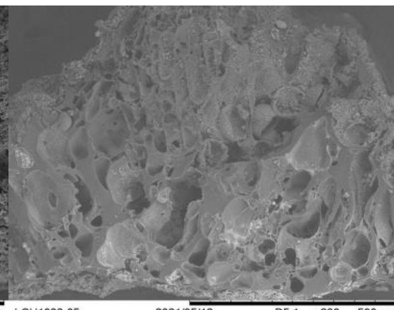
Geophytes of Parenchyma from UN 60

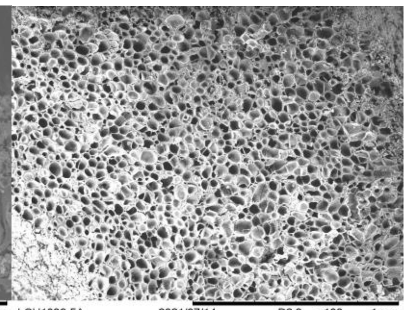

LCH2089-04 2021/03/21 D3.6 x120 500 um

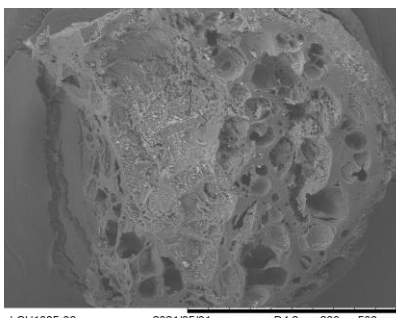

LCH1109-2A 2021/07/21 D2.5 x150 500 um

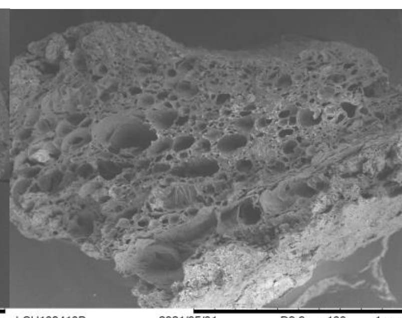

LCH1106-3B 2021/07/14 D2.8 x150 500 um

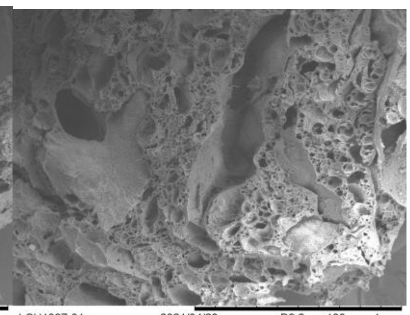

LCH1106-3A 2021/07/14 D2.6 x120 500 um

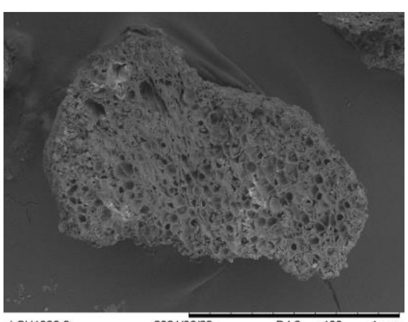

LCH1099-05 2021/05/12 D5.1 x200 500 um


LCH1096-5A 2021/07/14 D2.3 x100 1 mm

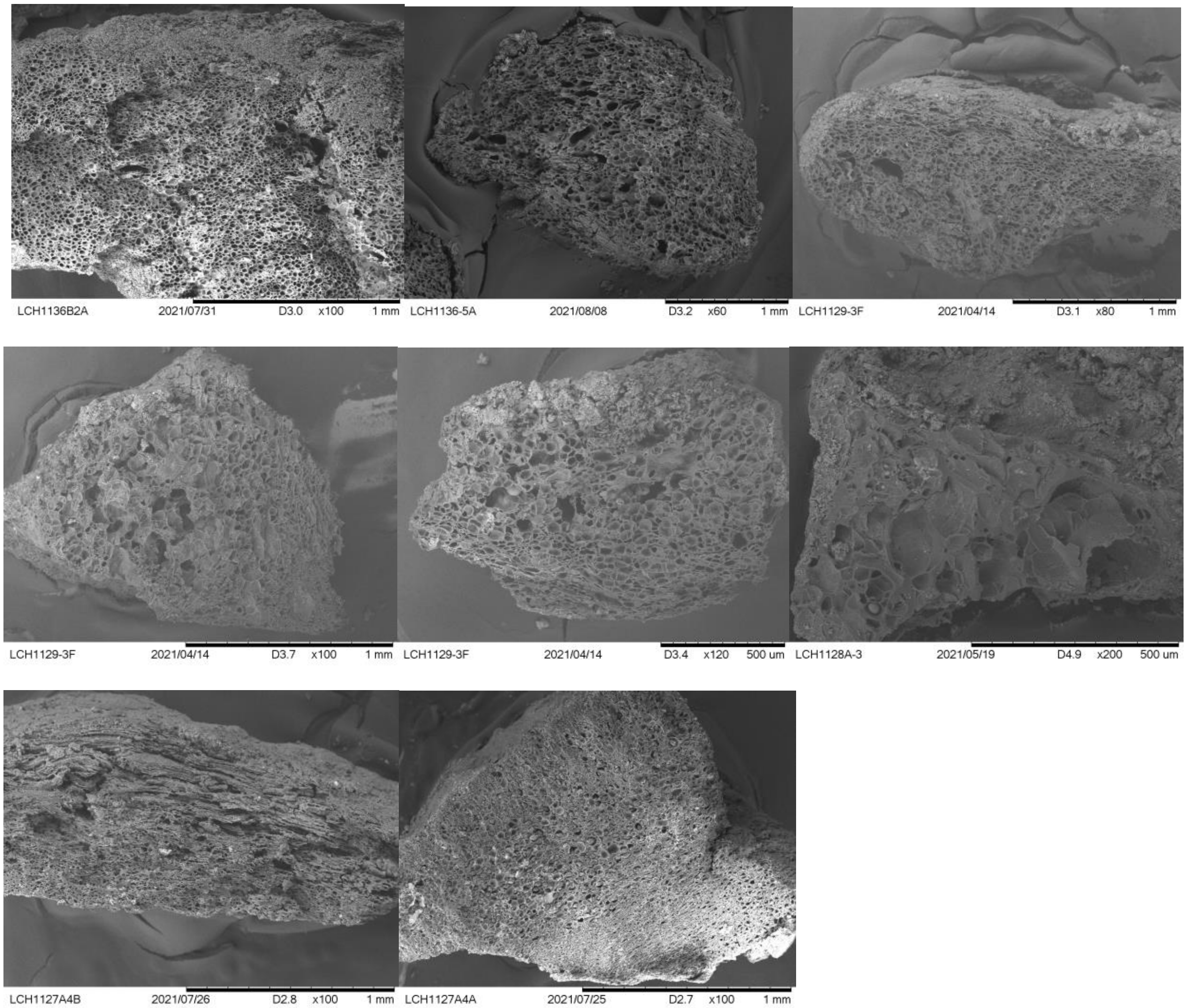

LCH1095-06 2021/05/01 D4.2 x200 500 um


LCH109410B 2021/05/01 D3.6 x100 1 mm

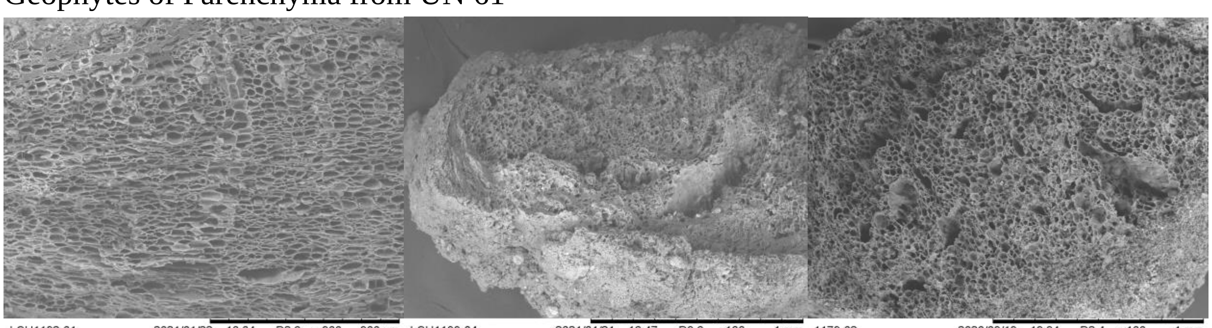

LCH1087-01 2021/04/29 D3.2 x100 1 mm


LCH1086-3 2021/06/23 D4.2 x100 1 mm

Geophytes of Parenchyma from the hearth within UN 61



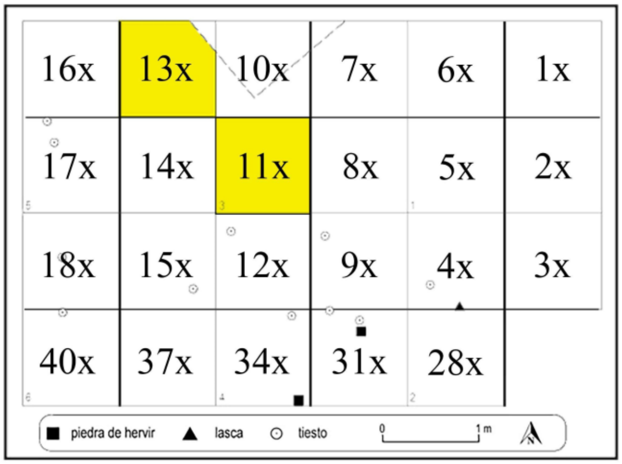
Geophytes of Parenchyma from UN 61



UNIDENTIFIED SEEDS

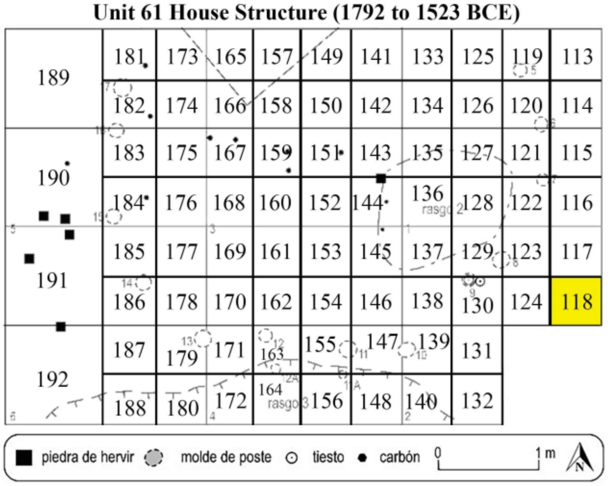
UNID SEED A

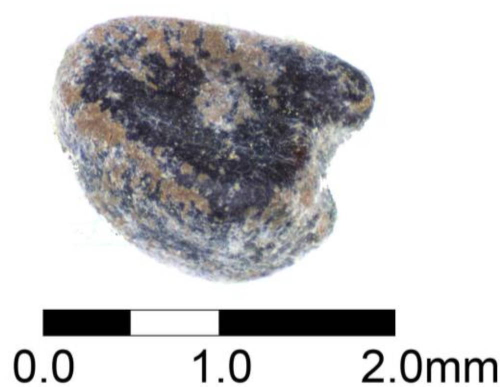
Unit 54 (500 BCE to 100 CE)



UNID SEED B

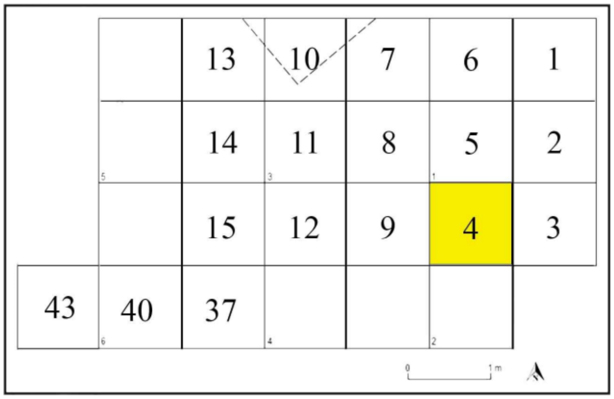
Unit 61 House Structure (1792 to 1523 BCE)



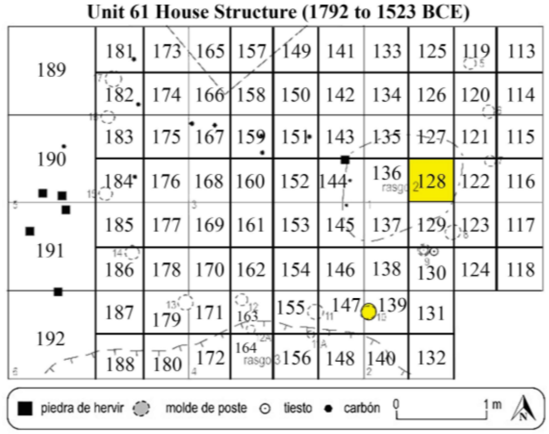


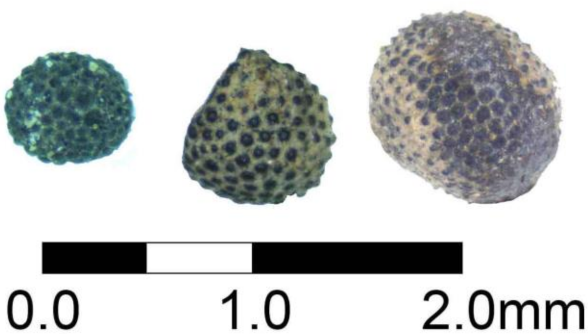
UNID SEED C

AR 16-15 (100 BCE to 100 CE)



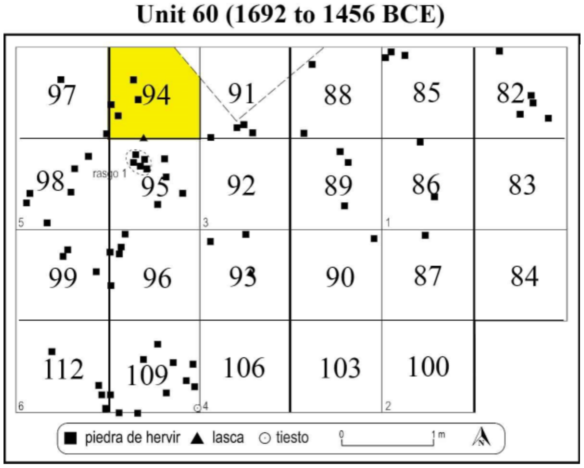
Unit 61 House Structure (1792 to 1523 BCE)

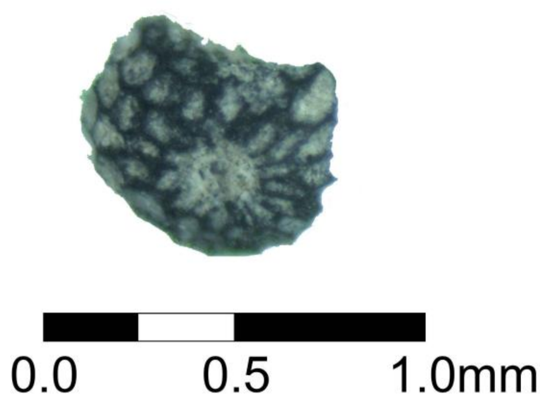




UNID SEED D

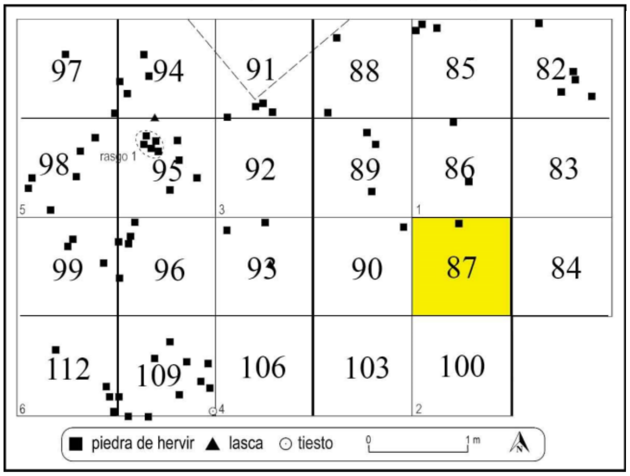
Unit 60 (1692 to 1456 BCE)





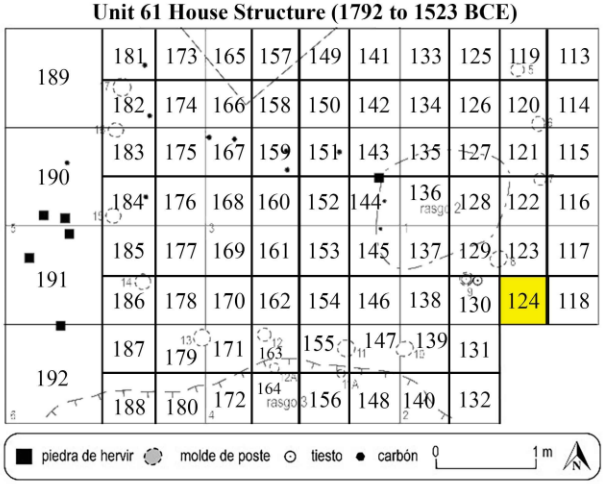
UNID Fruit A

Unit 60 (1692 to 1456 BCE)



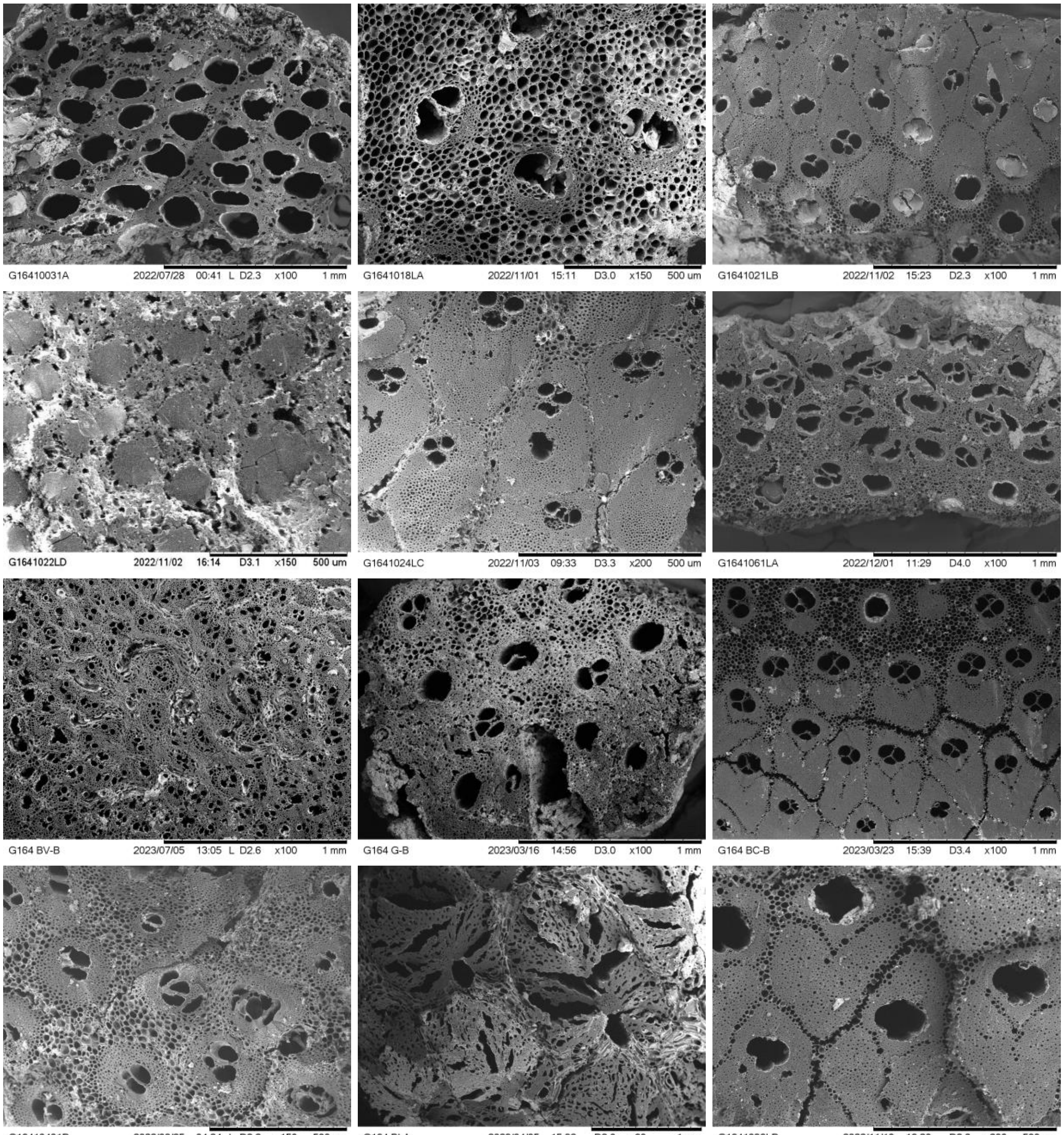
UNID Fruit B

Unit 61 House Structure (1792 to 1523 BCE)



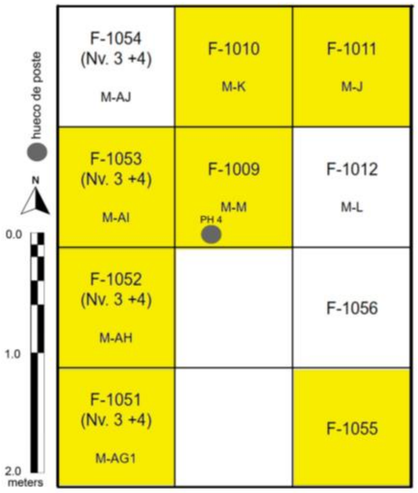
Appendix H: G164 Sitio Bolívar - Identified Wood Taxa from the 2021 Excavations Scanning Electron Micrographs and Context Maps

Scientific Name: ARECACEAE **Common Name:** palm Transverse Views

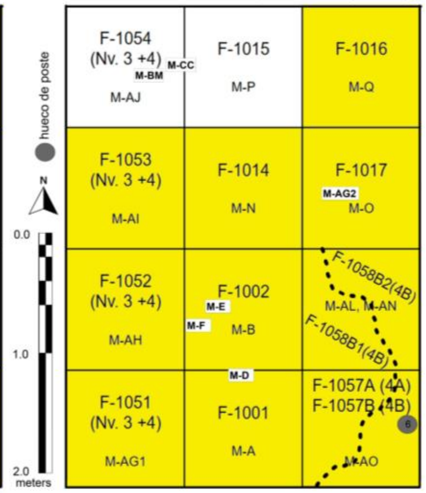


Maps of ARECACEAE wood charcoal

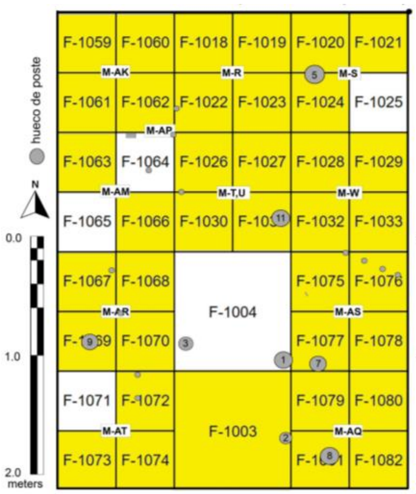
G164 Sitio Bolívar Op. F Nv. 3



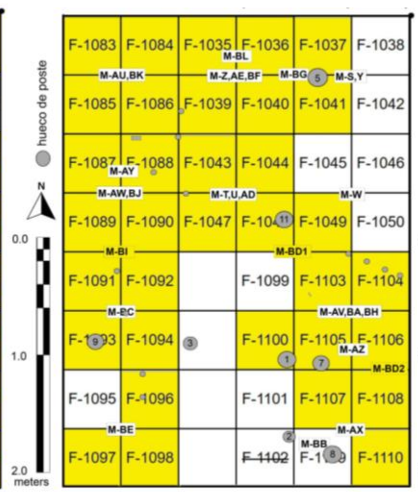
G164 Sitio Bolívar Op. F Nv. 4



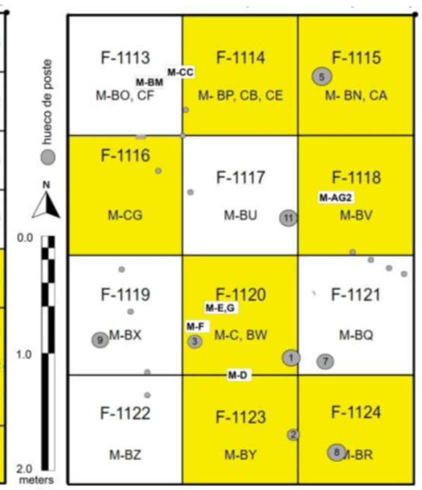
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

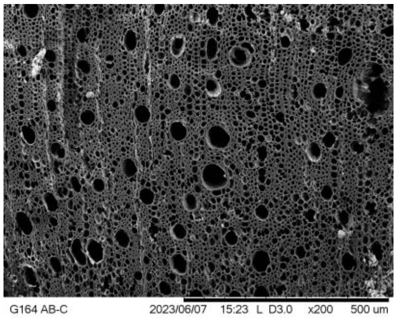


G164 Sitio Bolívar Op. F Nv. 5C

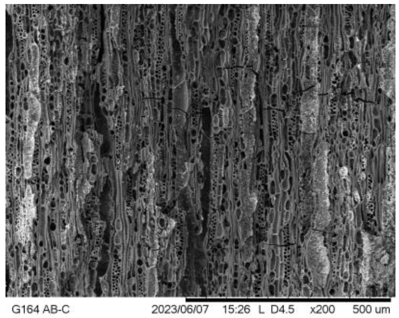


Scientific Name: ADOXACEAE *Viburnum* sp.
Common Name: viburnum

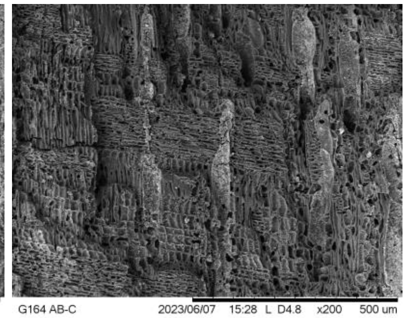
Transverse View



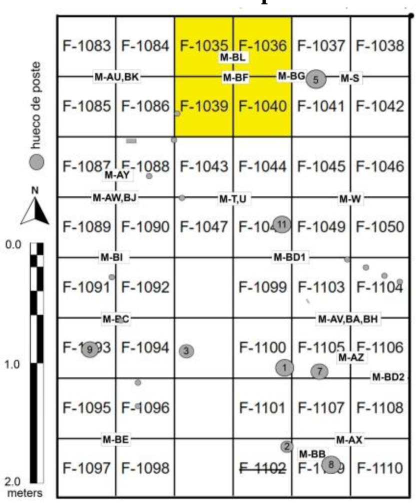
Tangential View



Radial View

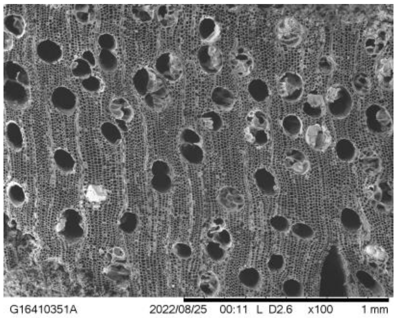


G164 Sitio Bolívar Op. F Nv. 5B

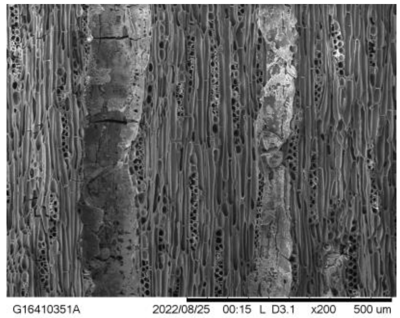


Scientific Name: ANACARDIACEAE cf. *Amphipterygium* sp.
Common Name: cuachalalate

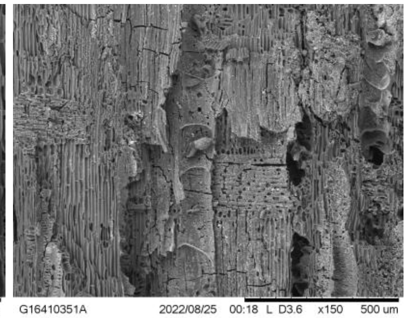
Transverse View



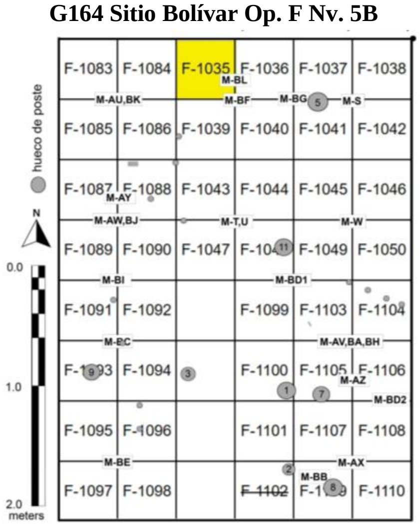
Tangential View



Radial View

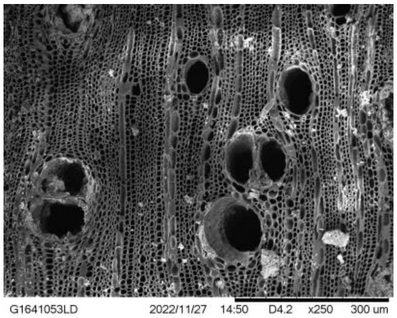


G164 Sitio Bolívar Op. F Nv. 5B

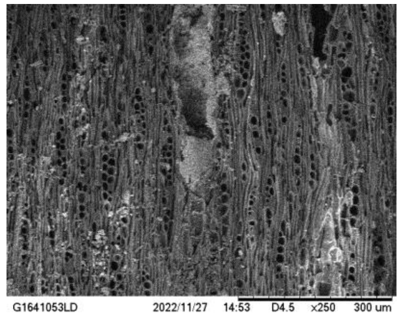


Scientific Name: ANACARDIACEAE *Anacardium occidentale* L.
Common Name: cashew, marañón

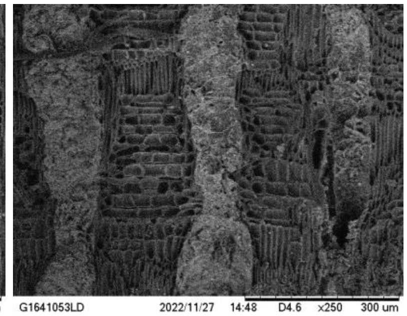
Transverse View



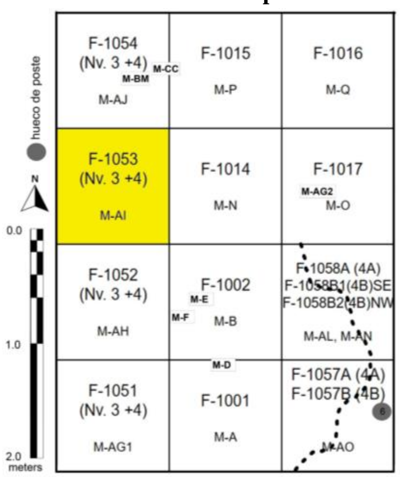
Tangential View



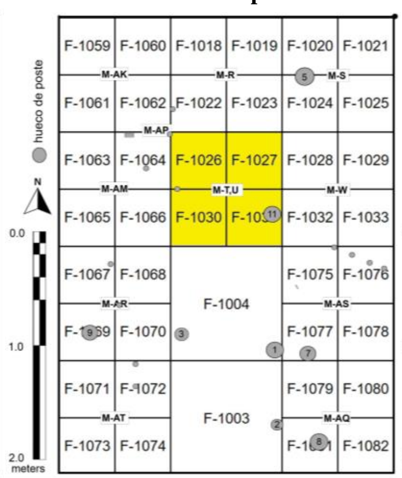
Radial View



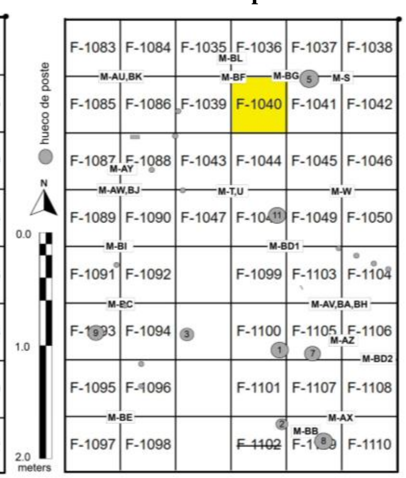
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

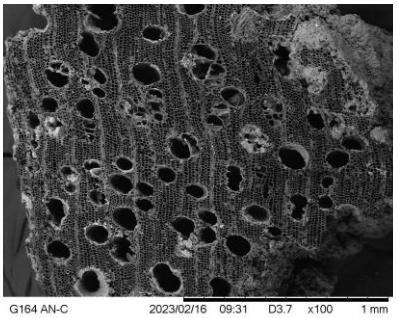


G164 Sitio Bolívar Op. F Nv. 5B

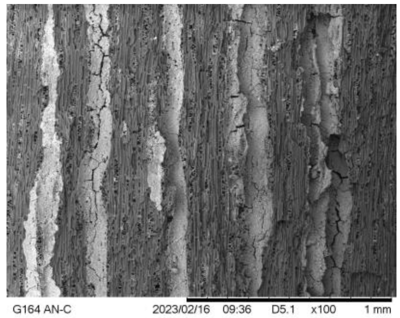


Scientific Name: ANACARDIACEAE *Astronium graveolens* Jacq.
Common Name: zorro, ron-ron, tigrillo, tolerante, cucaracho

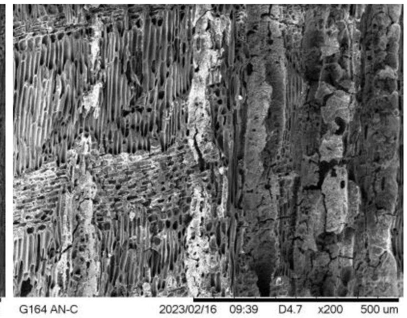
Transverse View



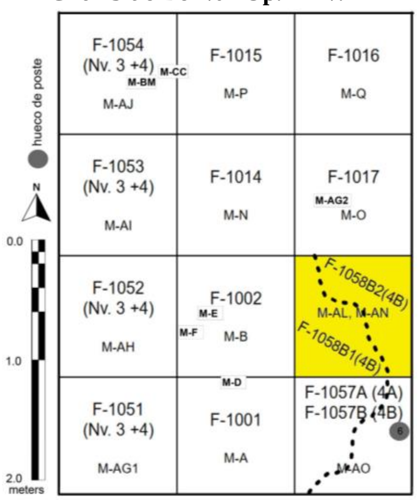
Tangential View



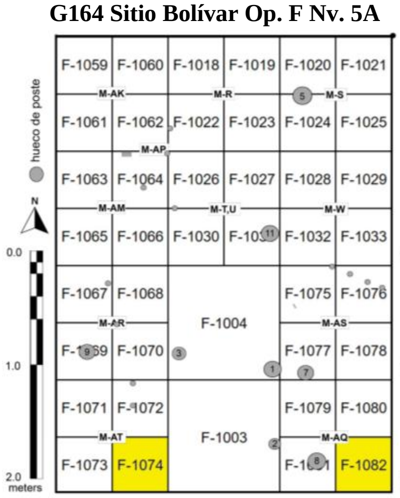
Radial View



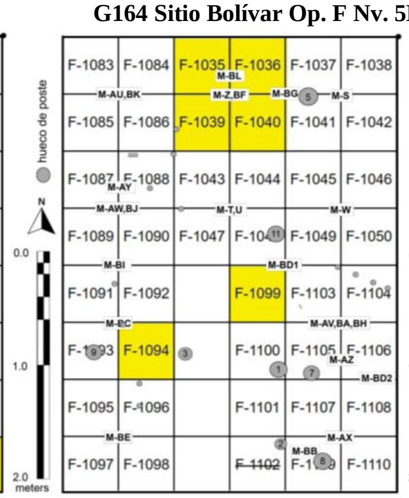
G164 Sitio Bolívar Op. F Nv. 4



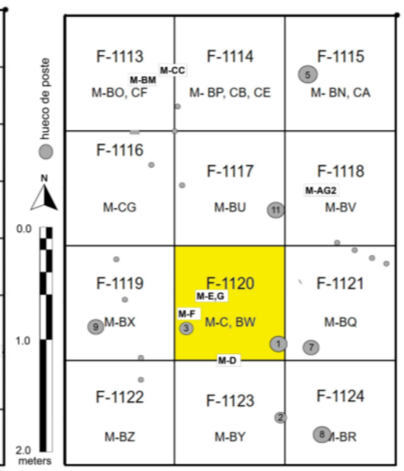
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

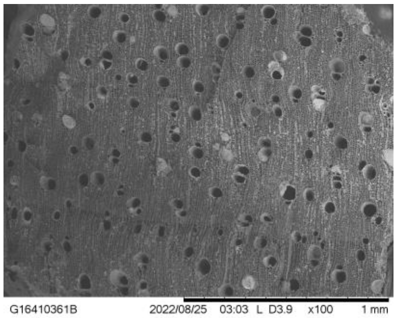


G164 Sitio Bolívar Op. F Nv. 5C

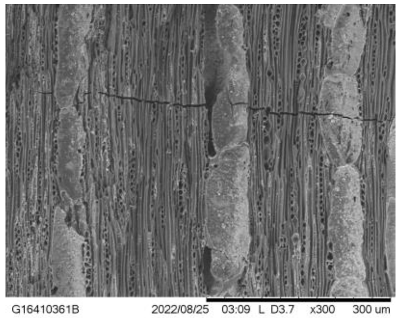


Scientific Name: ANACARDIACEAE *Campnosperma panamense* Standl.
Common Name: orey

Transverse View

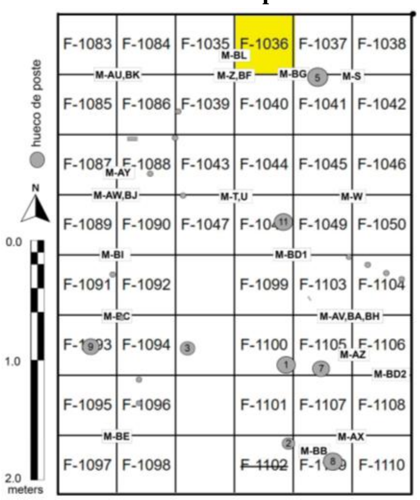


Tangential View

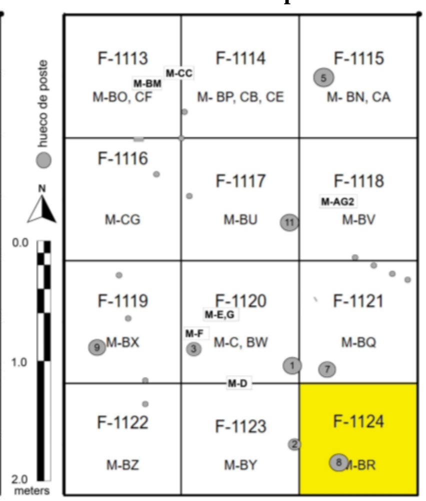


Radial View

G164 Sitio Bolívar Op. F Nv. 5B

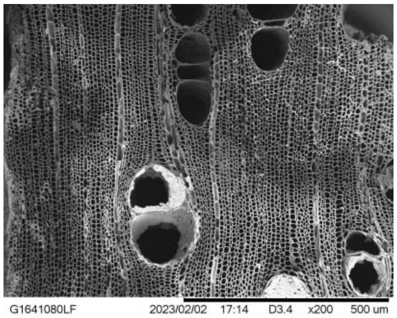


G164 Sitio Bolívar Op. F Nv. 5C

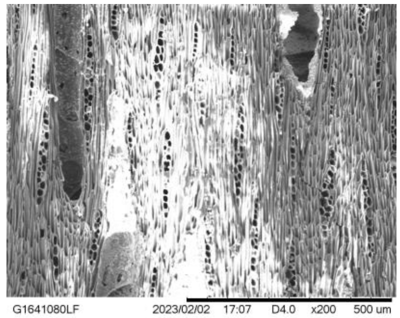


Scientific Name: ANACARDIACEAE *cf. Mosquitoxylum jamaicense* Krug & Urb.
Common Name: pasak'

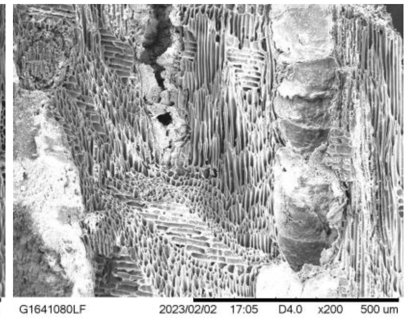
Transverse View



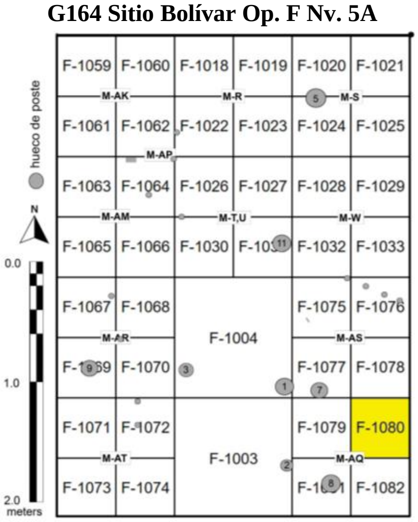
Tangential View



Radial View

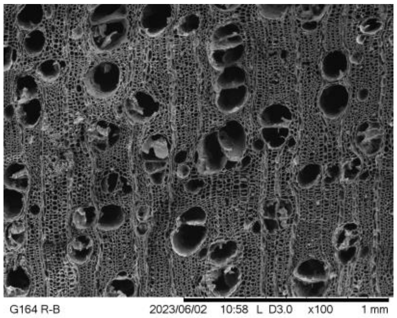


G164 Sitio Bolívar Op. F Nv. 5A

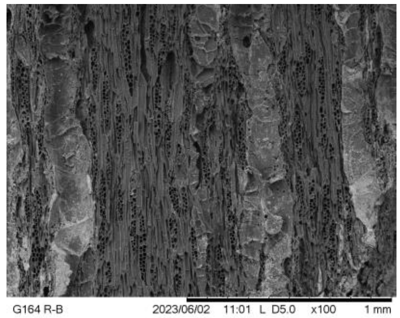


Scientific Name: ANACARDIACEAE *Spondias* sp.
Common Name: jocote, jobo, hogplum

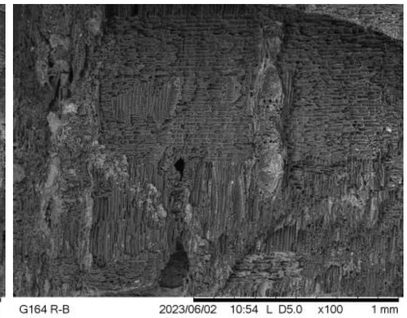
Transverse View



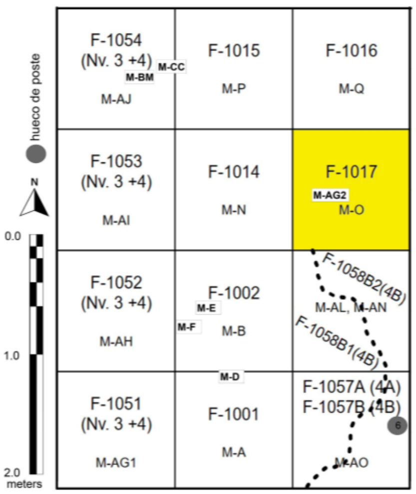
Tangential View



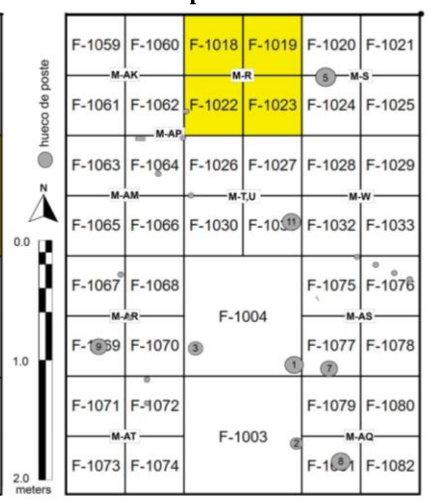
Radial View



G164 Sitio Bolívar Op. F Nv. 4

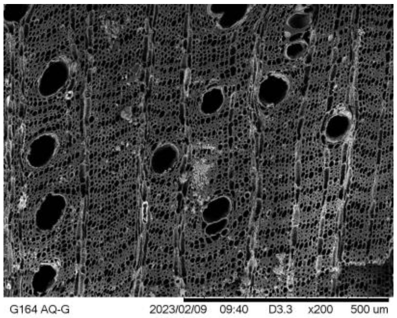


G164 Sitio Bolívar Op. F Nv. 5A

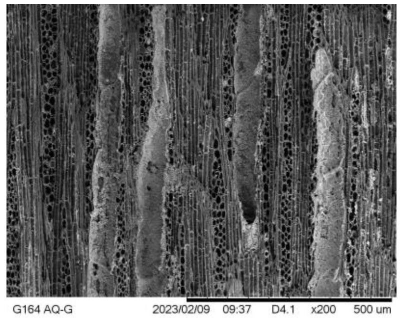


Scientific Name: ANNONACEAE *Annona* sp.
Common Name: cherimoya, soursop, toreta, canelo, anon, guanabana, pond apple

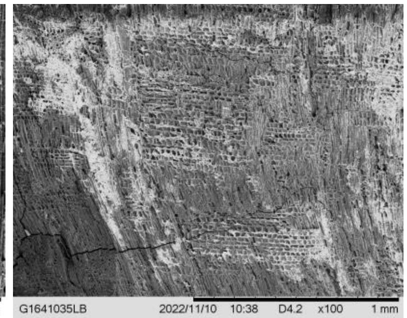
Transverse View



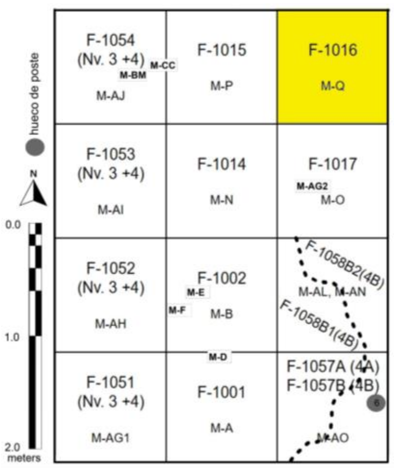
Tangential View



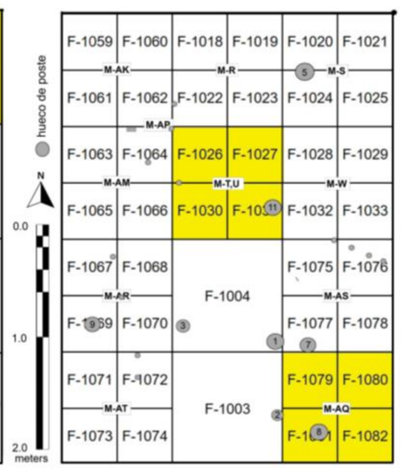
Radial View



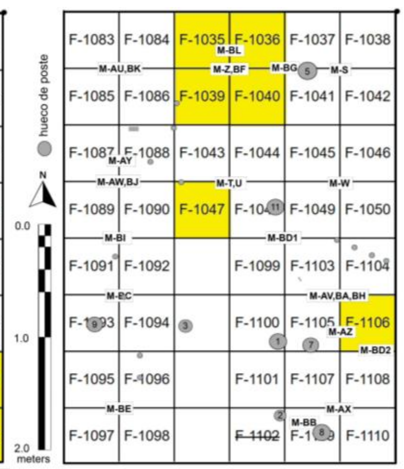
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

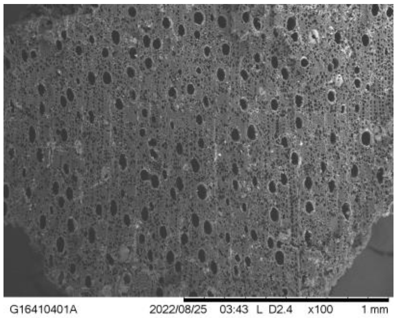


G164 Sitio Bolívar Op. F Nv. 5B

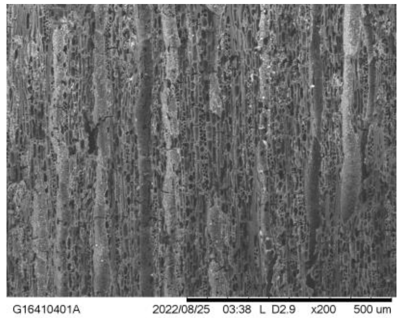


Scientific Name: APOCYNACEAE *Aspidosperma* sp.
Common Name: aracanga, alcarreto, volador

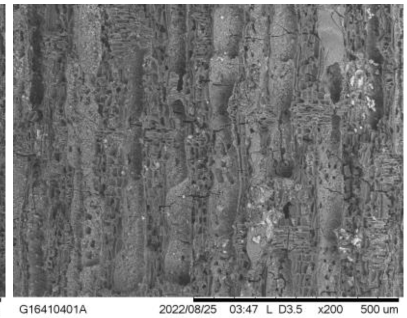
Transverse View



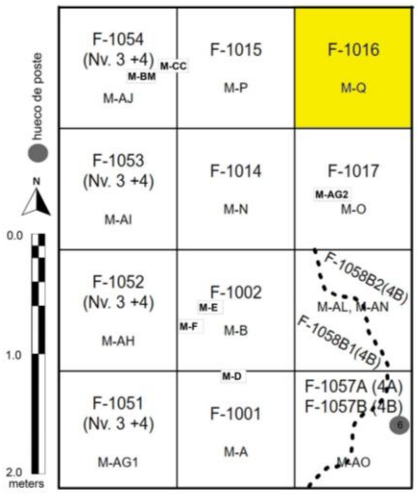
Tangential View



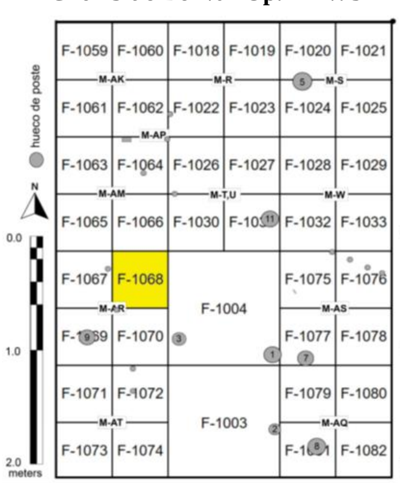
Radial View



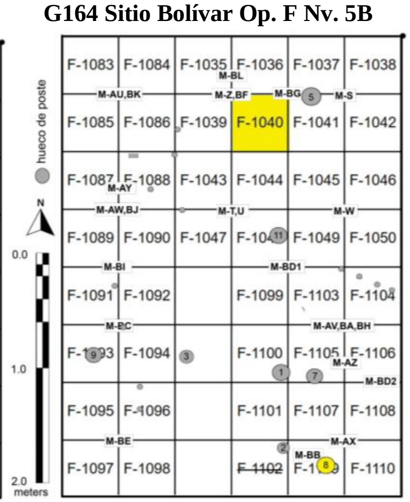
G164 Sitio Bolívar Op. F Nv. 4



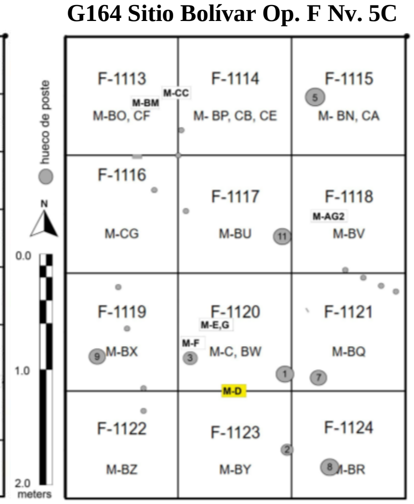
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

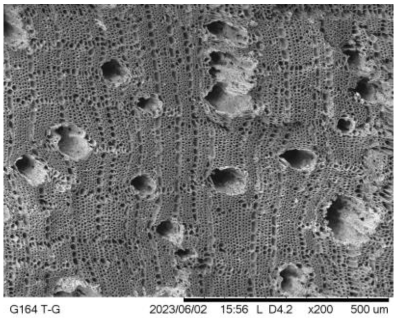


G164 Sitio Bolívar Op. F Nv. 5C

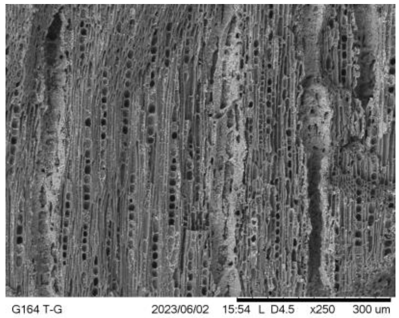


Scientific Name: APOCYNACEAE *Lacmellea* sp.
Common Name: leche de vaca, lagarto negro

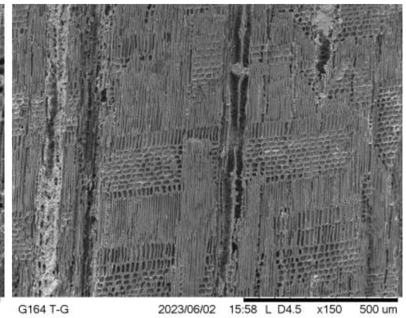
Transverse View



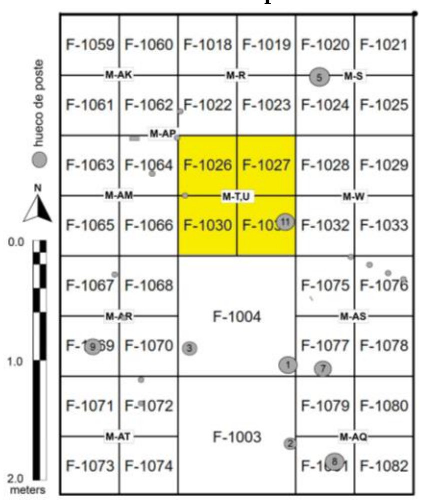
Tangential View



Radial View

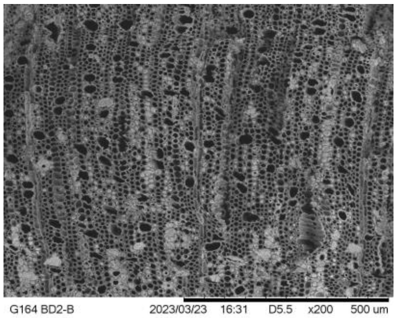


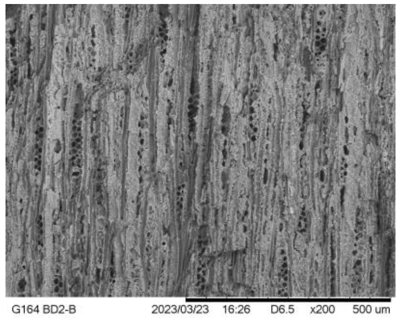
G164 Sitio Bolívar Op. F Nv. 5A



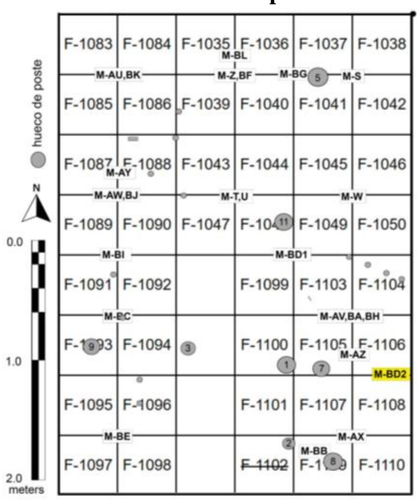
Scientific Name: APOCYNACEAE *Tabernaemontana* sp.
Common Name: milkwood

Transverse View	Tangential View	Radial View



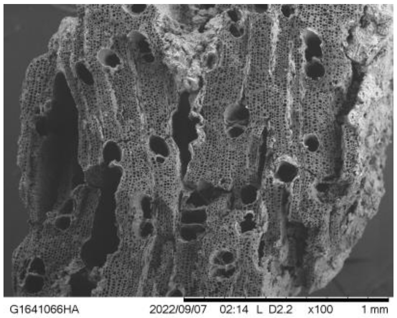


G164 Sitio Bolívar Op. F Nv. 5B



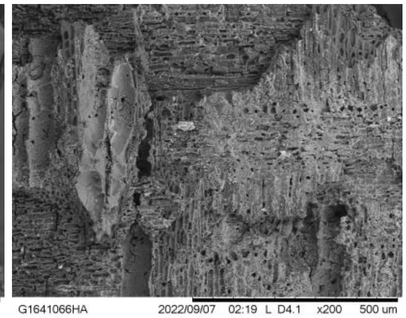
Scientific Name: ARALIACEAE cf. *Schefflera* sp.
Common Name: mangabé

Transverse View

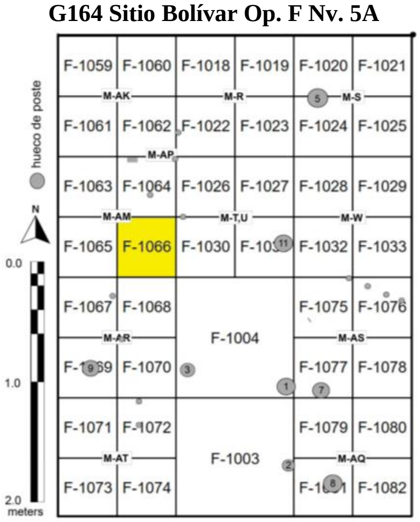


Tangential View

Radial View

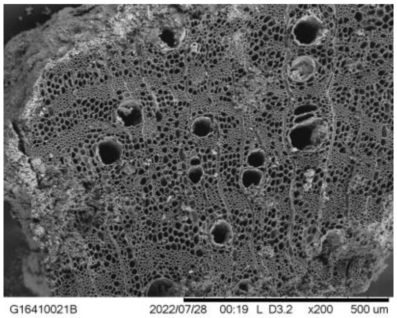


G164 Sitio Bolívar Op. F Nv. 5A

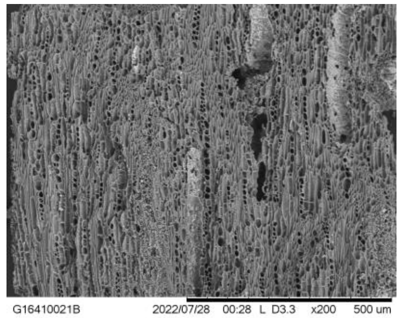


Scientific Name: BIGNONIACEAE *Crescentia cujete* Kunth.
Common Name: calabazo, totumo

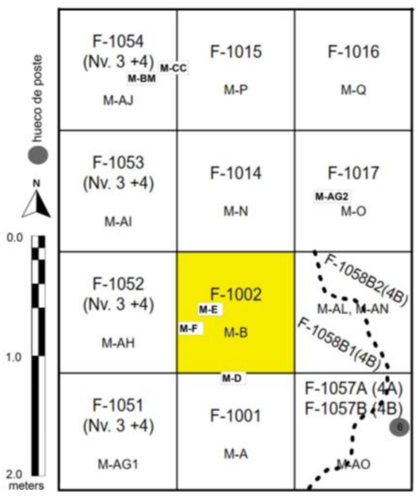
Transverse View



Tangential View

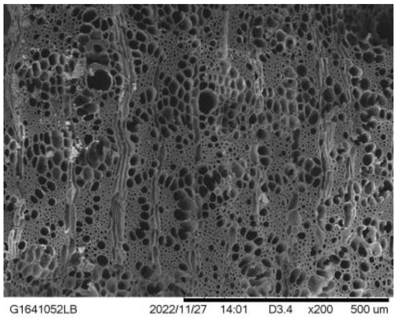


G164 Sitio Bolívar Op. F Nv. 4

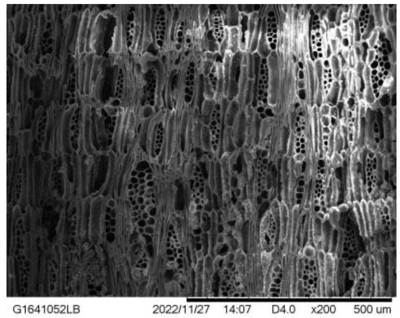


Scientific Name: BIGNONIACEAE *Handroanthus* sp.
Common Name: poui, pau d'arco, or ipê

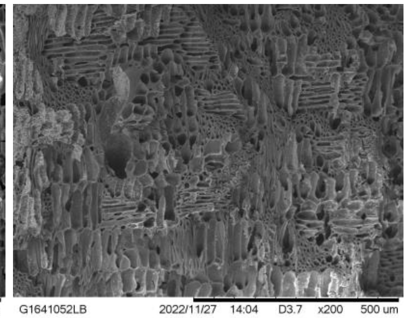
Transverse View



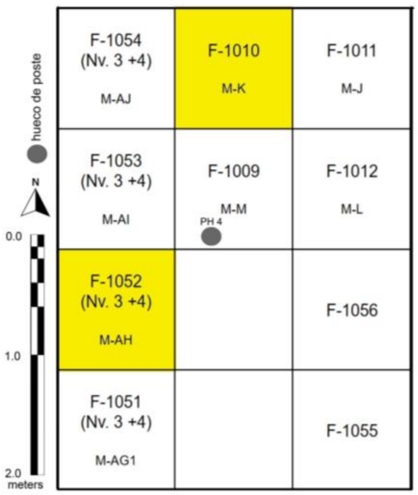
Tangential View



Radial View

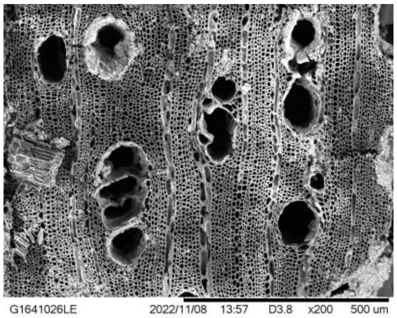


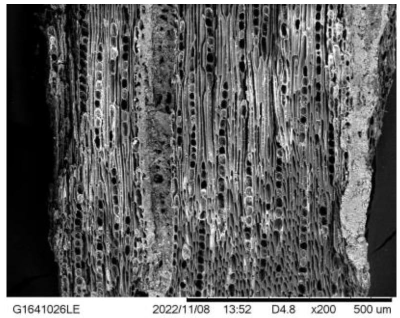
G164 Sitio Bolívar Op. F Nv. 3

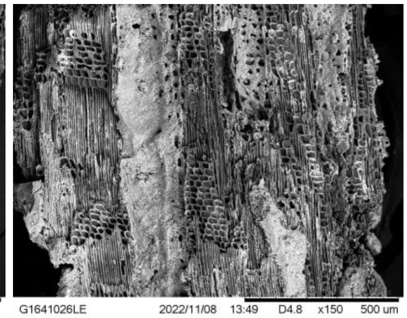


Scientific Name: BIGNONIACEAE *Jacaranda caucana* Pittier
Common Name: blue flamboyant, jacaranda

Transverse View | Tangential View | Radial View

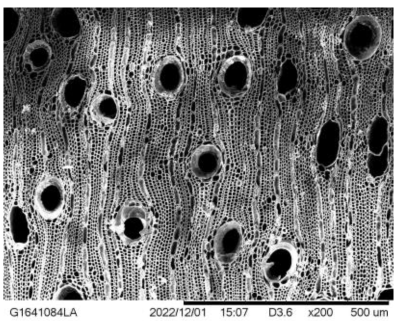


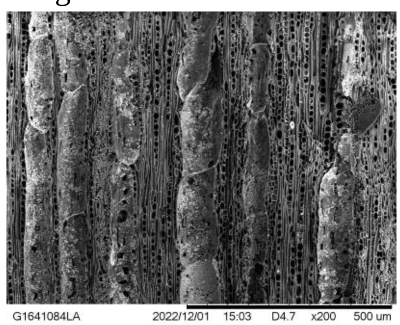


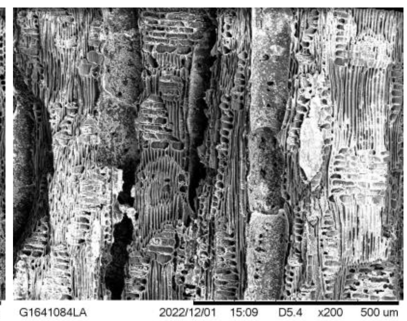


Scientific Name: BIGNONIACEAE *Jacaranda* sp.
Common Name: blue flamboyant, jacaranda

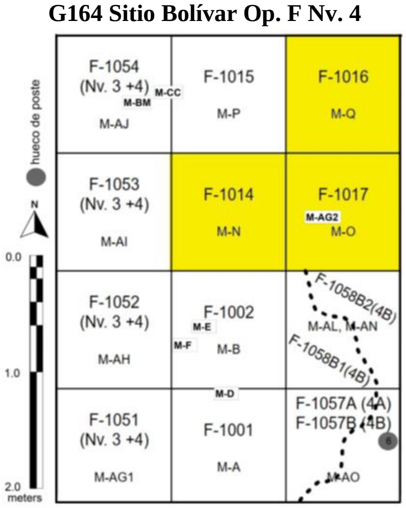
Transverse View | Tangential View | Radial View



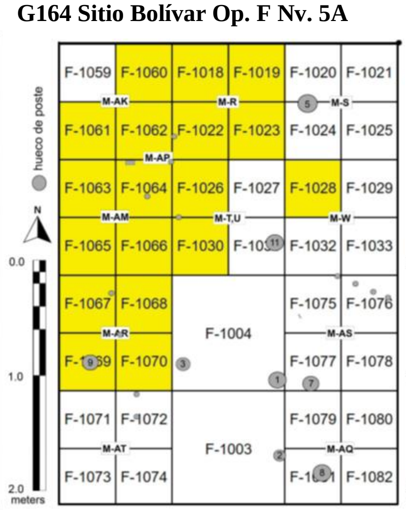




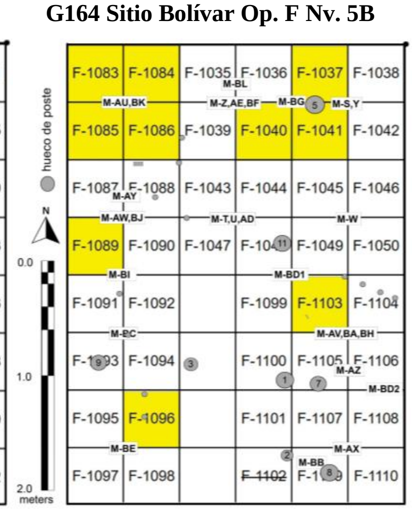
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

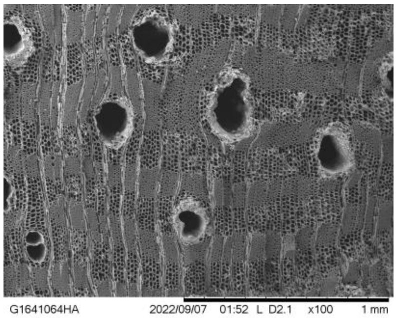


G164 Sitio Bolívar Op. F Nv. 5B



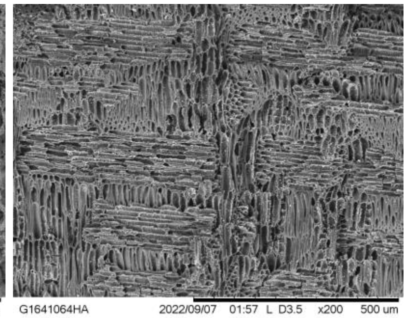
Scientific Name: BIGNONIACEAE *Tabebuia* sp.
Common Name: roble de sabana

Transverse View

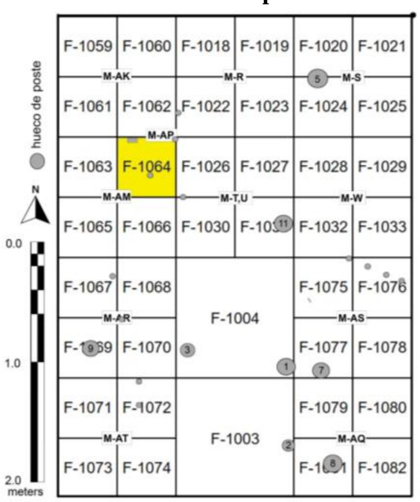


Tangential View

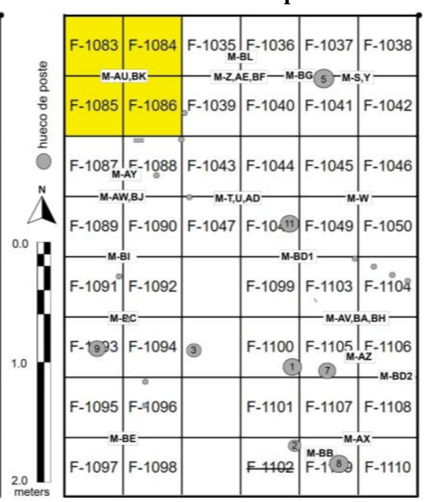
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

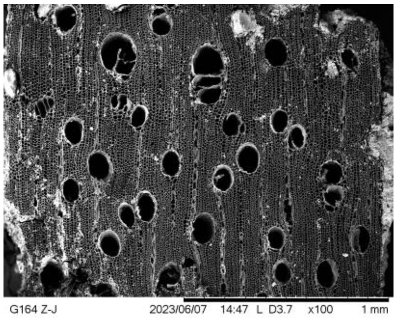


G164 Sitio Bolívar Op. F Nv. 5B

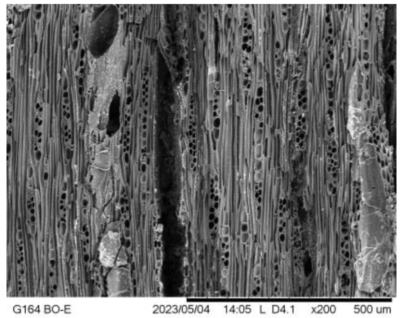


Scientific Name: BIXACEAE *Bixa* cf. *orellana* L.
Common Name: annatto, achiote

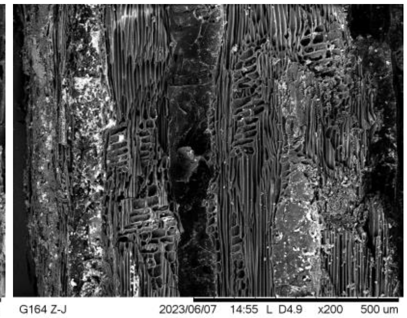
Transverse View



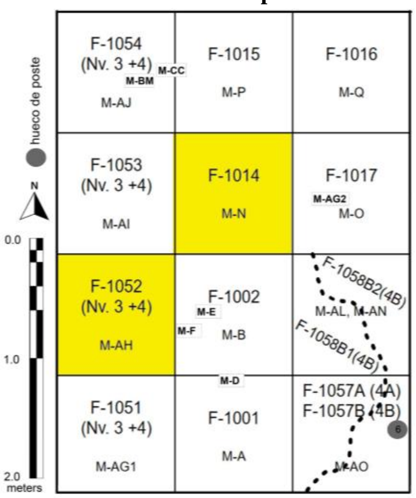
Tangential View



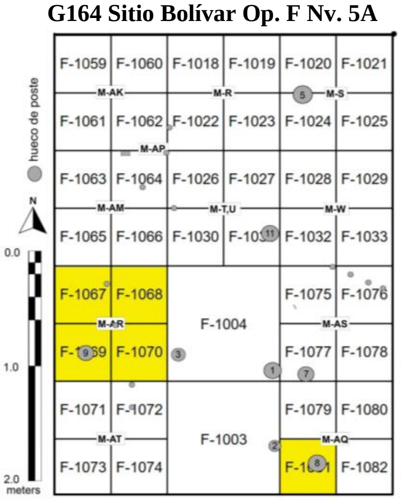
Radial View



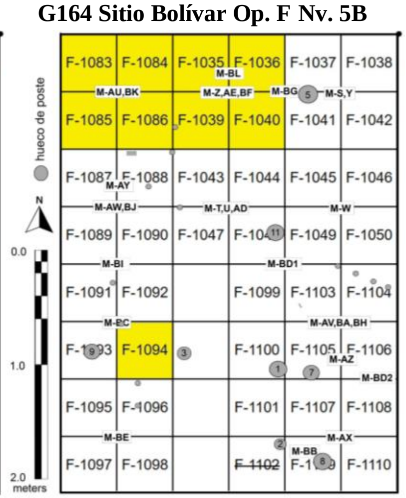
G164 Sitio Bolívar Op. F Nv. 4



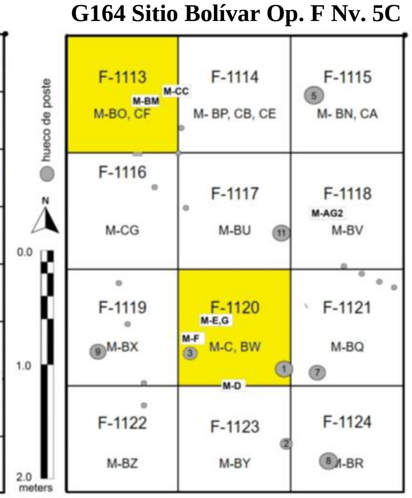
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

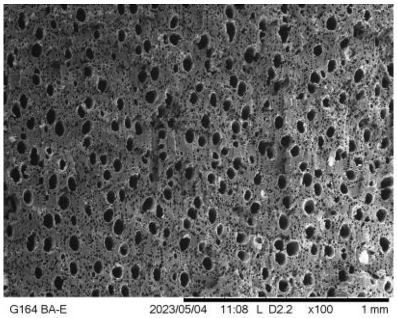


G164 Sitio Bolívar Op. F Nv. 5C

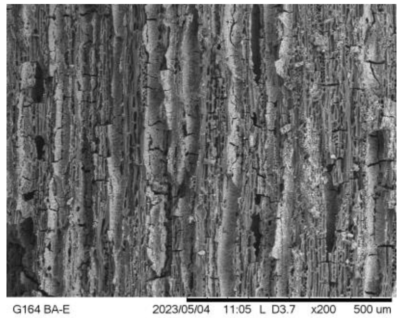


Scientific Name: BORAGINACEAE *Bourreria* sp.
Common Name: canalú

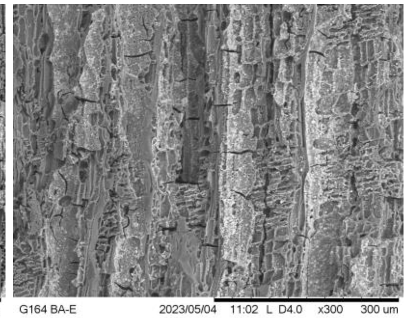
Transverse View



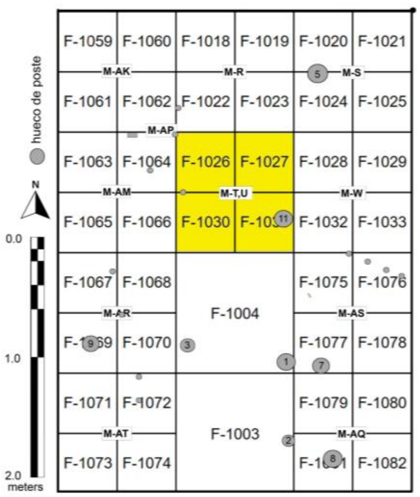
Tangential View



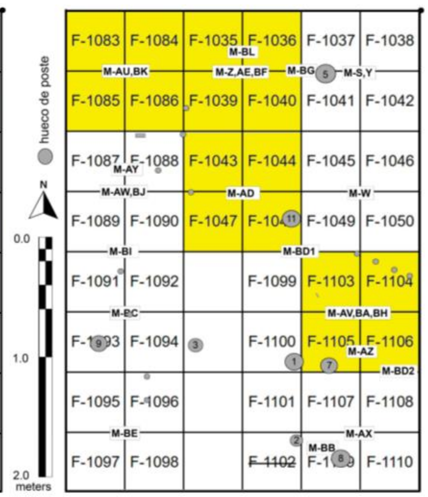
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

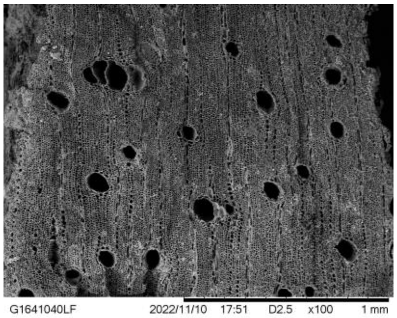


G164 Sitio Bolívar Op. F Nv. 5B

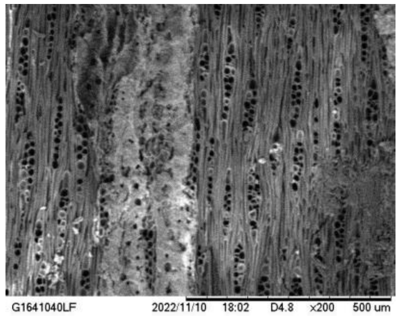


Scientific Name: BURSERACEAE *Tetragastris panamensis* (Engl.) Kuntze
Common Name: anime, cuatro estomagos, chutra, kerosin

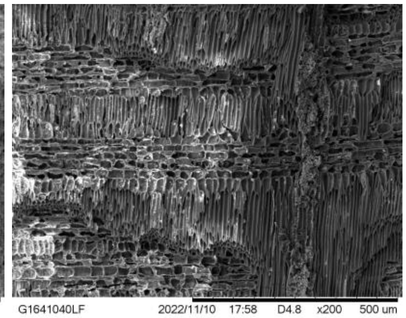
Transverse View



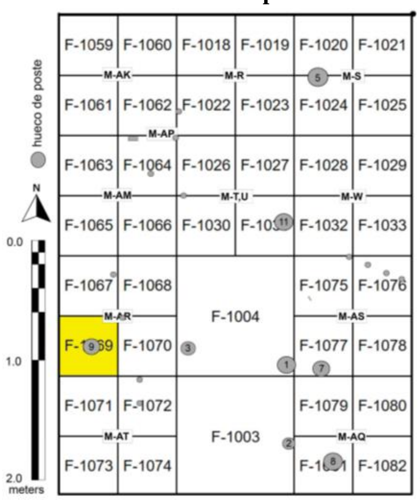
Tangential View



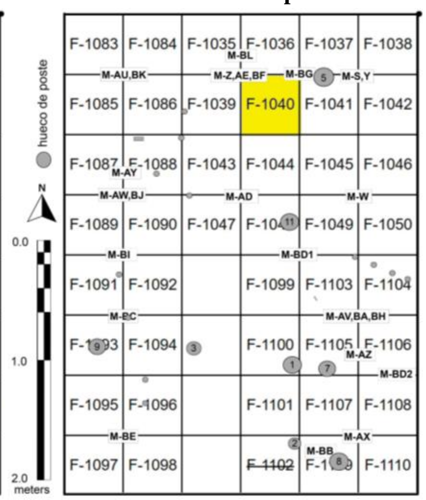
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

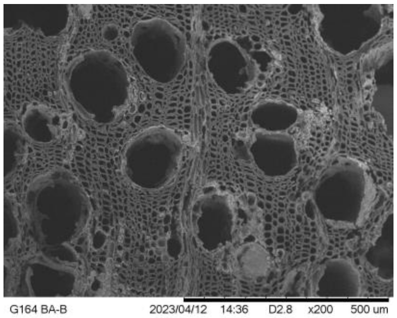


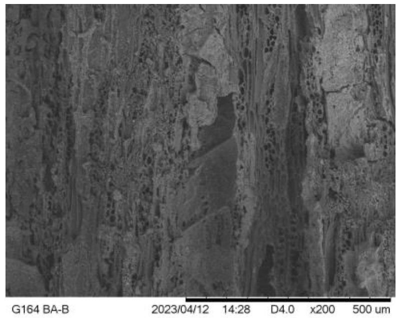
G164 Sitio Bolívar Op. F Nv. 5B

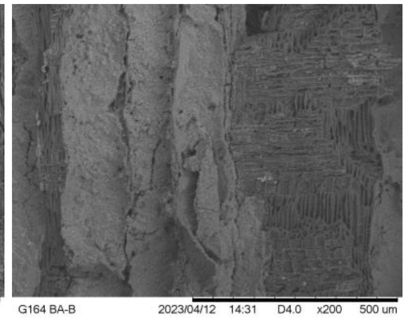


Scientific Name: BURSERACEAE cf. *Protium* sp.
Common Name: canalú

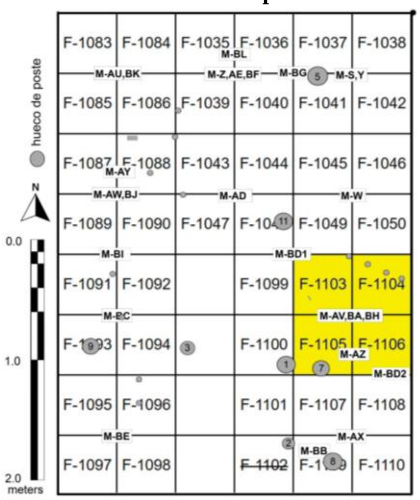
Transverse View | Tangential View | Radial View





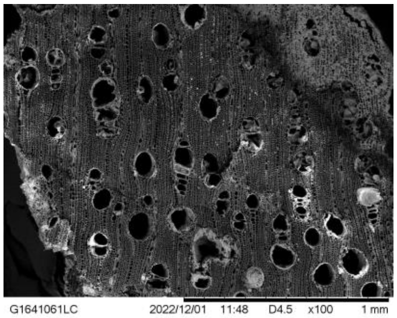


G164 Sitio Bolívar Op. F Nv. 5B

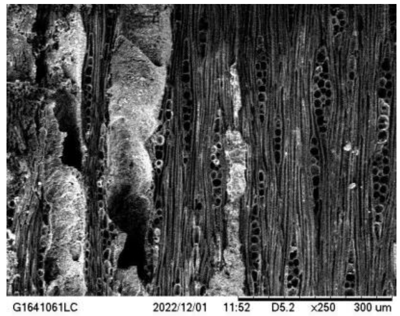


Scientific Name: CANNABACEAE *Trema* sp.
Common Name: jordancillo, capulin

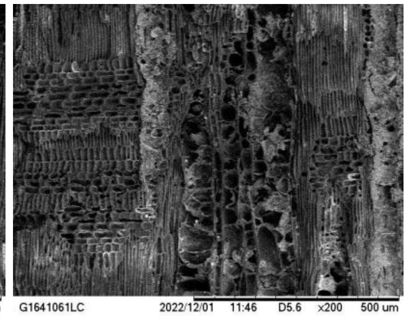
Transverse View



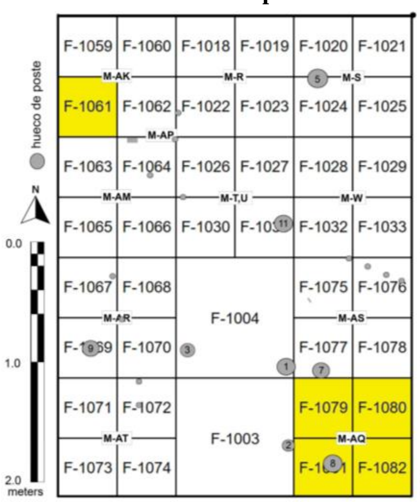
Tangential View



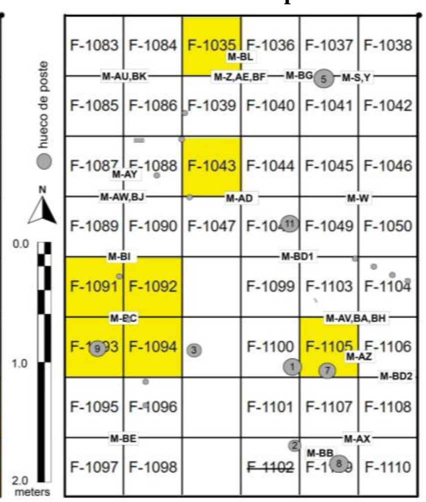
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

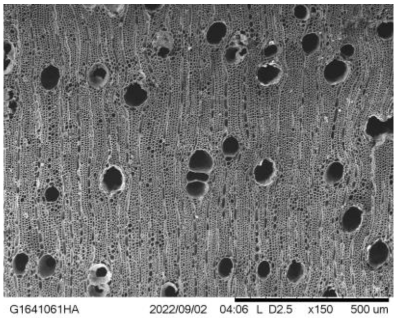


G164 Sitio Bolívar Op. F Nv. 5B

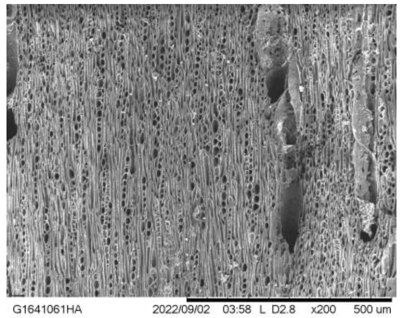


Scientific Name: CAPPARACEAE *Capparis* sp.
Common Name: caper bush, carne de venado, garrotillo

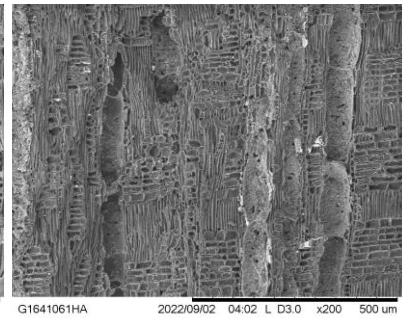
Transverse View



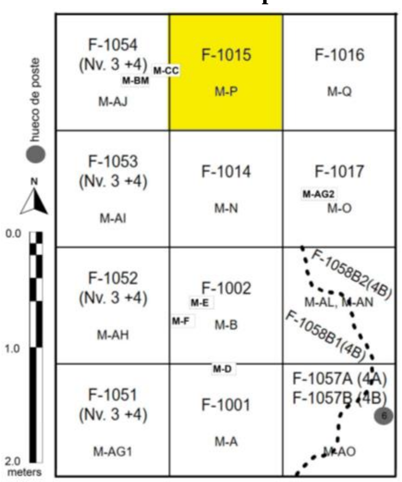
Tangential View



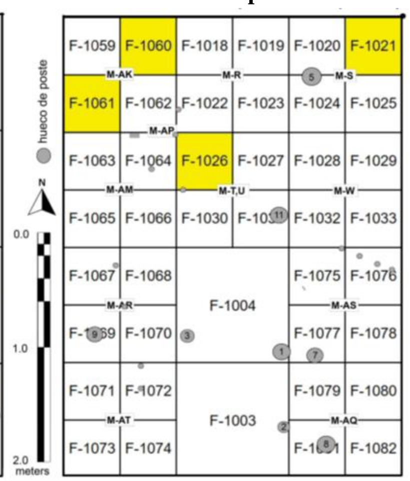
Radial View



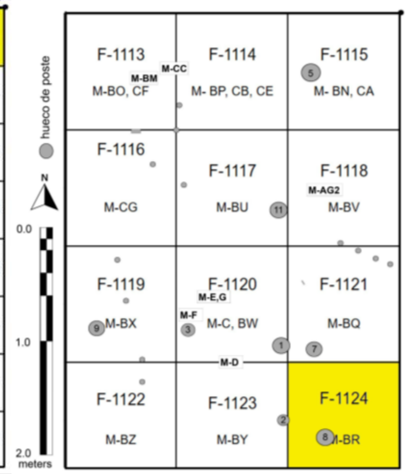
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

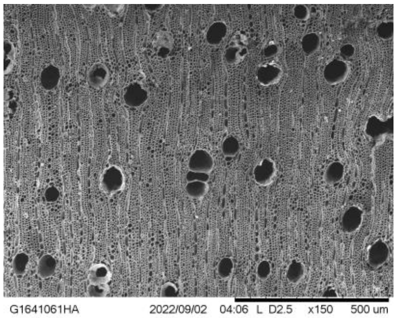


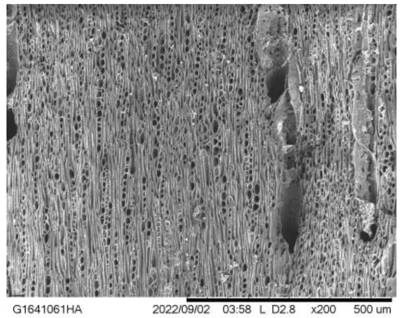
G164 Sitio Bolívar Op. F Nv. 5C

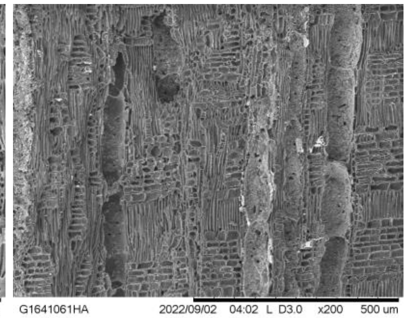


Scientific Name: CELASTRACEAE *Maytenus* sp.
Common Name: mayten

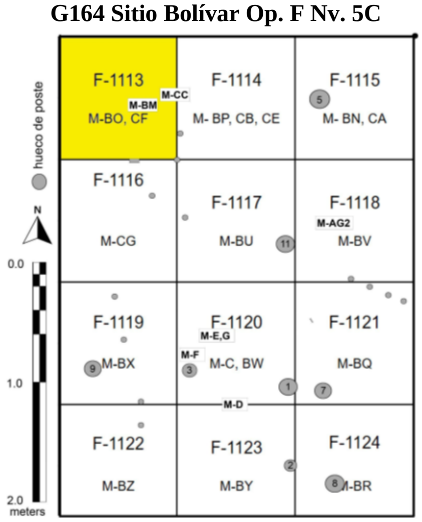
Transverse View | Tangential View | Radial View





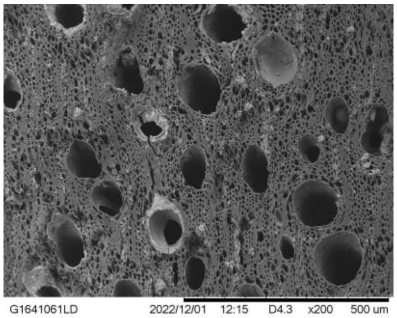


G164 Sitio Bolívar Op. F Nv. 5C

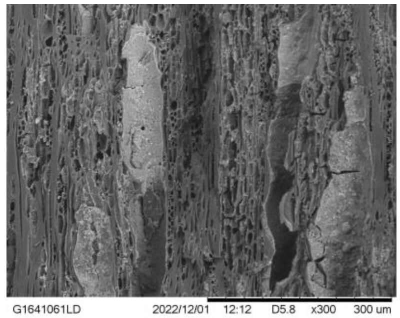


Scientific Name: CELASTRACEAE *Wimmeria* sp.
Common Name: no common name

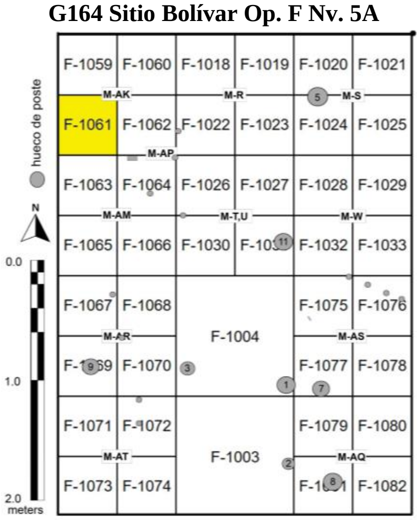
Transverse View



Tangential View

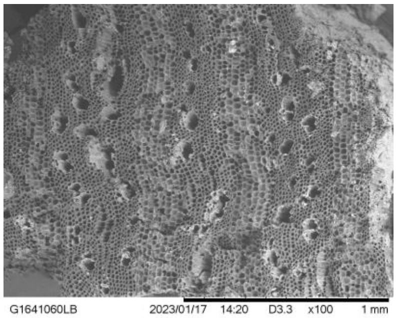


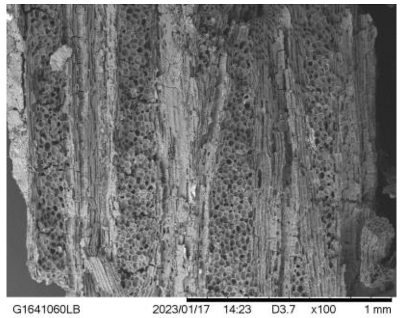
G164 Sitio Bolívar Op. F Nv. 5A

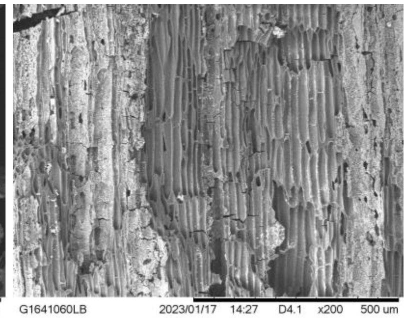


Scientific Name: CHLORANTHACEAE *Hedyosmum* sp.
Common Name: sauquillo, limoncillo

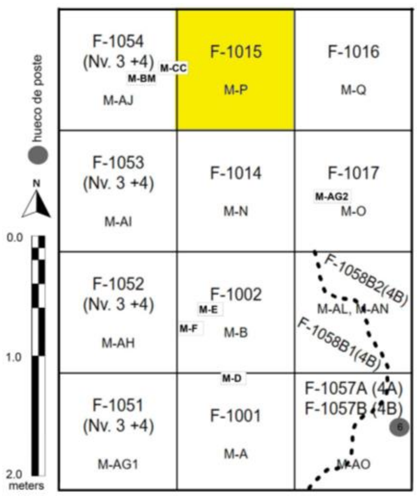
Transverse View | Tangential View | Radial View



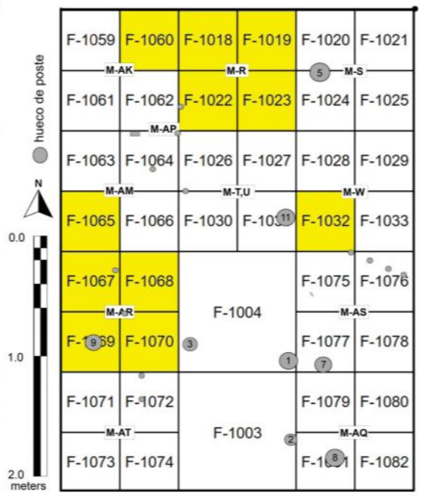




G164 Sitio Bolívar Op. F Nv. 4

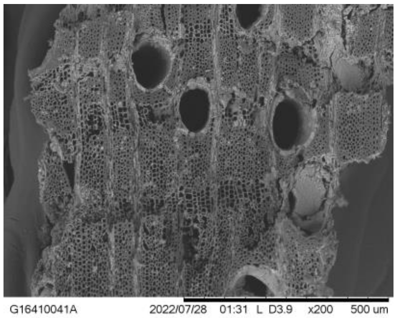


G164 Sitio Bolívar Op. F Nv. 5A

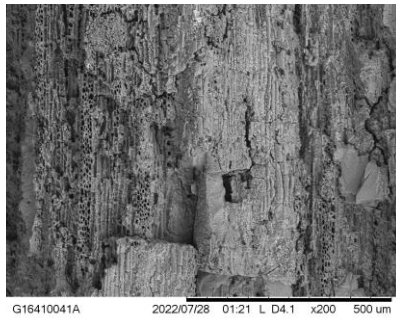


Scientific Name: CLUSIACEAE cf. *Symphonia globulifera* L. f.
Common Name: cerillo, cero, barillo

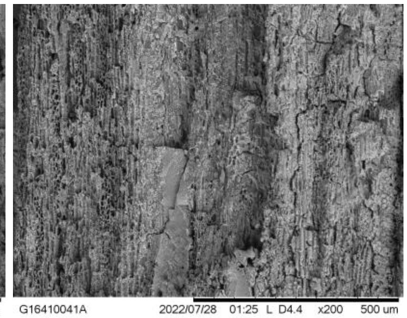
Transverse View



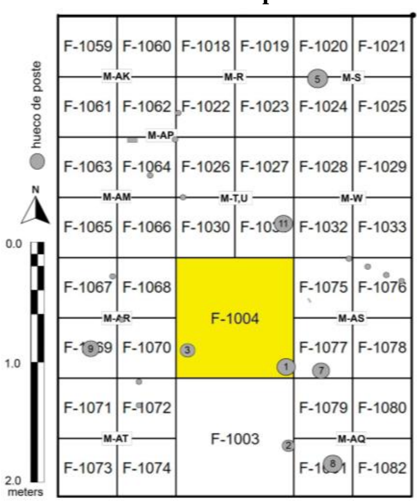
Tangential View



Radial View

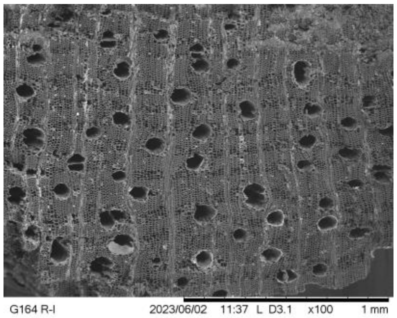


G164 Sitio Bolívar Op. F Nv. 5A

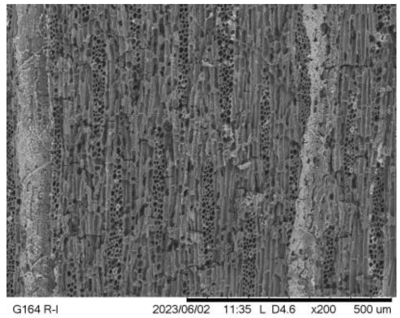


Scientific Name: CLUSIACEAE *Garcinia* sp.
Common Name: madroño, chaparrón, sastra, sastro

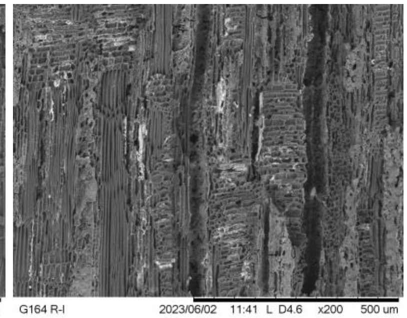
Transverse View



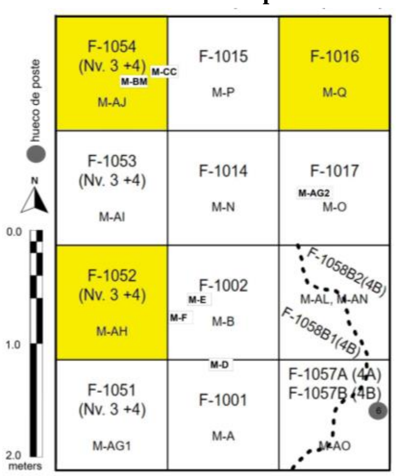
Tangential View



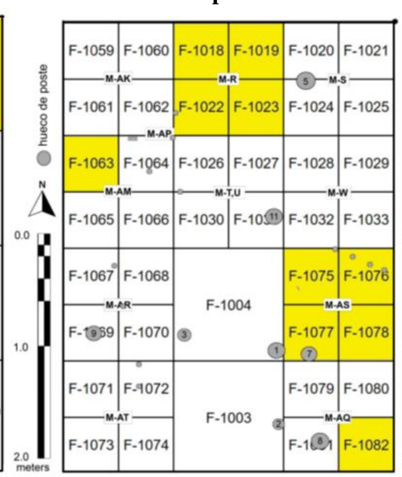
Radial View



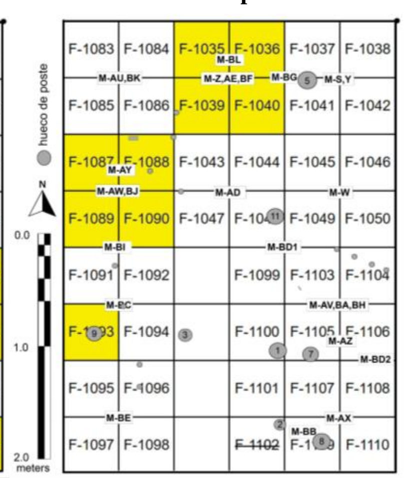
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

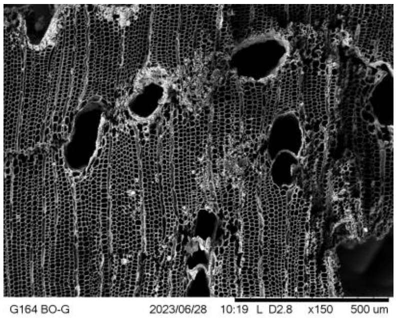


G164 Sitio Bolívar Op. F Nv. 5B



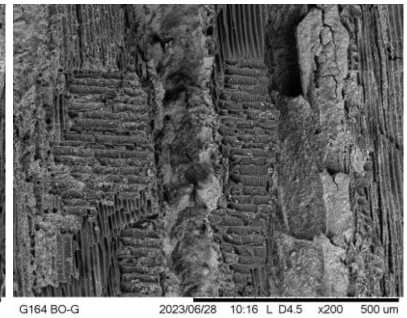
Scientific Name: COMBRETACEAE *Terminalia* cf. *amazonia* (J.F. Gmel.) Exell
Common Name: amarillo, roble amarillo, carabazuelo

Transverse View



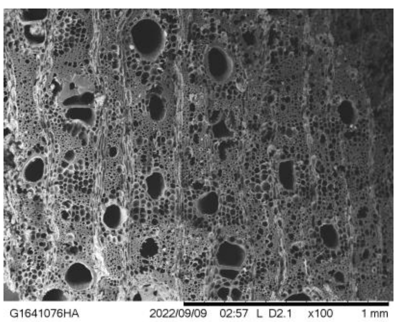
Tangential View

Radial View

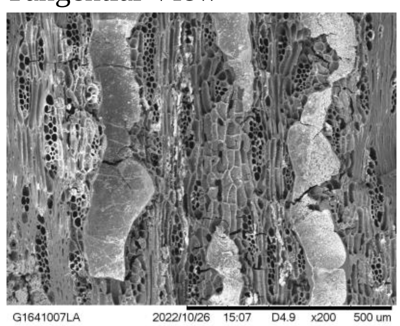


Scientific Name: COMBRETACEAE *Terminalia* cf. *buceras* (L.) C. Wright
Common Name: black olive

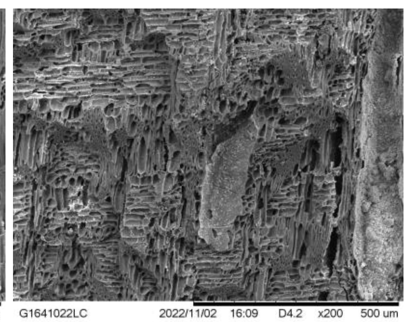
Transverse View



Tangential View

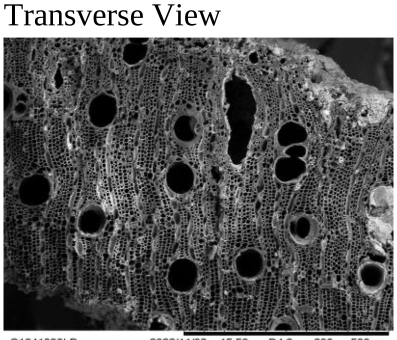


Radial View

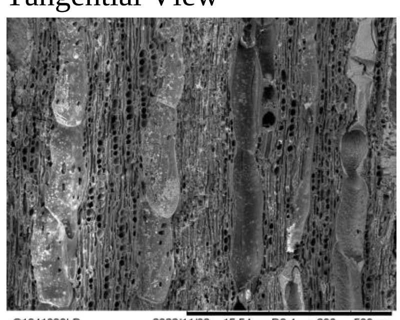


Scientific Name: COMBRETACEAE *Terminalia* cf, *oblonga* (Ruiz & Pav.) Steud.
Common Name: guayabo de montaña, guayabillo, guayabón

Transverse View



Tangential View



Radial View

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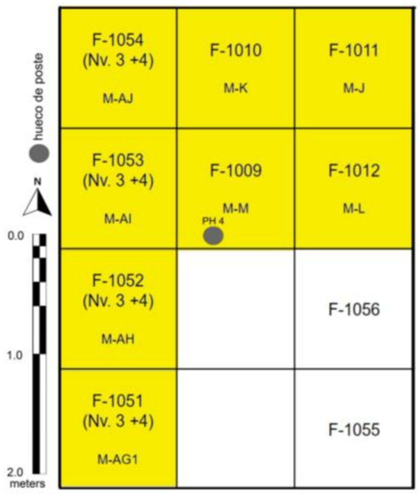
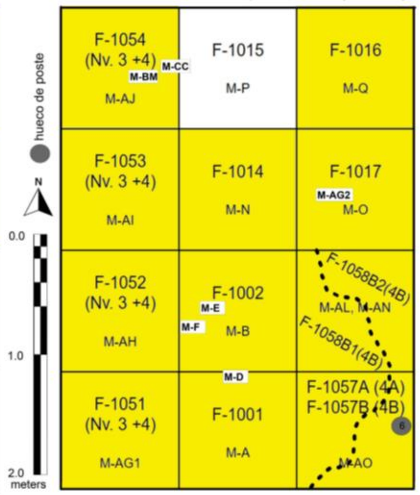
*All *Terminalia* spp. combined in maps

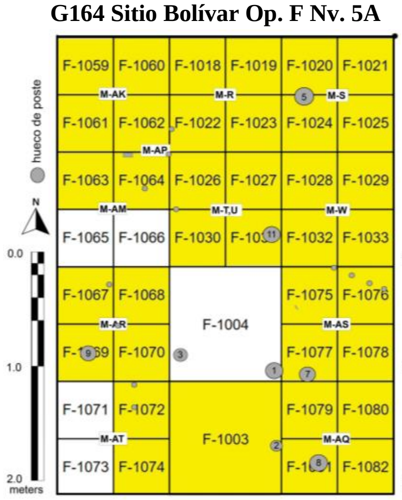
G164 Sitio Bolívar Op. F Nv. 3



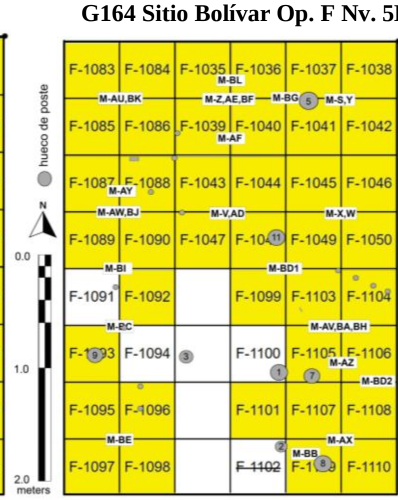
G164 Sitio Bolívar Op. F Nv. 4



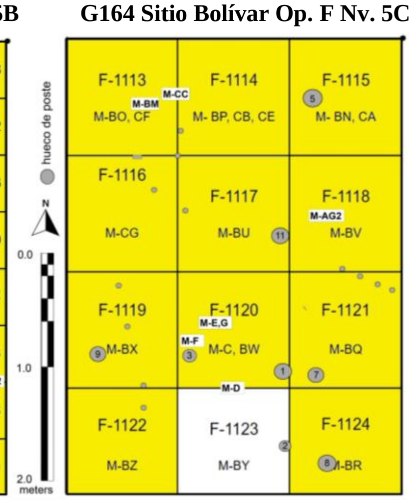
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

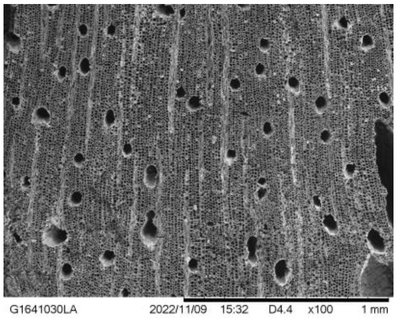


G164 Sitio Bolívar Op. F Nv. 5C

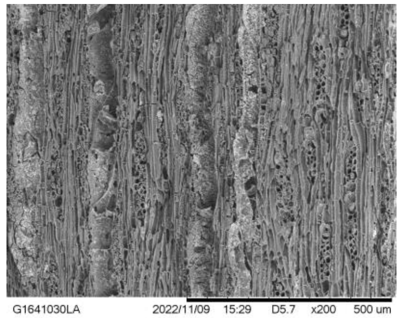


Scientific Name: CORNACEAE *Cornus* spp.
Common Name: lloró, mata hombro, dogwood

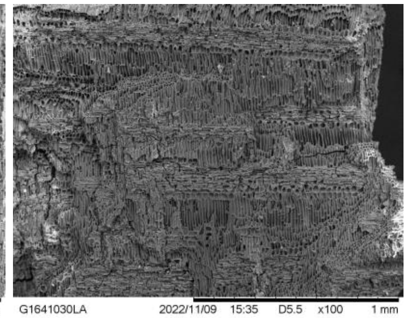
Transverse View



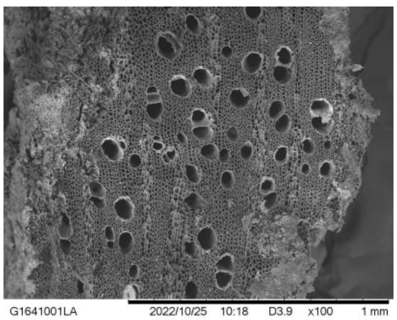
Tangential View



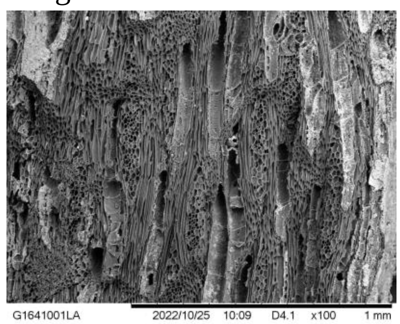
Radial View



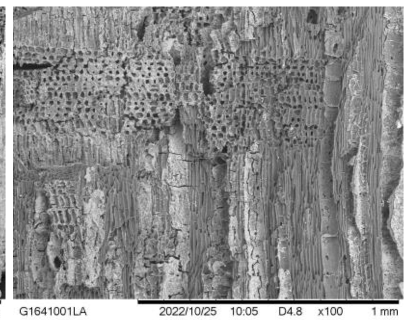
Transverse View



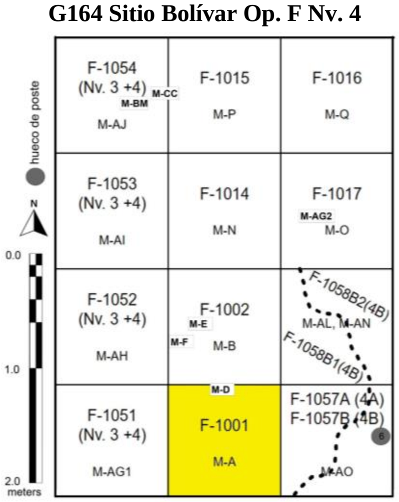
Tangential View



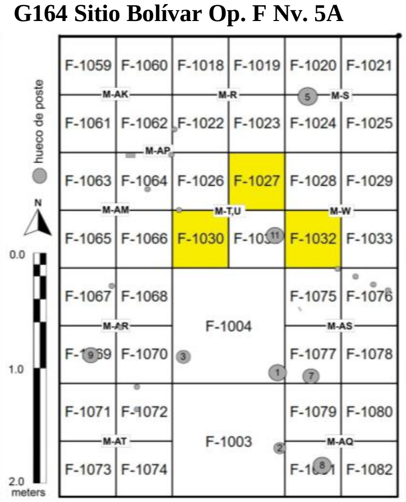
Radial View



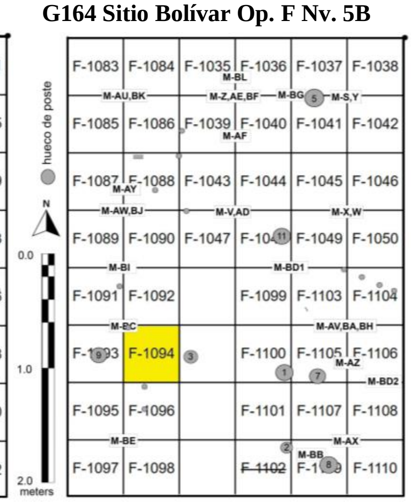
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

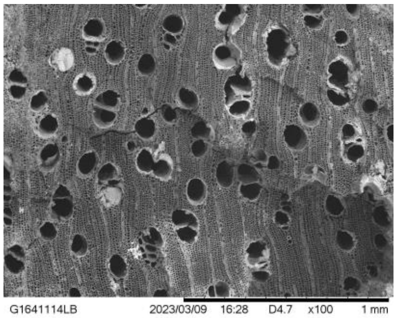


G164 Sitio Bolívar Op. F Nv. 5B

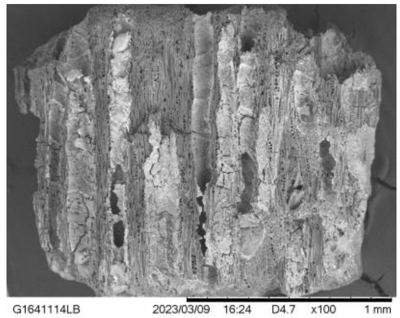


Scientific Name: EUPHORBIACEAE *Croton* sp.
Common Name: sangrillo, sangare, algodoncillo

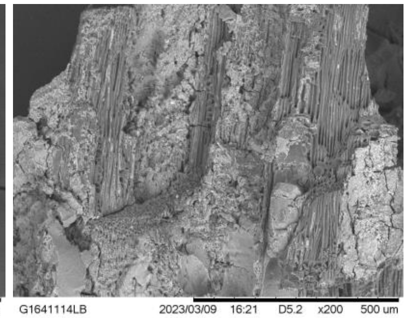
Transverse View



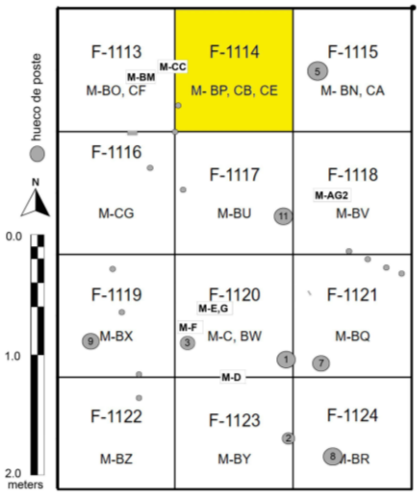
Tangential View



Radial View

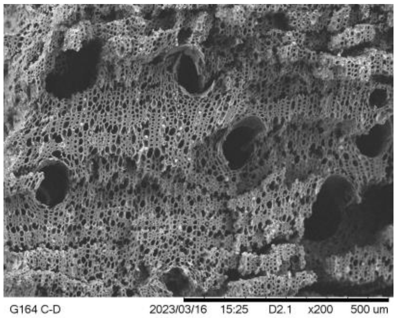


G164 Sitio Bolívar Op. F Nv. 5C

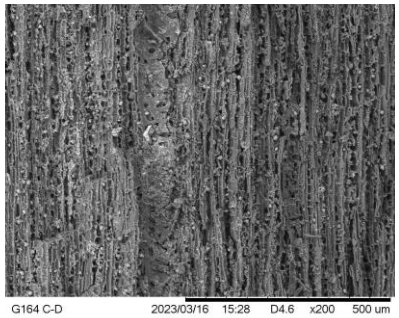


Scientific Name: EUPHORBIACEAE *Hura crepitans* L.
Common Name: nuno, tronador, havillo, ceibo, sandbox tree

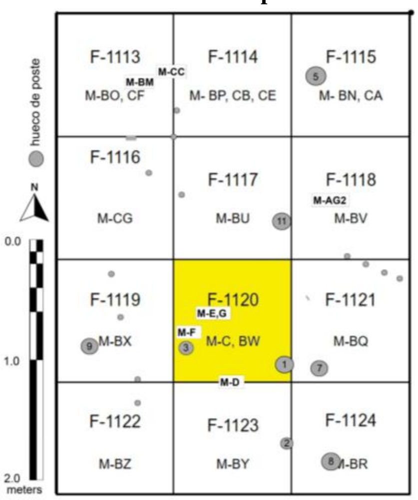
Transverse View



Tangential View

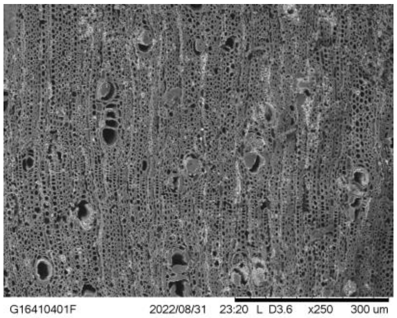


G164 Sitio Bolívar Op. F Nv. 5C

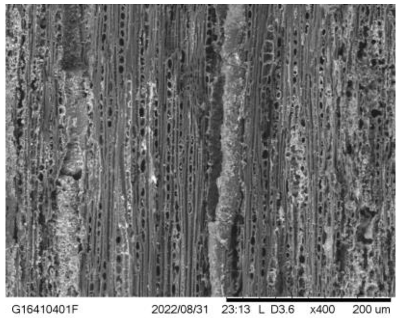


Scientific Name: EUPHORBIACEAE *Sebastiania* sp.
Common Name: milkwood

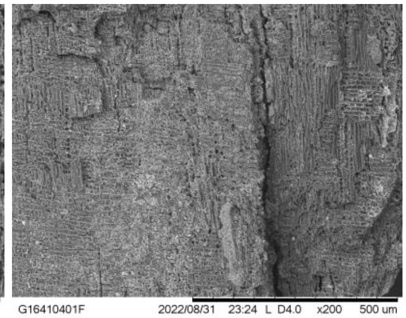
Transverse View



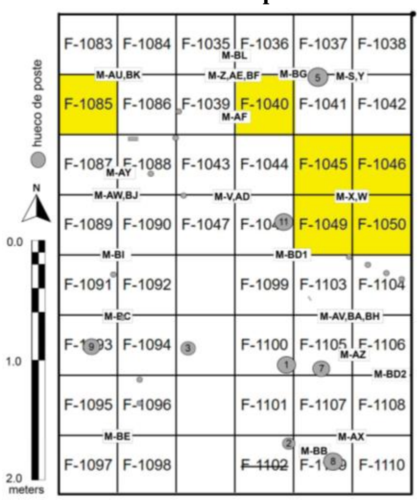
Tangential View



Radial View

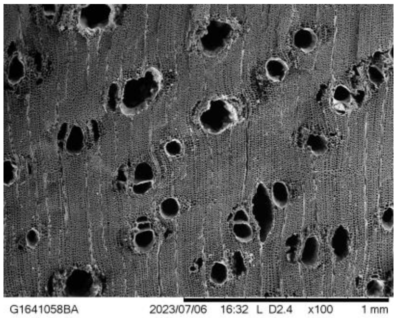


G164 Sitio Bolívar Op. F Nv. 5B

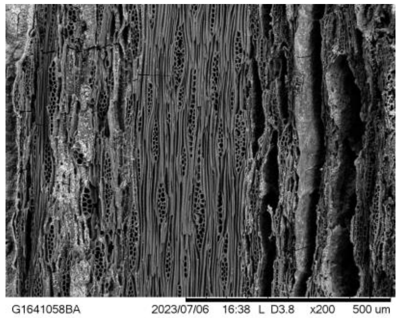


Scientific Name: FABACEAE *Acacia* sp.
Common Name: acacia

Transverse View

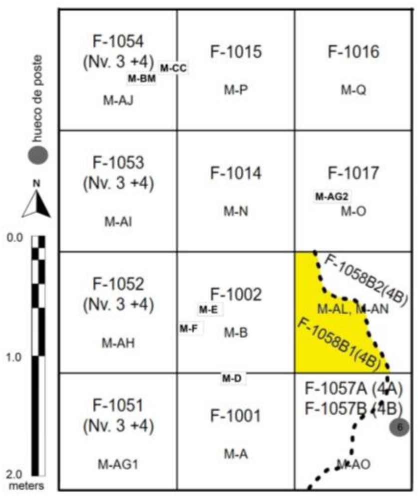


Tangential View



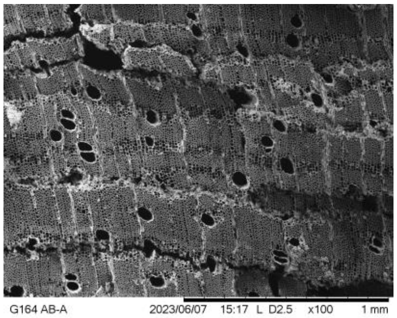
Radial View

G164 Sitio Bolívar Op. F Nv. 4

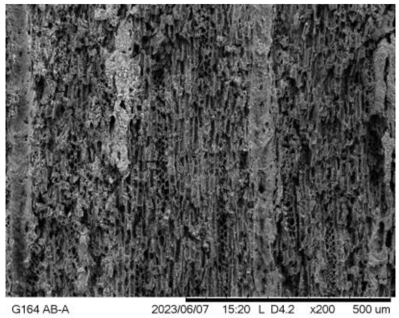


Scientific Name: FABACEAE *Calliandra* sp.
Common Name: gallito

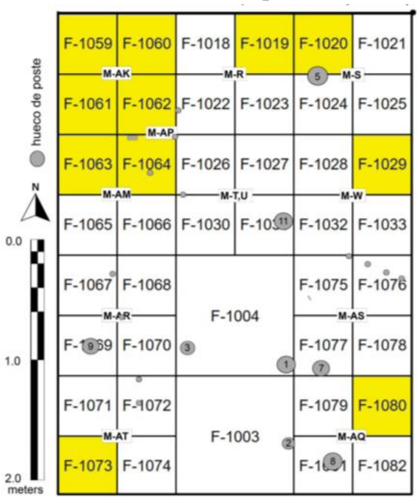
Transverse View



Tangential View

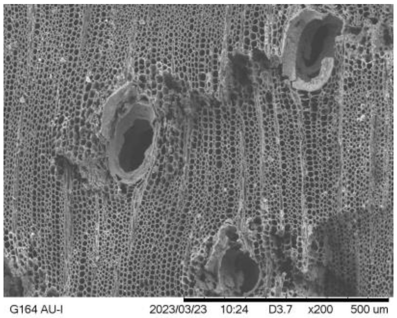


G164 Sitio Bolívar Op. F Nv. 5A

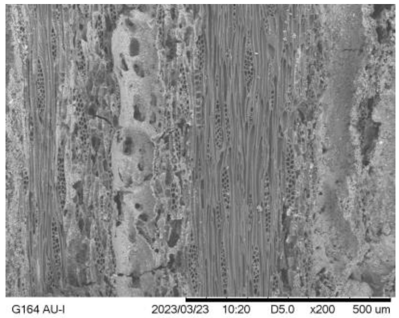


Scientific Name: FABACEAE *Cassia* sp.
Common Name: caña fistula

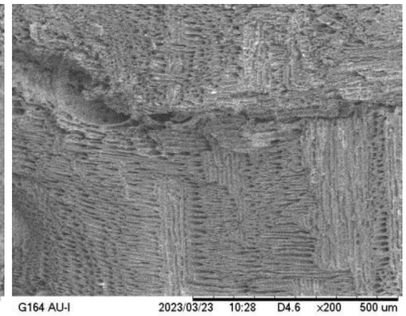
Transverse View



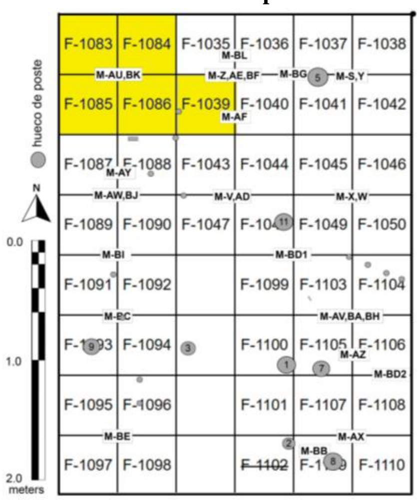
Tangential View



Radial View

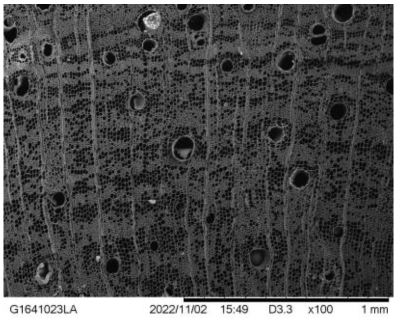


G164 Sitio Bolívar Op. F Nv. 5B

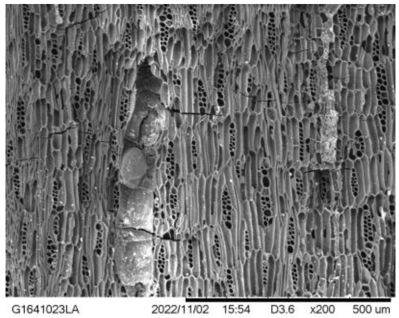


Scientific Name: FABACEAE *Diphysa robinioides* Benth.
Common Name: macano, cacique

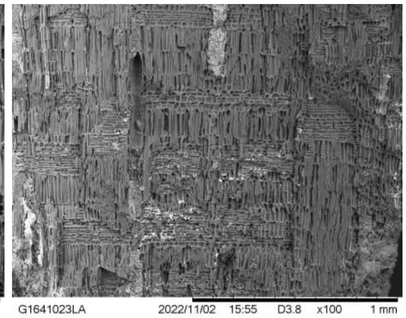
Transverse View



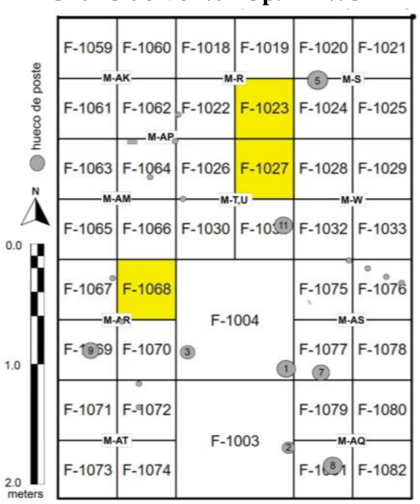
Tangential View



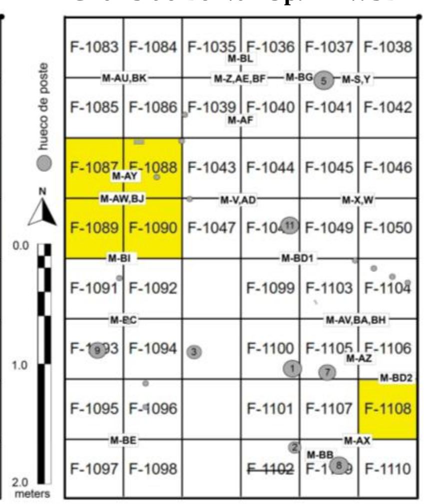
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

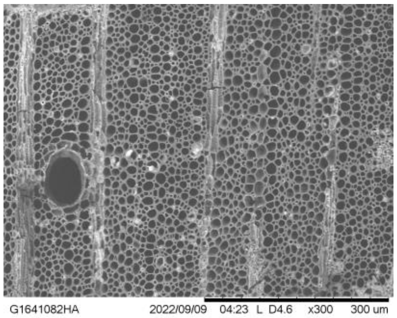


G164 Sitio Bolívar Op. F Nv. 5B

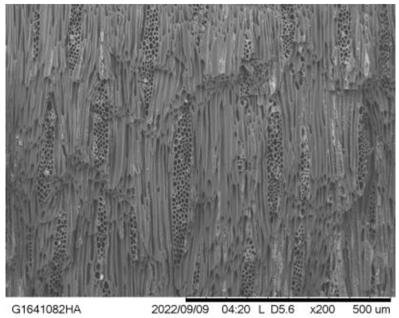


Scientific Name: FABACEAE *Hymenaea* sp.
Common Name: algarrobo, guapinol

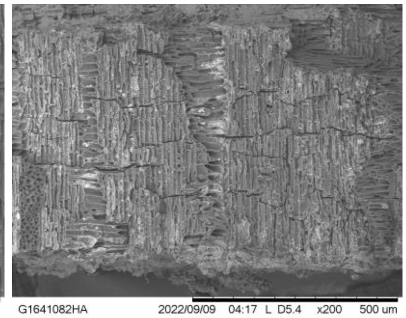
Transverse View



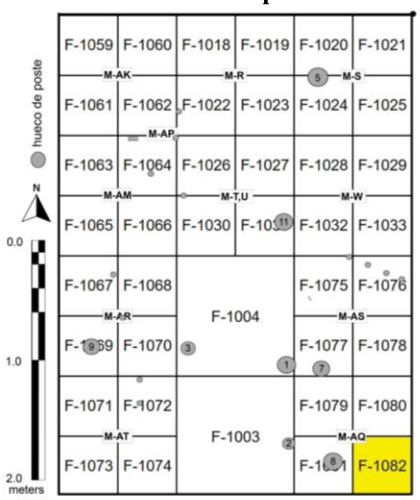
Tangential View



Radial View

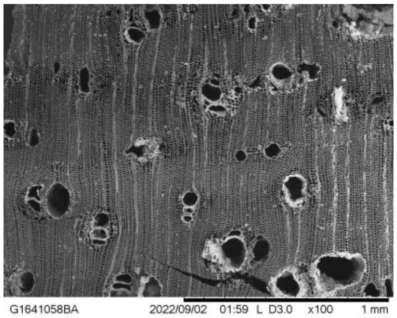


G164 Sitio Bolívar Op. F Nv. 5A



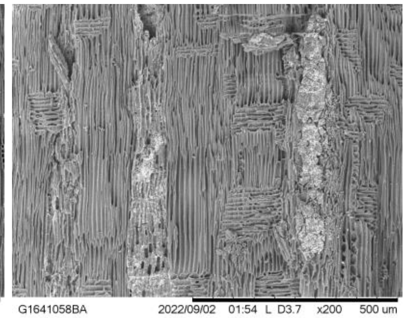
Scientific Name: FABACEAE *Inga* sp.
Common Name: guama, guaba, guabito, paterna, ice cream bean

Transverse View

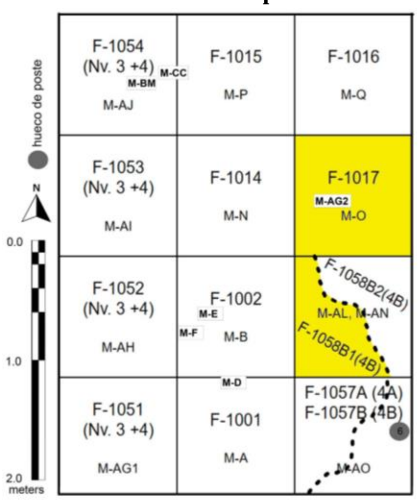


Tangential View

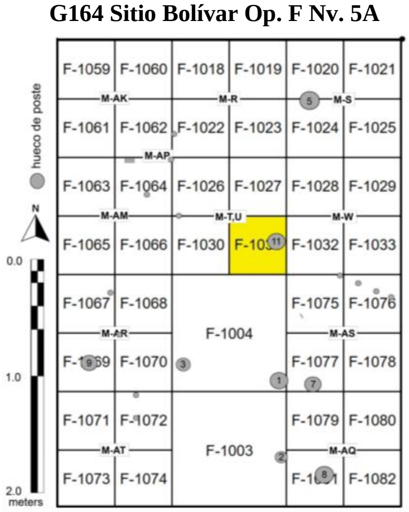
Radial View



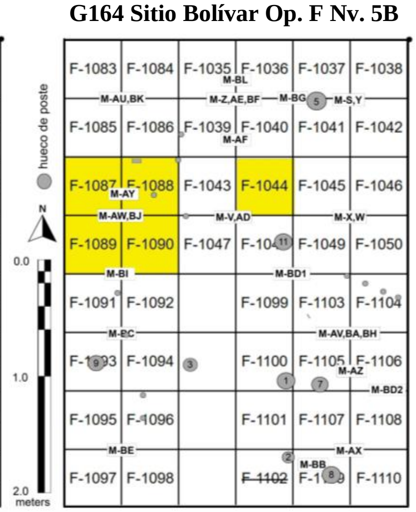
G164 Sitio Bolívar Op. F Nv. 4



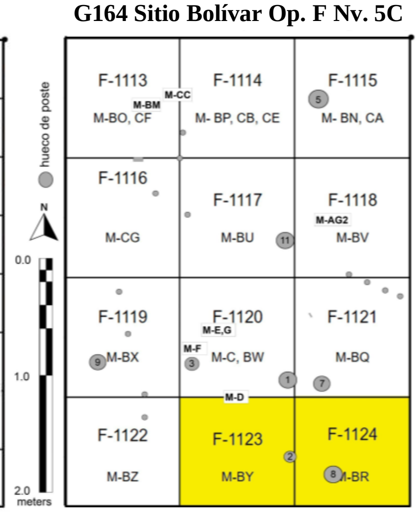
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

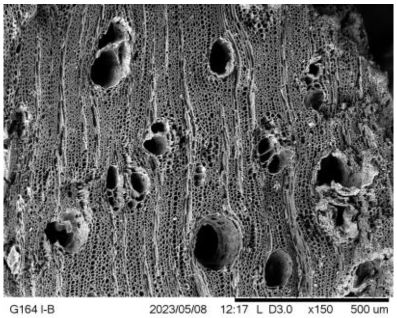


G164 Sitio Bolívar Op. F Nv. 5C

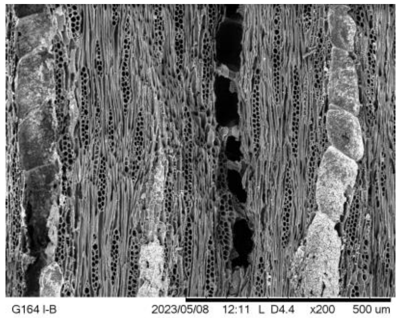


Scientific Name: FABACEAE *Parkinsonia aculeata* L.
Common Name: árbol sarigua, palo verde

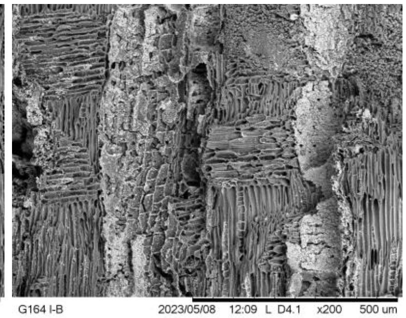
Transverse View



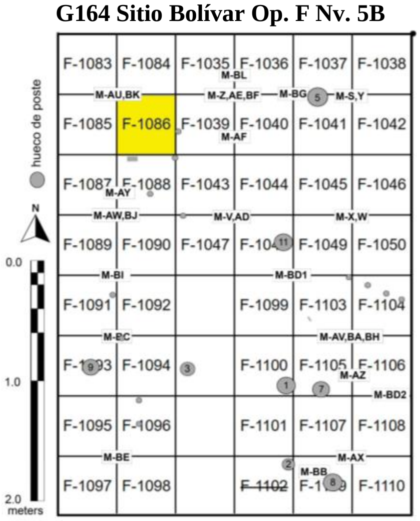
Tangential View



Radial View

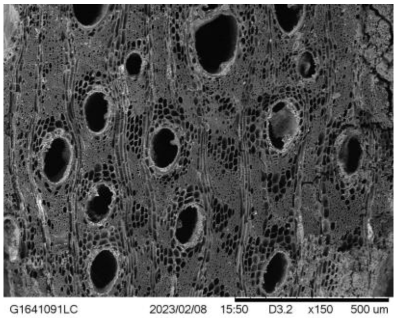


G164 Sitio Bolívar Op. F Nv. 5B

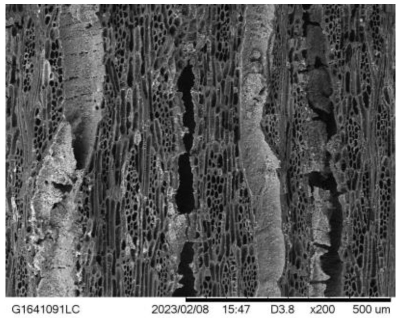


Scientific Name: FABACEAE *Peltogyne* sp.
Common Name: amaranto

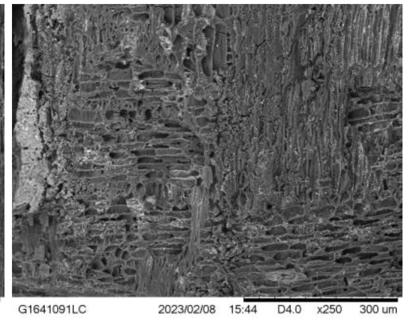
Transverse View



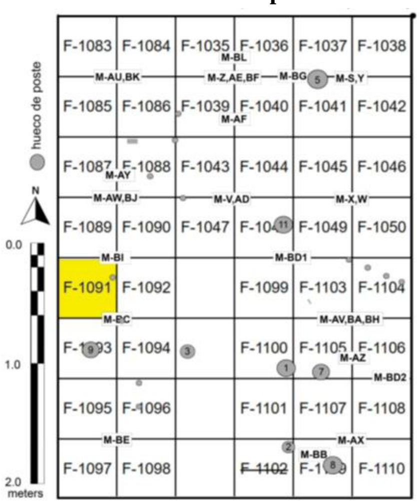
Tangential View



Radial View

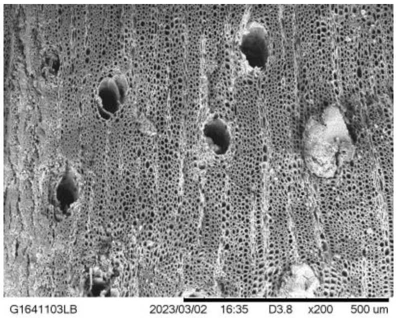


G164 Sitio Bolívar Op. F Nv. 5B

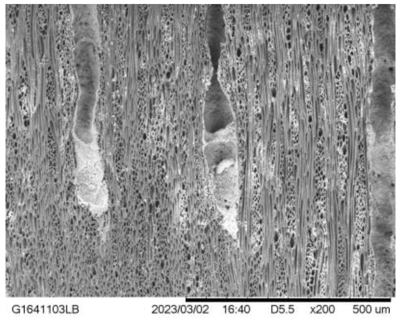


Scientific Name: FABACEAE *Prioria copaifera* Griseb.
Common Name: cativo

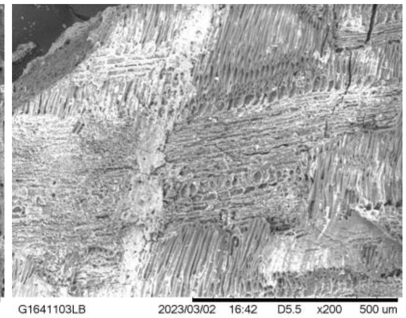
Transverse View



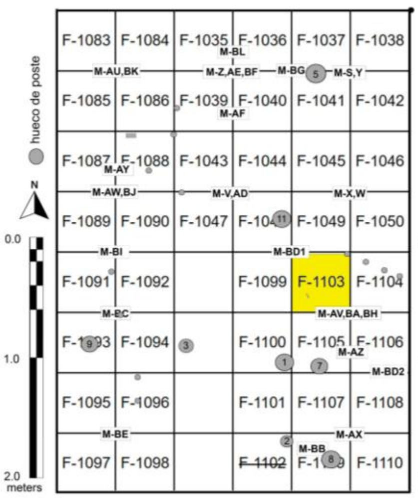
Tangential View



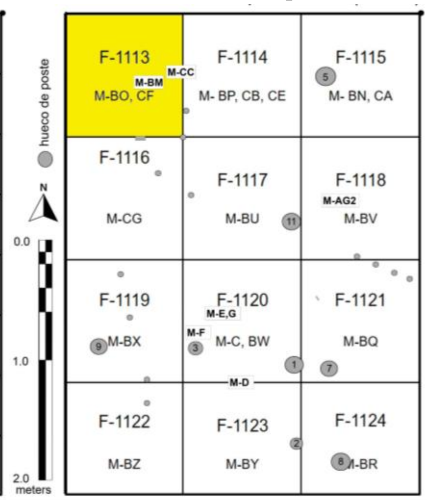
Radial View



G164 Sitio Bolívar Op. F Nv. 5B

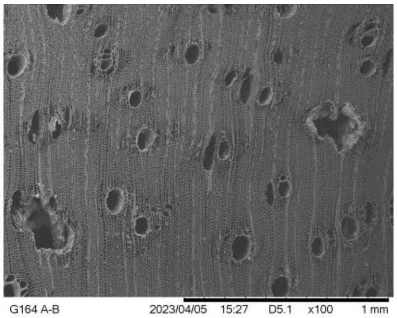


G164 Sitio Bolívar Op. F Nv. 5C

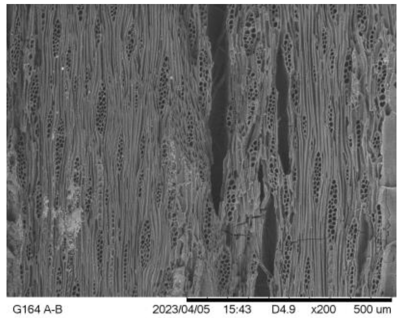


Scientific Name: FABACEAE *Samanea saman* (Jacq.) Merr.
Common Name: guachapalí, cenízaro, rain tree

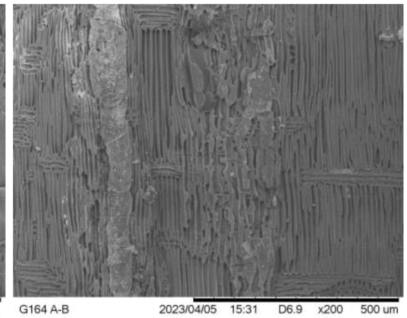
Transverse View



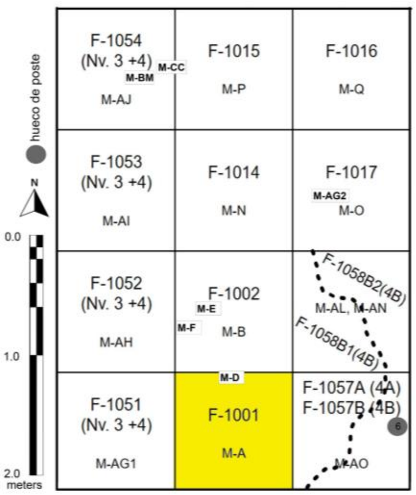
Tangential View



Radial View

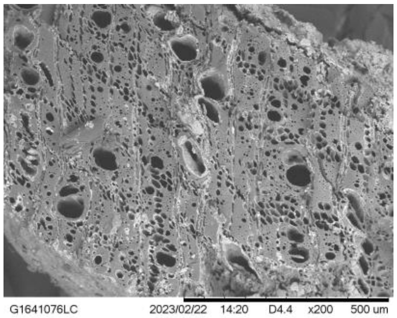


G164 Sitio Bolívar Op. F Nv. 4

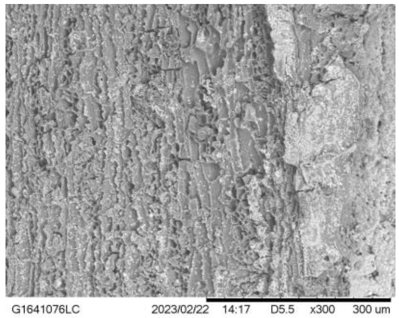


Scientific Name: FABACEAE cf. *Swartzia* sp.
Common Name: naranjita, naranjo de monte, limoncillo, cutarro, malvecino

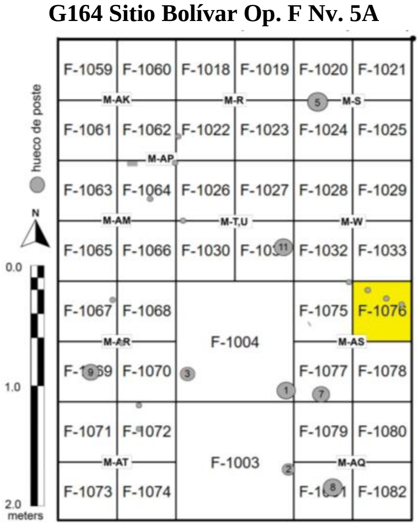
Transverse View



Tangential View

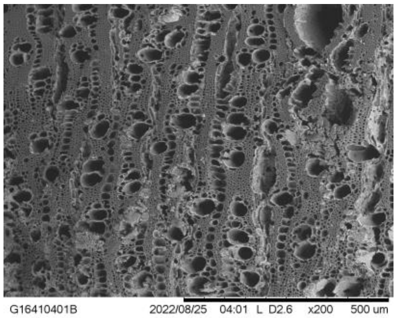


G164 Sitio Bolívar Op. F Nv. 5A

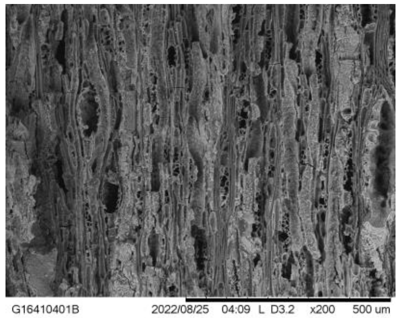


Scientific Name: LACISTEMATACEAE *Lacistema aggregatum* (P.J. Bergius) Rusby
Common Name: huesito

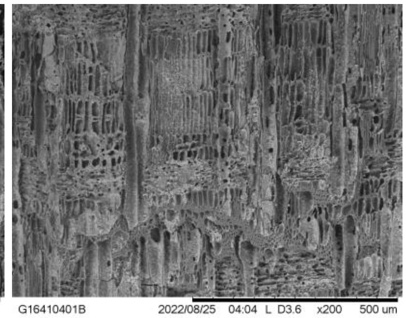
Transverse View



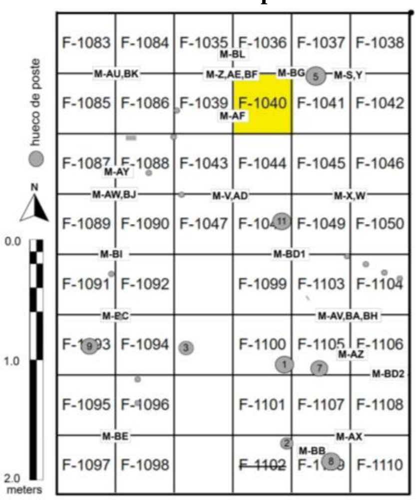
Tangential View



Radial View

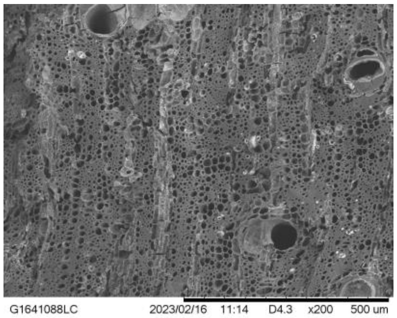


G164 Sitio Bolívar Op. F Nv. 5B

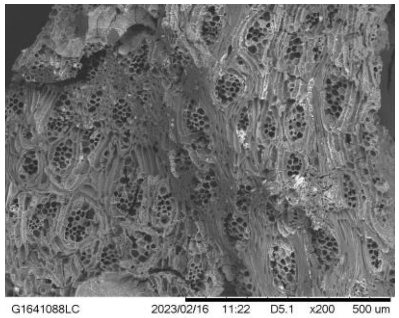


Scientific Name: LAURACEAE *Beilschmiedia* sp.
Common Name: aguacatillo, torpedo

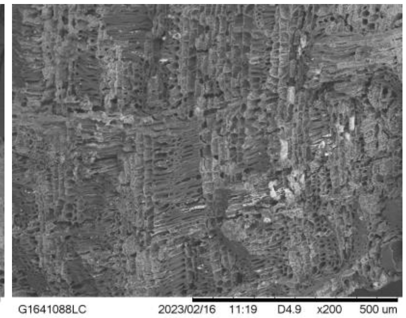
Transverse View



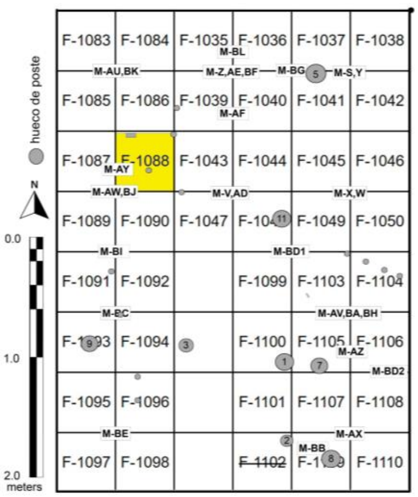
Tangential View



Radial View

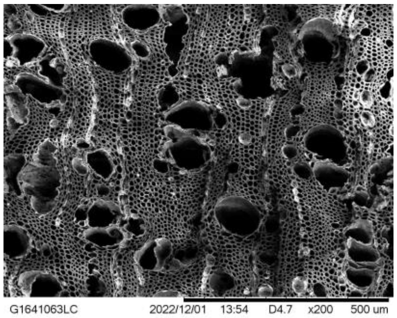


G164 Sitio Bolívar Op. F Nv. 5B

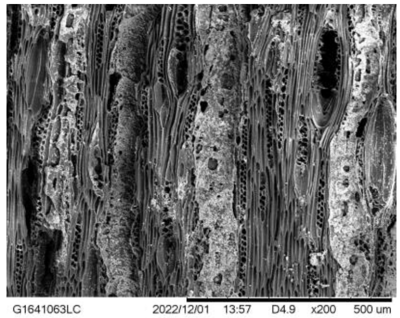


Scientific Name: LAURACEAE *Cinnamomum* sp.
Common Name: sigua, sigua blanca

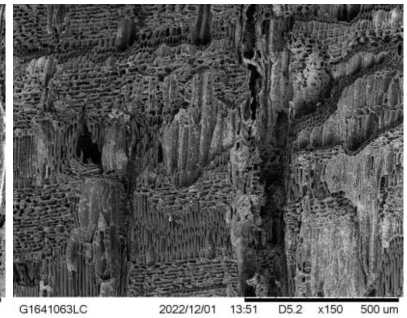
Transverse View



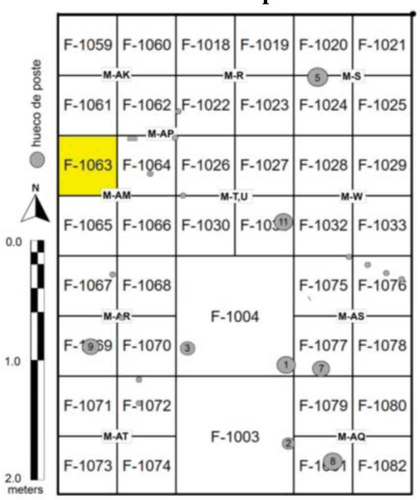
Tangential View



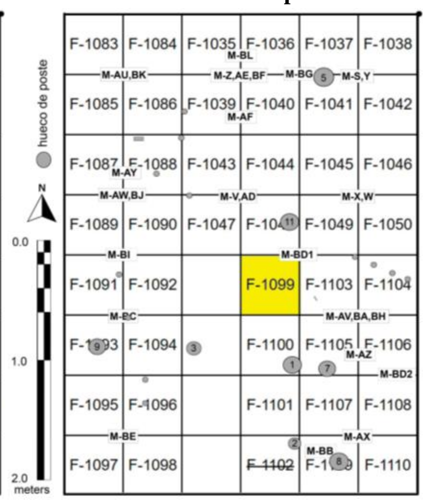
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

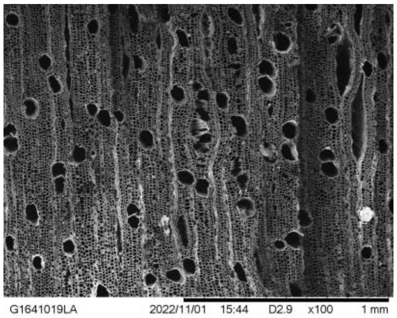


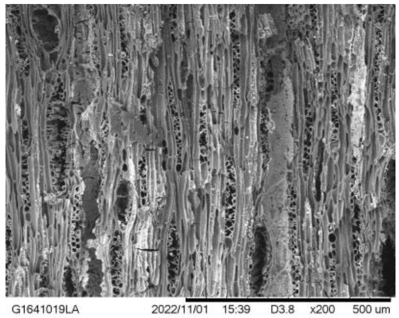
G164 Sitio Bolívar Op. F Nv. 5B

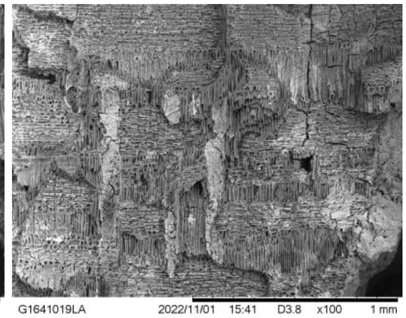


Scientific Name: LAURACEAE *Nectandra/Ocotea* sp.
Common Name: sigua

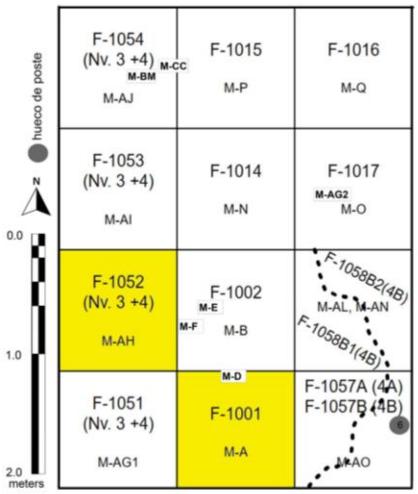
Transverse View | Tangential View | Radial View



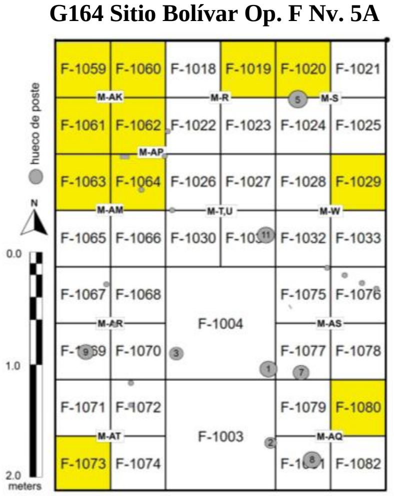


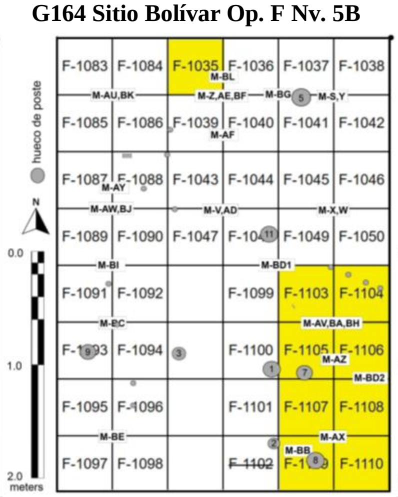


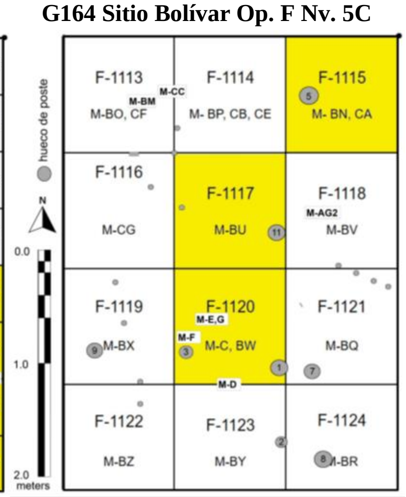
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A | **G164 Sitio Bolívar Op. F Nv. 5B** | **G164 Sitio Bolívar Op. F Nv. 5C**

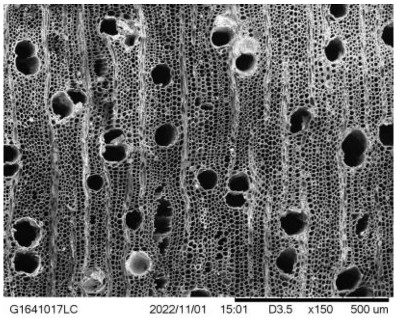




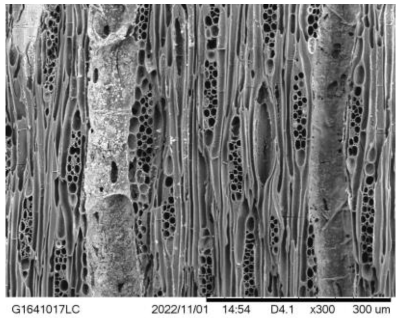


Scientific Name: LAURACEAE *Persea* sp.
Common Name: aguacate, avocado

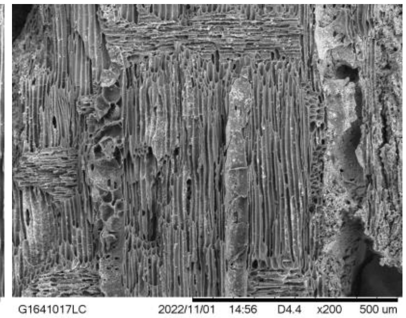
Transverse View



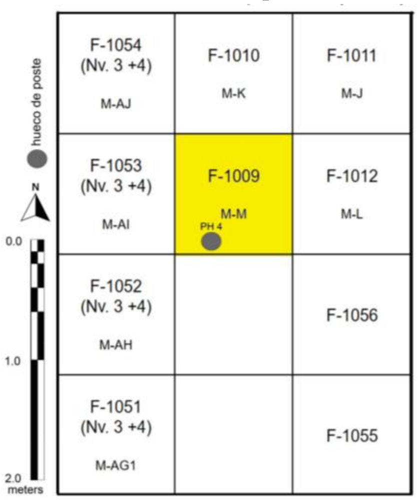
Tangential View



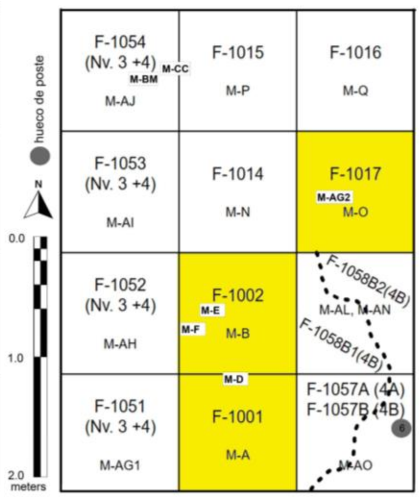
Radial View



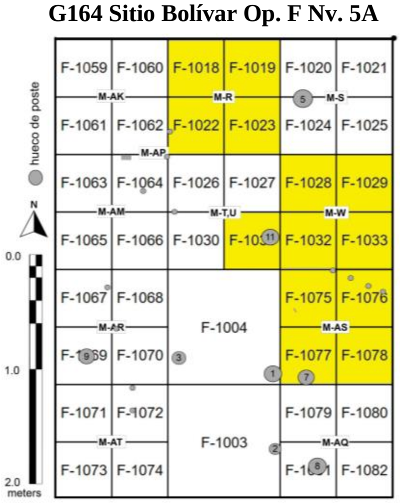
G164 Sitio Bolívar Op. F Nv. 3



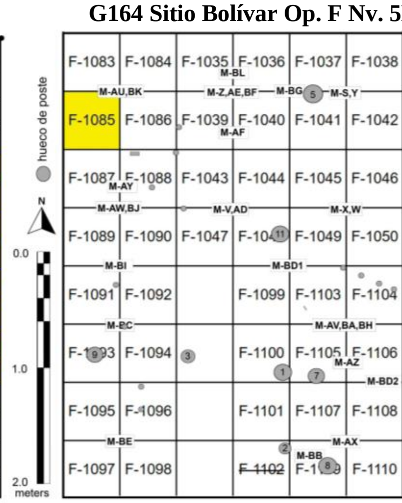
G164 Sitio Bolívar Op. F Nv. 4



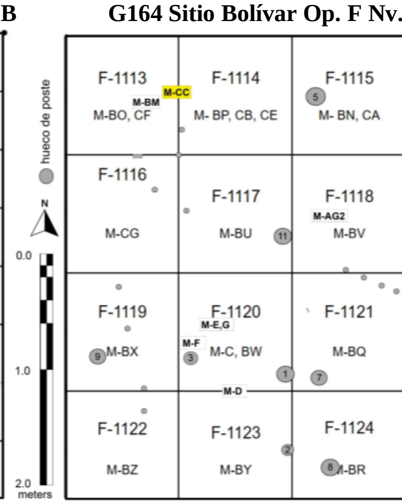
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

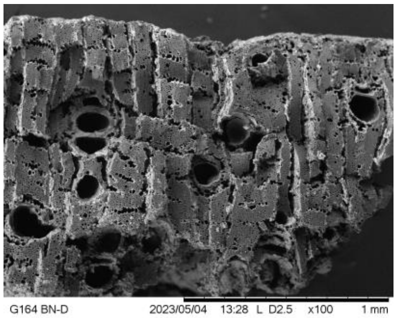


G164 Sitio Bolívar Op. F Nv. 5C

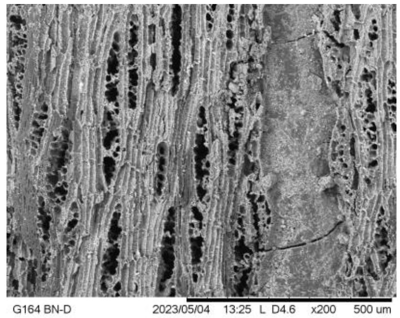


Scientific Name: LECYTHIDACEAE *Couratari* cf. *scottmorii* Prance
Common Name: coquito, condon de mono, zorro, carapelo, congolo

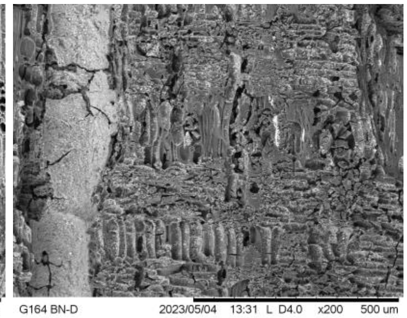
Transverse View



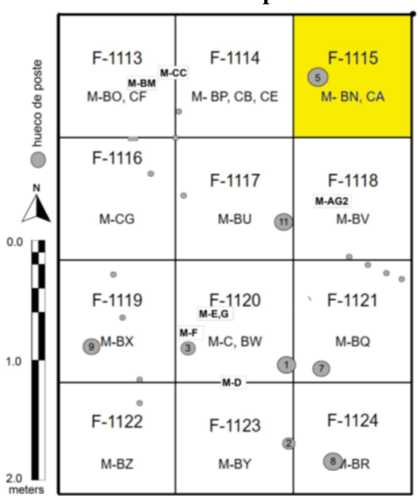
Tangential View



Radial View

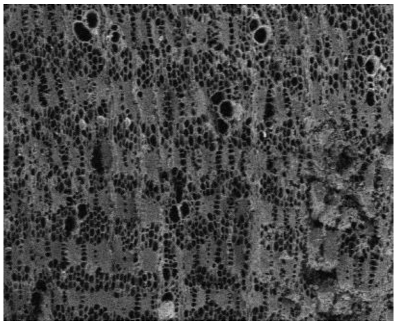


G164 Sitio Bolívar Op. F Nv. 5C

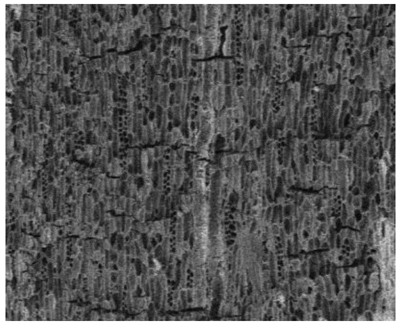


Scientific Name: MALPIGHIACEAE *Bunchosia* sp.
Common Name: cerezo de monte

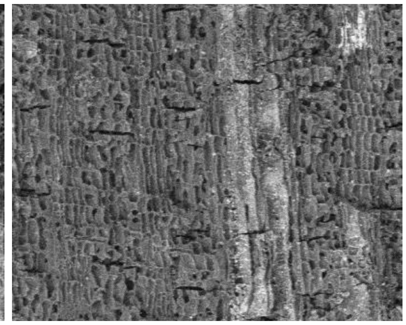
Transverse View



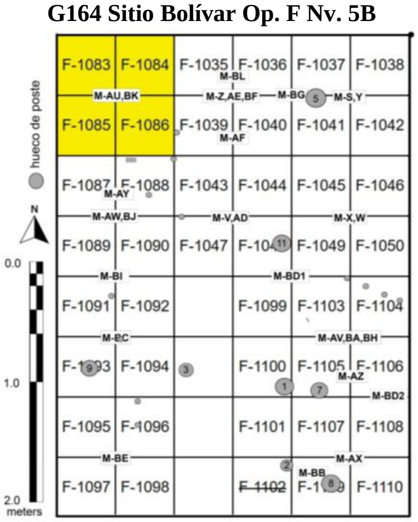
Tangential View



Radial View

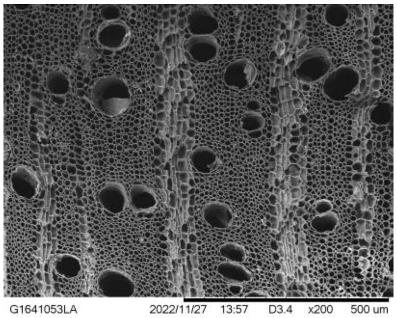


G164 Sitio Bolívar Op. F Nv. 5B

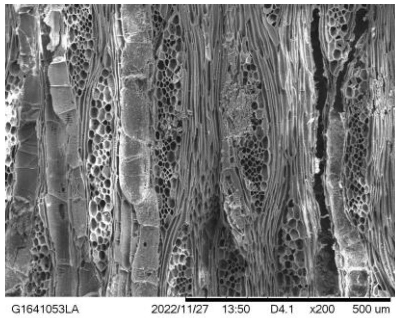


Scientific Name: MALVACEAE BYTTNERIOIDEAE *Theobroma* sp.
Common Name: cacao

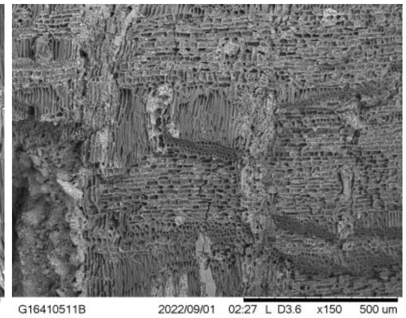
Transverse View



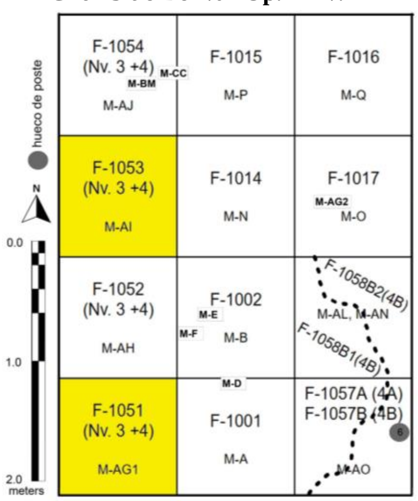
Tangential View



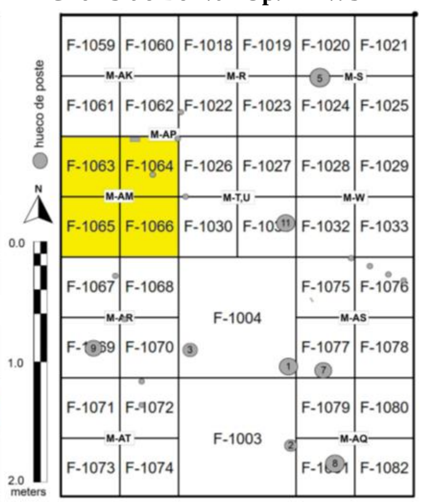
Radial View



G164 Sitio Bolívar Op. F Nv. 4

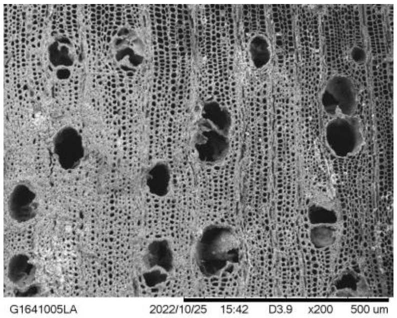


G164 Sitio Bolívar Op. F Nv. 5A

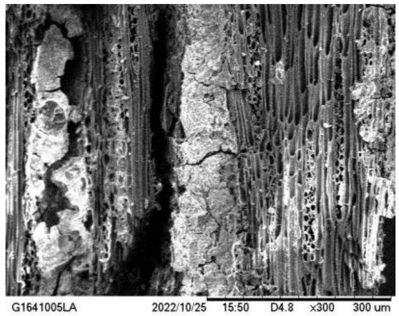


Scientific Name: MALVACEAE GREWIOIDEAE *Heliocarpus* sp.
Common Name: majaguillo, majagua

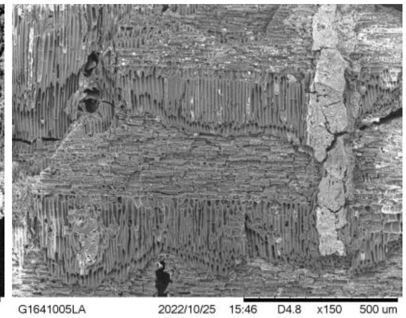
Transverse View



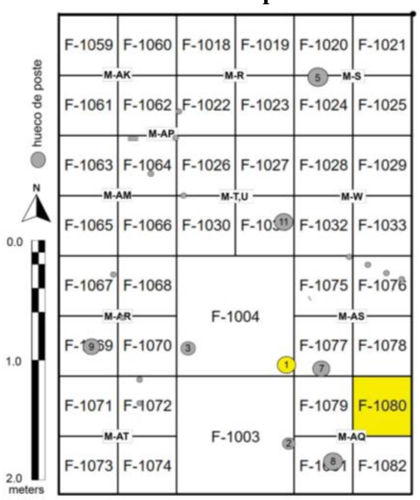
Tangential View



Radial View

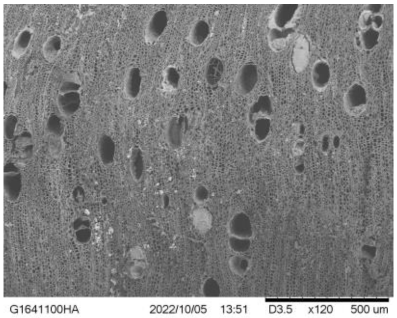


G164 Sitio Bolívar Op. F Nv. 5A

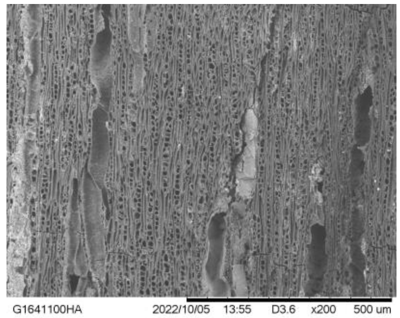


Scientific Name: MELASTOMATACEAE *Bellucia* sp.
Common Name: coronillo

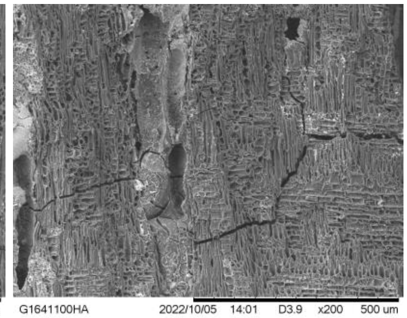
Transverse View



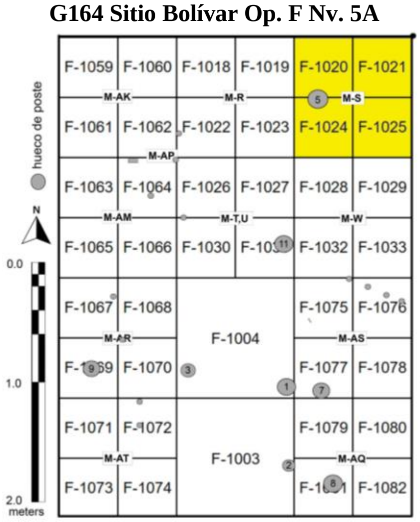
Tangential View



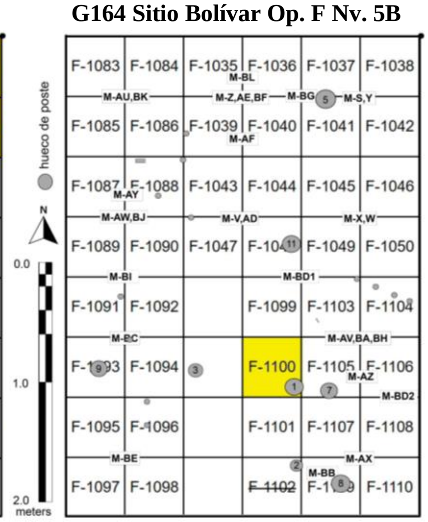
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

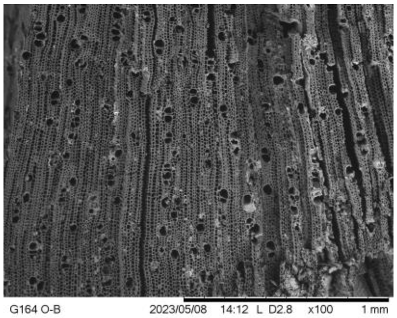


G164 Sitio Bolívar Op. F Nv. 5B

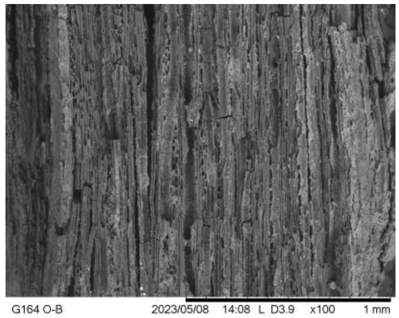


Scientific Name: MELASTOMATACEAE *Clidemia* sp.
Common Name: soapbush, canillo

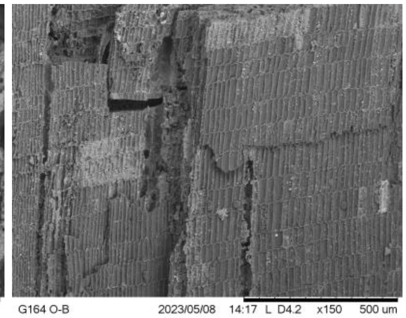
Transverse View



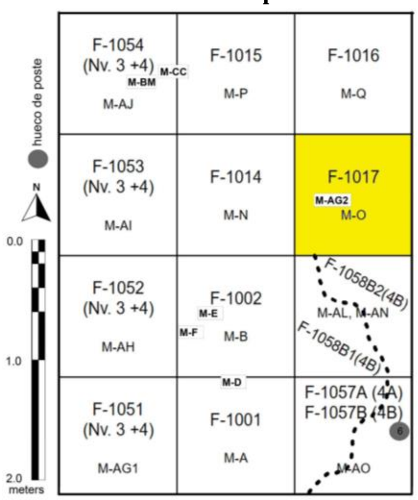
Tangential View



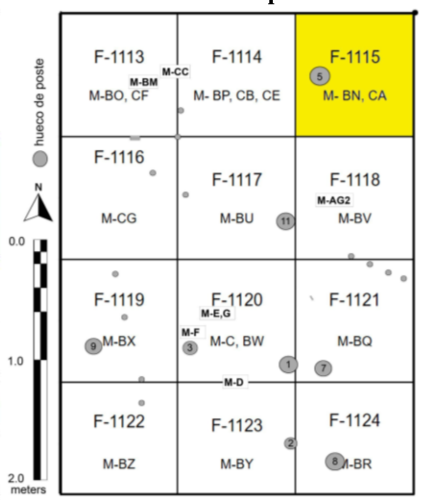
Radial View



G164 Sitio Bolívar Op. F Nv. 4

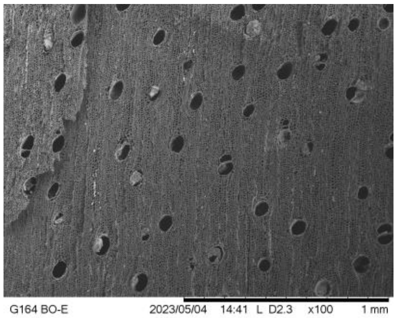


G164 Sitio Bolívar Op. F Nv. 5C

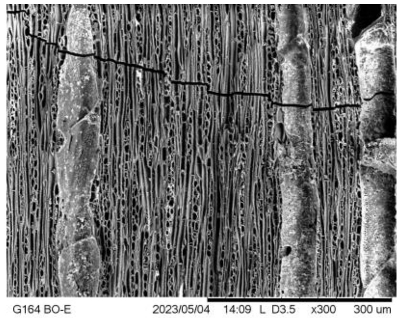


Scientific Name: MELASTOMATACEAE *Tibouchina* sp.
Common Name: glory bush, lasiandra

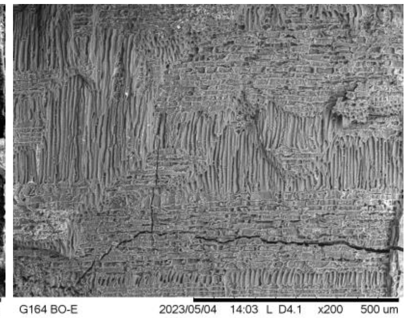
Transverse View



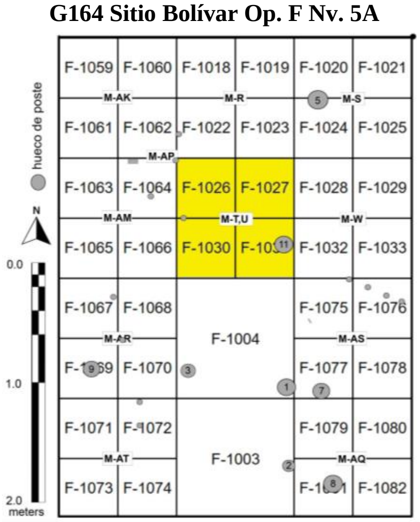
Tangential View



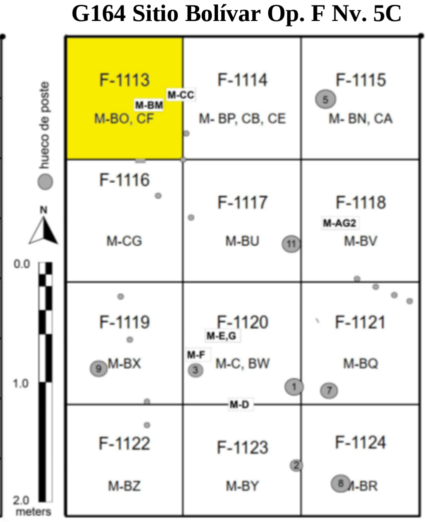
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

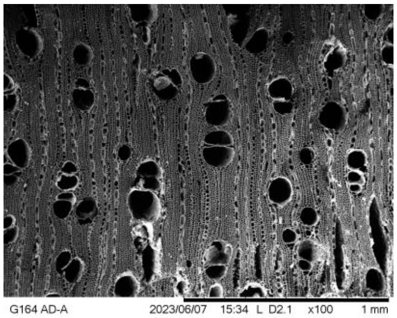


G164 Sitio Bolívar Op. F Nv. 5C

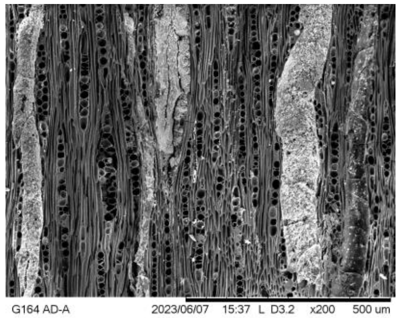


Scientific Name: MELIACEAE *Cabralea* sp.
Common Name: canjerana

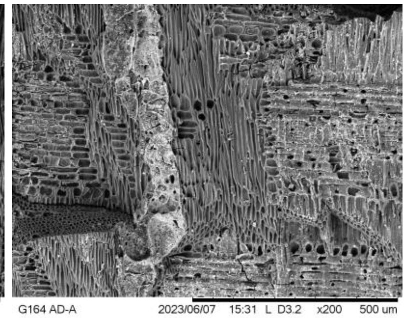
Transverse View



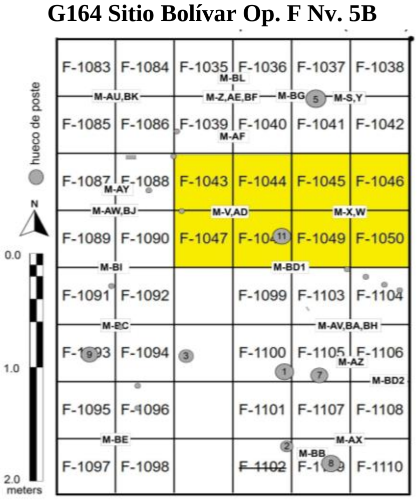
Tangential View



Radial View

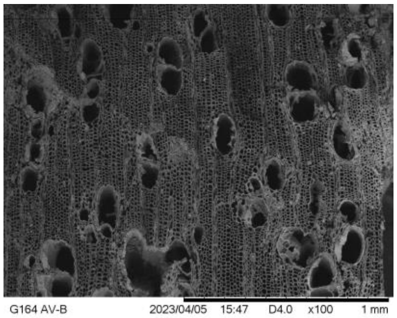


G164 Sitio Bolívar Op. F Nv. 5B

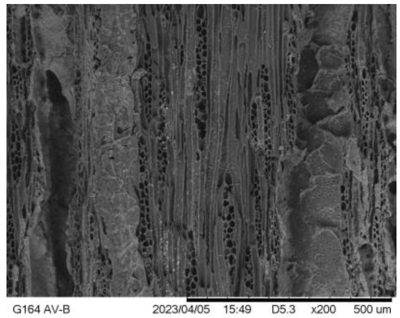


Scientific Name: MELIACEAE *Swietenia* sp.
Common Name: caoba, mahogany

Transverse View

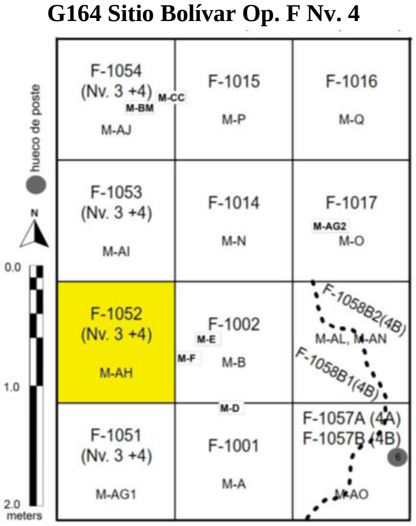


Tangential View

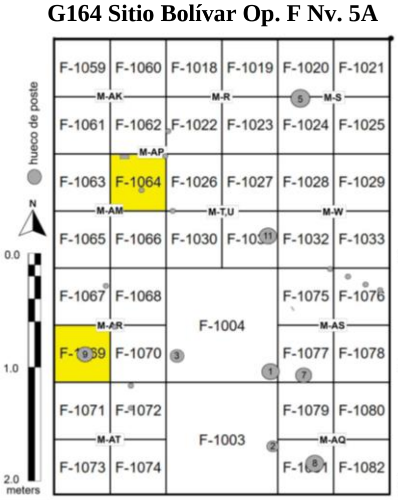


Radial View

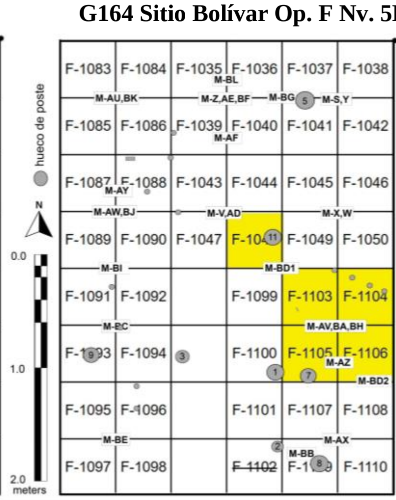
G164 Sitio Bolívar Op. F Nv. 4



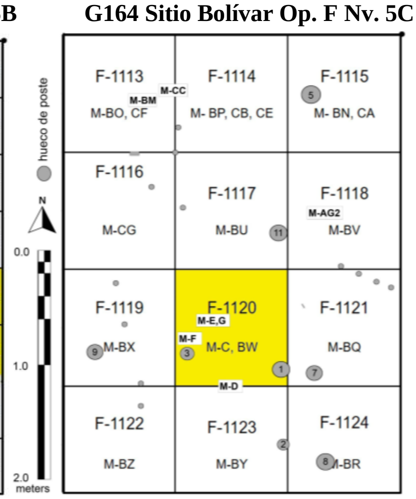
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

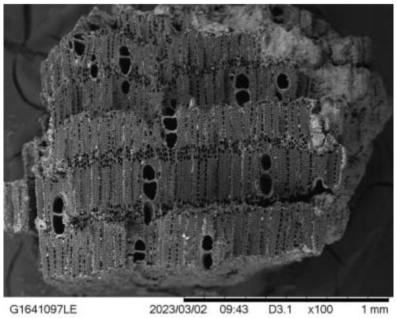


G164 Sitio Bolívar Op. F Nv. 5C

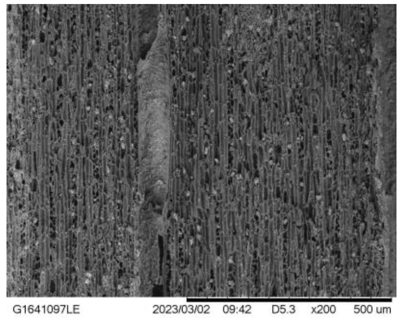


Scientific Name: MELIACEAE Trichilia sp.
Common Name: conejo colorado, fosforito, alfajía colorado, alfaje, terciopelo

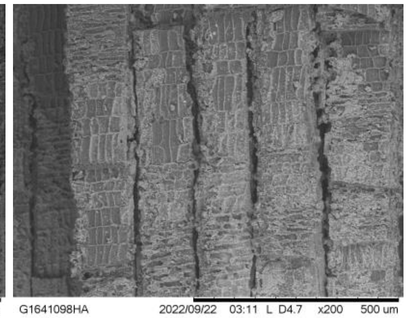
Transverse View



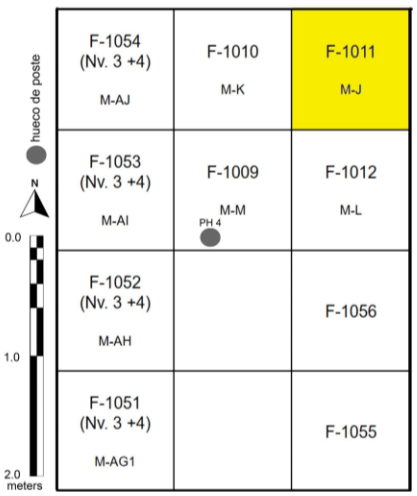
Tangential View



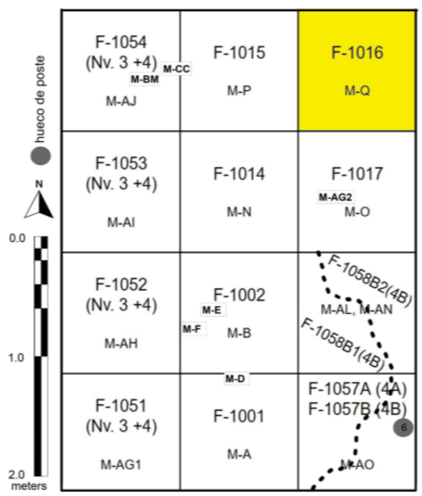
Radial View



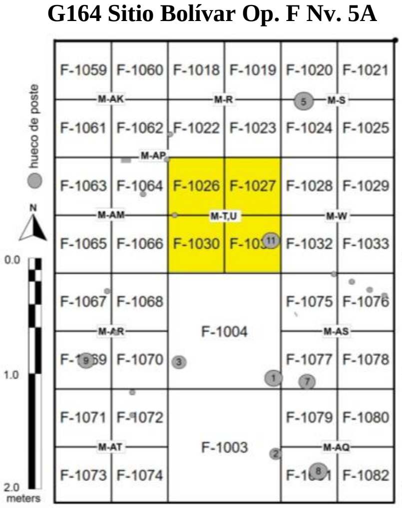
G164 Sitio Bolívar Op. F Nv. 3



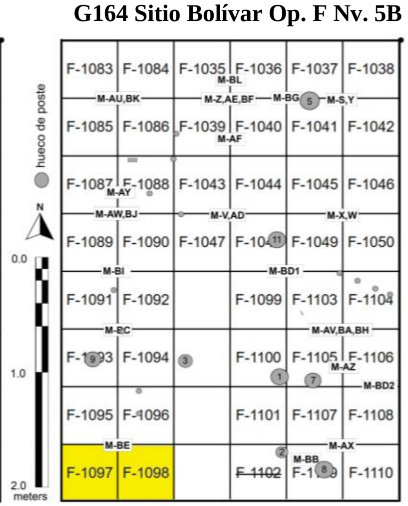
G164 Sitio Bolívar Op. F Nv. 4



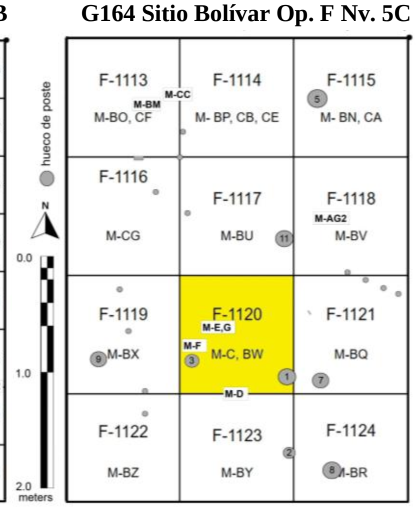
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

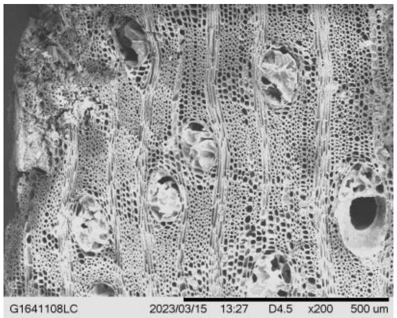


G164 Sitio Bolívar Op. F Nv. 5C

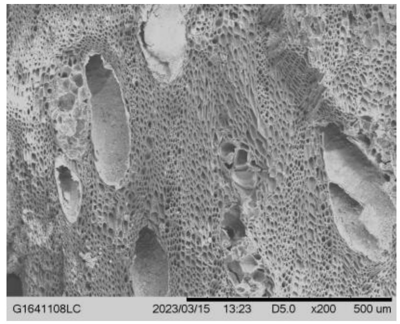


Scientific Name: MORACEAE *Brosimum* sp.
Common Name: breadnut, ramon, berbá, cacique

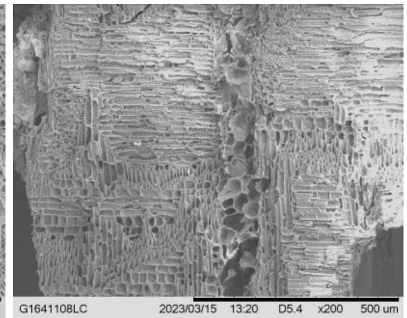
Transverse View



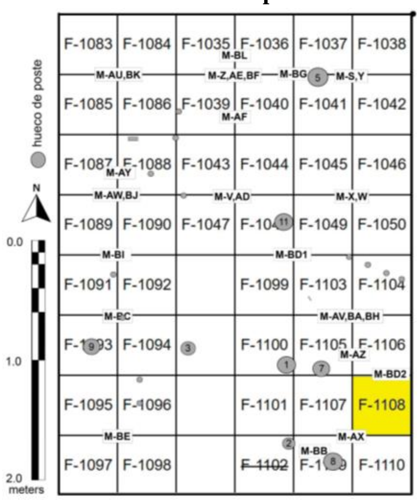
Tangential View



Radial View

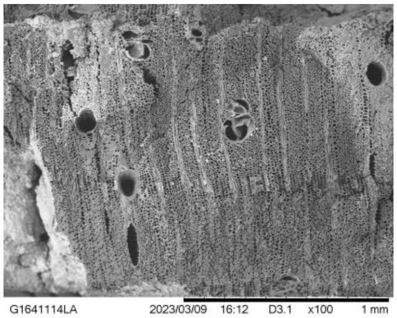


G164 Sitio Bolívar Op. F Nv. 5B

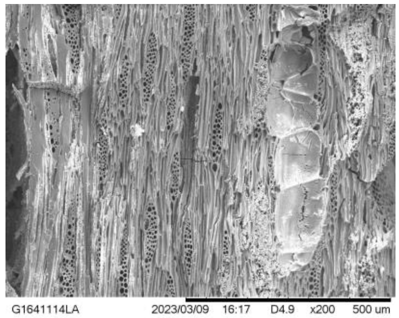


Scientific Name: MORACEAE *Ficus* sp.
Common Name: fig, higuerón

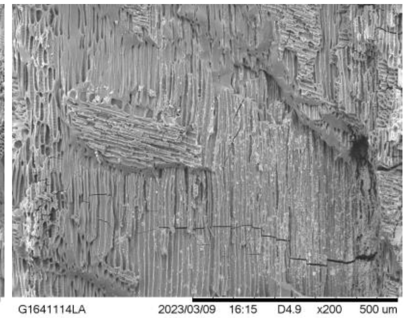
Transverse View



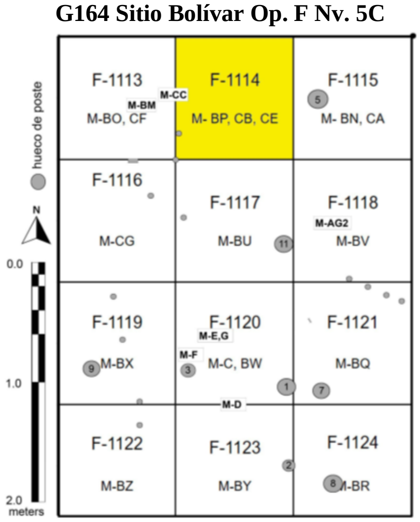
Tangential View



Radial View

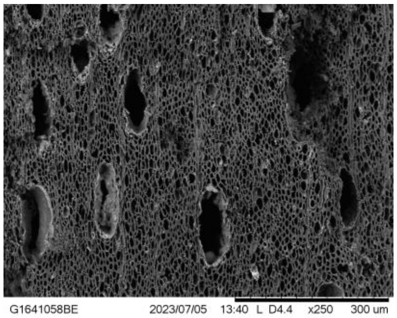


G164 Sitio Bolívar Op. F Nv. 5C

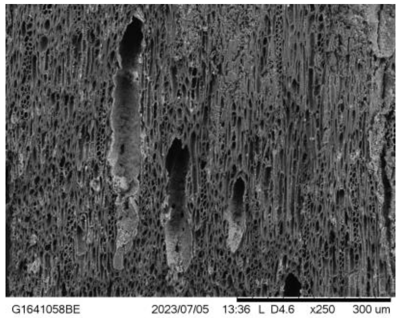


Scientific Name: MORACEAE cf. *Poulsenia armata* (Miq.) Standl.
Common Name: chilamate, chanchama, cucua, mastate

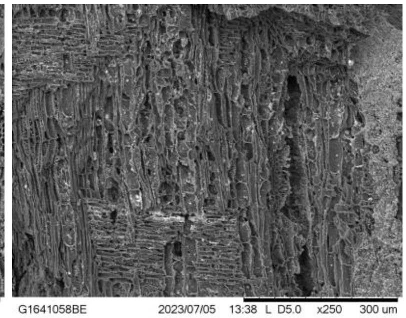
Transverse View



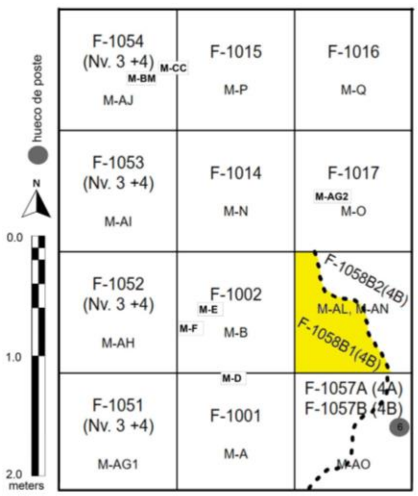
Tangential View



Radial View

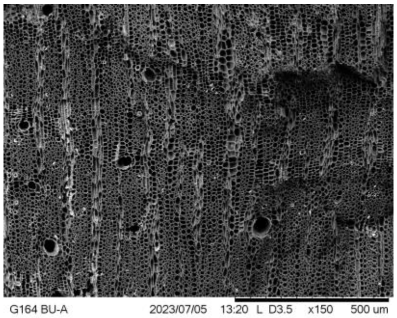


G164 Sitio Bolívar Op. F Nv. 4

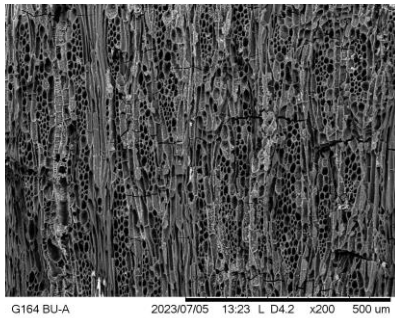


Scientific Name: MORACEAE *Trophis* sp.
Common Name: lija

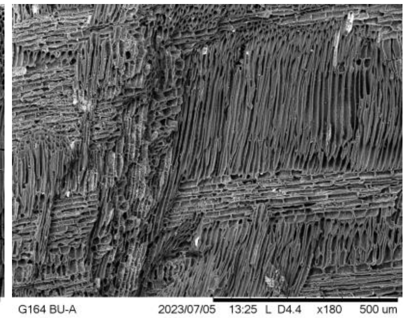
Transverse View



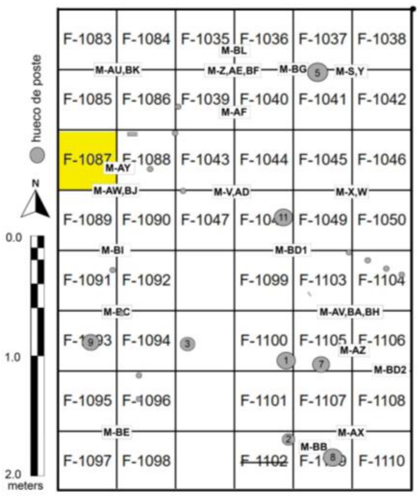
Tangential View



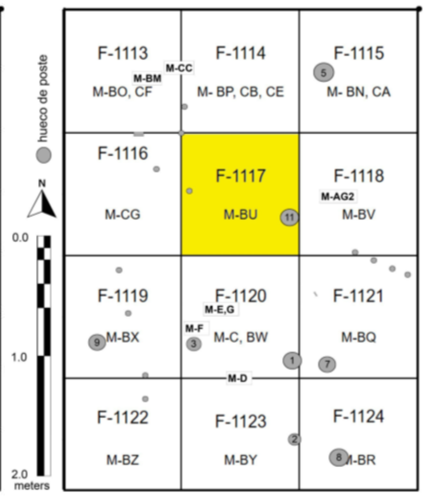
Radial View



G164 Sitio Bolívar Op. F Nv. 5B

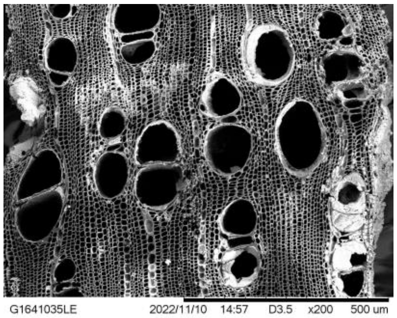


G164 Sitio Bolívar Op. F Nv. 5C

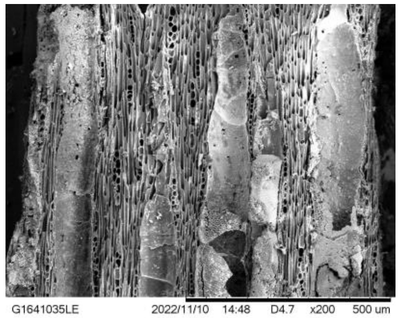


Scientific Name: MYRISTICACEAE cf. *Otoba* sp.
Common Name: miguelario, velario, fruta dorada

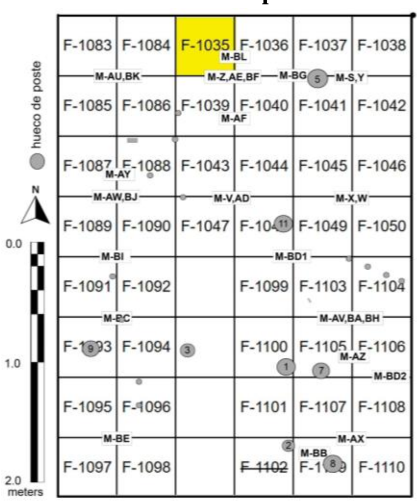
Transverse View



Tangential View

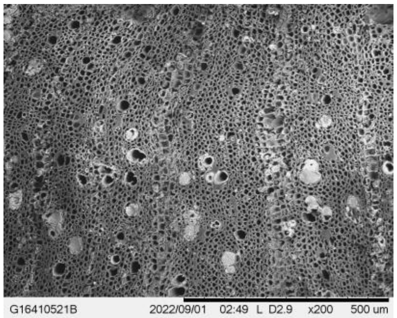


G164 Sitio Bolívar Op. F Nv. 5B

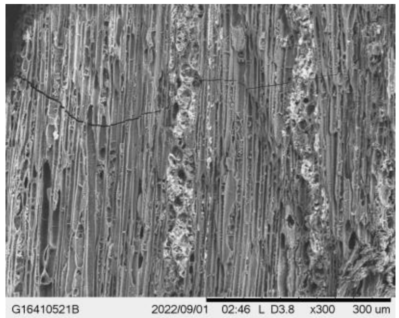


Scientific Name: MYRSINACEAE *Ardisia* sp.
Common Name: coralberry

Transverse View

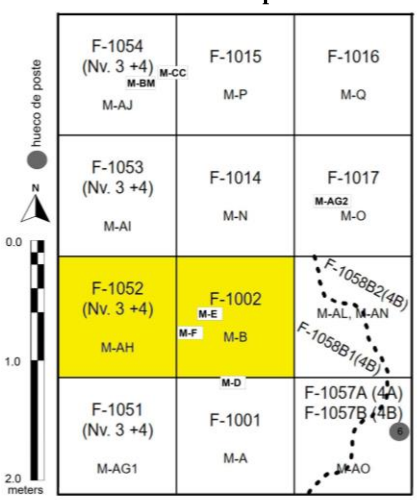


Tangential View

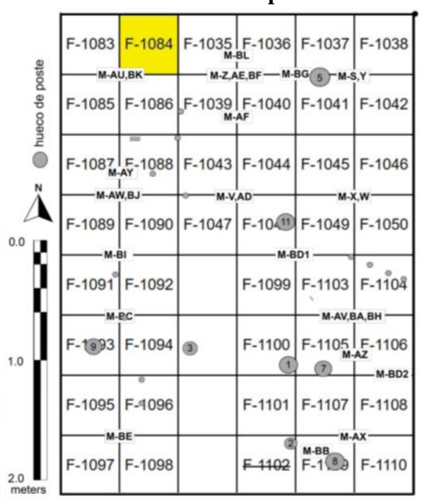


Radial View

G164 Sitio Bolívar Op. F Nv. 4

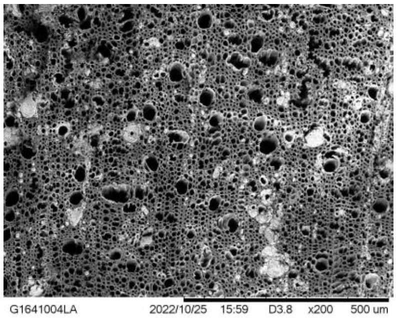


G164 Sitio Bolívar Op. F Nv. 5B

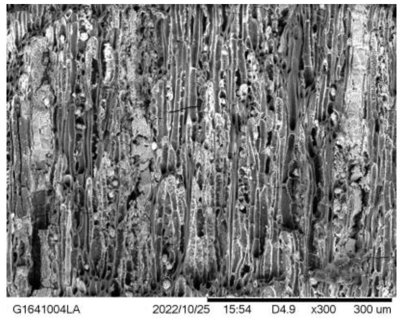


Scientific Name: MYRTACEAE *Eugenia* sp.
Common Name: pitanga, guayabillo, escobillo blanco

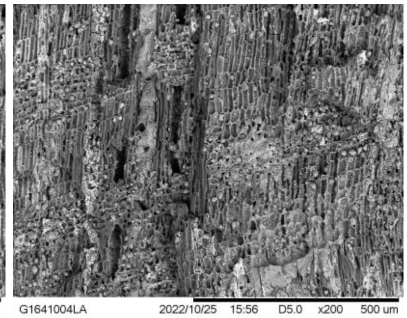
Transverse View



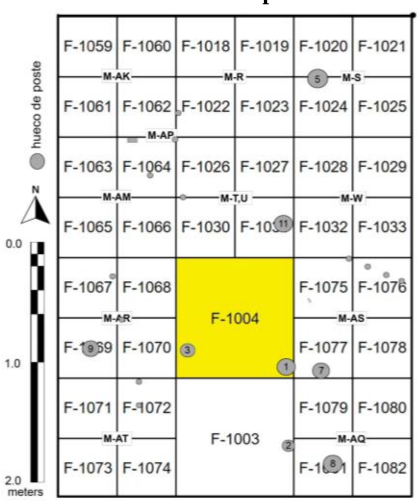
Tangential View



Radial View

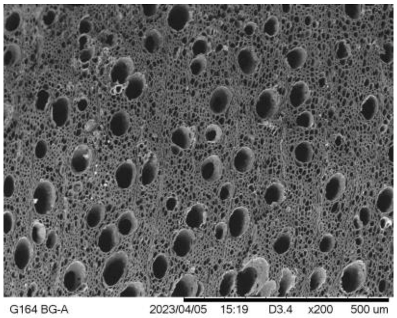


G164 Sitio Bolívar Op. F Nv. 5A

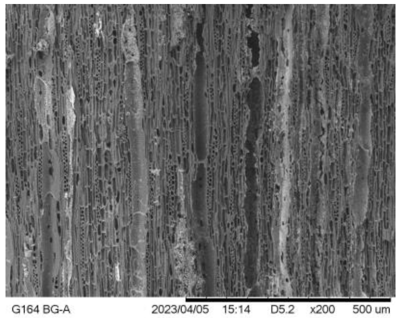


Scientific Name: MYRTACEAE *Psidium* sp.
Common Name: guava, guayaba

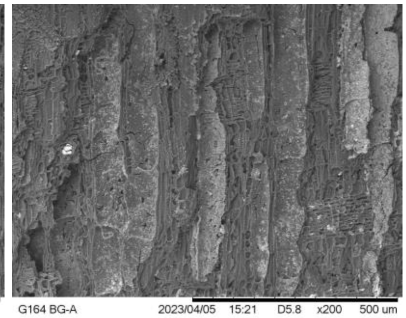
Transverse View



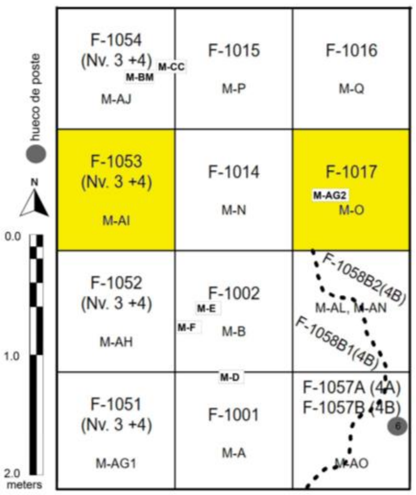
Tangential View



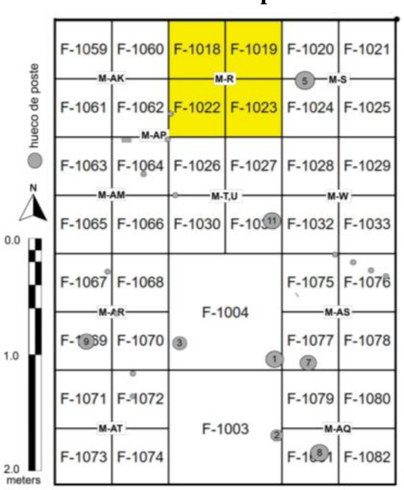
Radial View



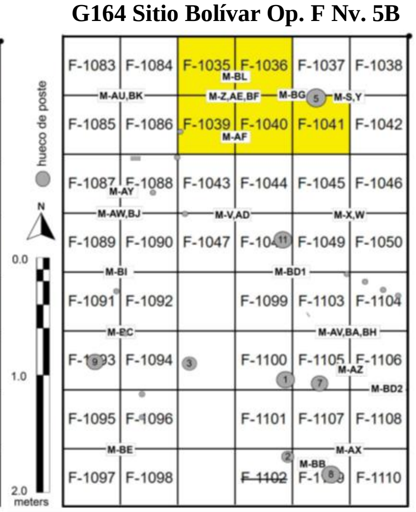
G164 Sitio Bolívar Op. F Nv. 4



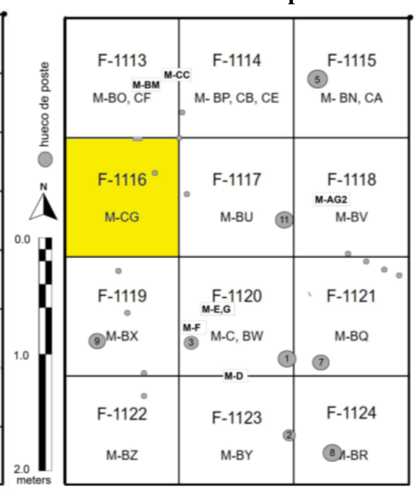
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

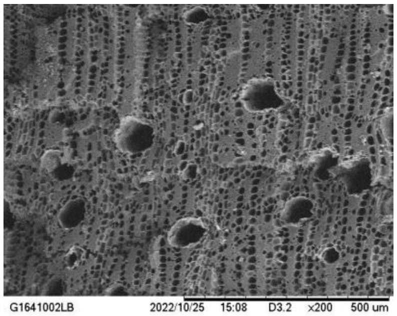


G164 Sitio Bolívar Op. F Nv. 5C

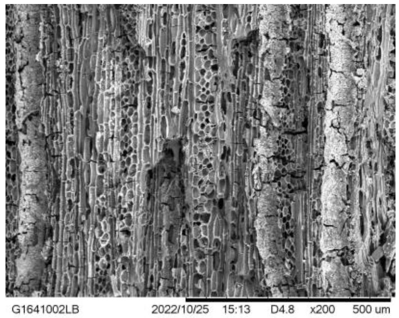


Scientific Name: OCHNACEAE *Ouratea* sp.
Common Name: unknown

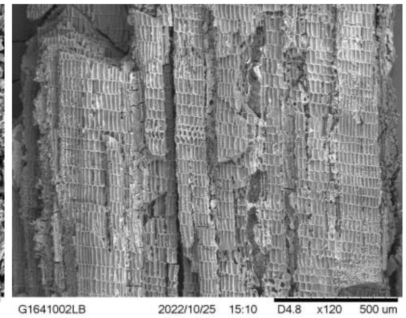
Transverse View



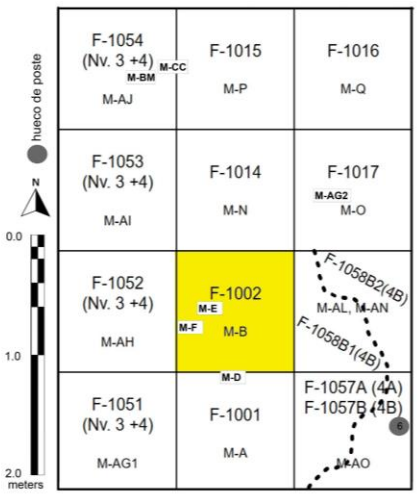
Tangential View



Radial View

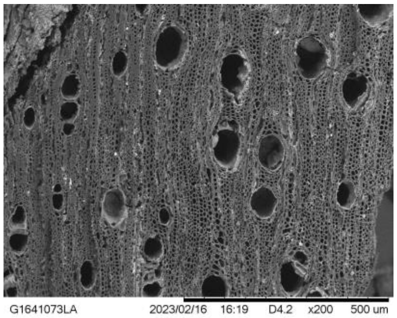


G164 Sitio Bolívar Op. F Nv. 4

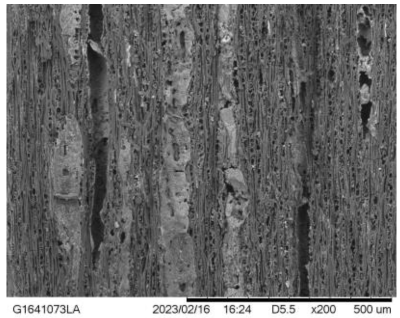


Scientific Name: POLYGONACEAE *Coccoloba* sp.
Common Name: uvito, sea grape, uvero

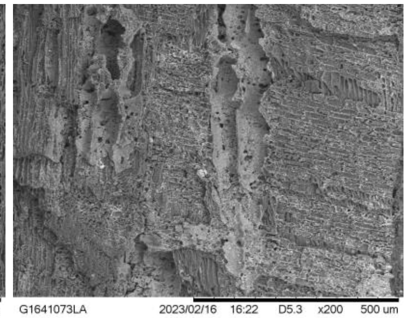
Transverse View



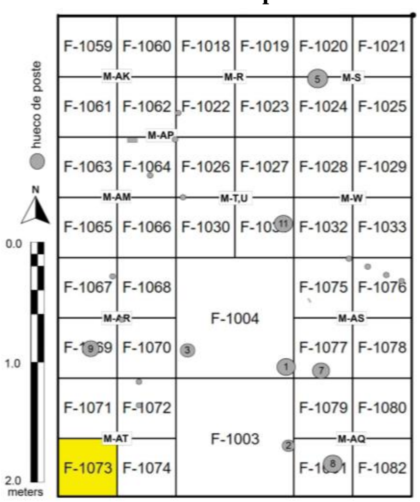
Tangential View



Radial View

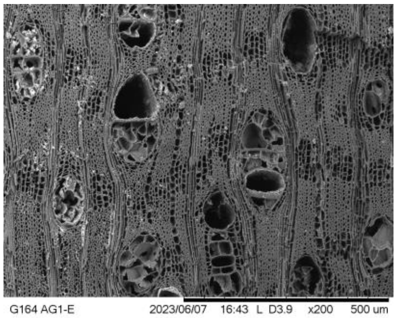


G164 Sitio Bolívar Op. F Nv. 5A

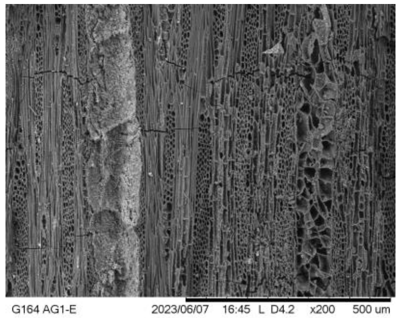


Scientific Name: RUBIACEAE cf. *Cosmibuena* sp.
Common Name: tabaquillo

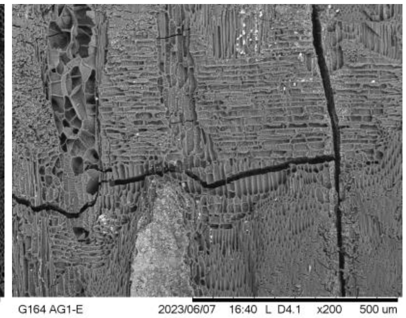
Transverse View



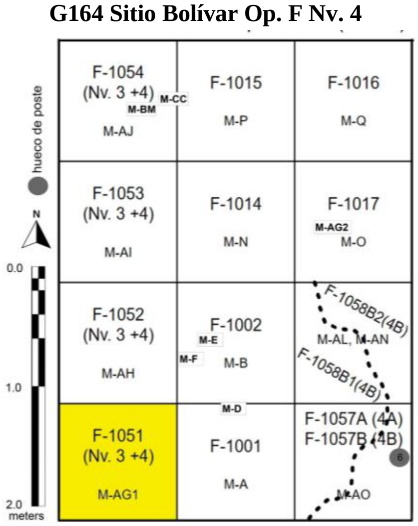
Tangential View



Radial View

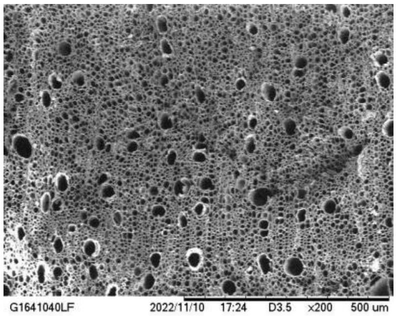


G164 Sitio Bolívar Op. F Nv. 4

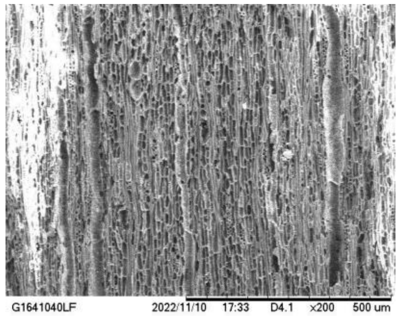


Scientific Name: RUBIACEAE *Coutarea/Exostema* sp.
Common Name: azulejo, quina

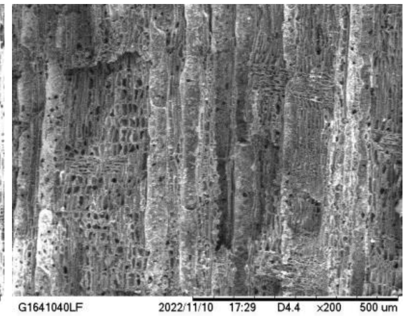
Transverse View



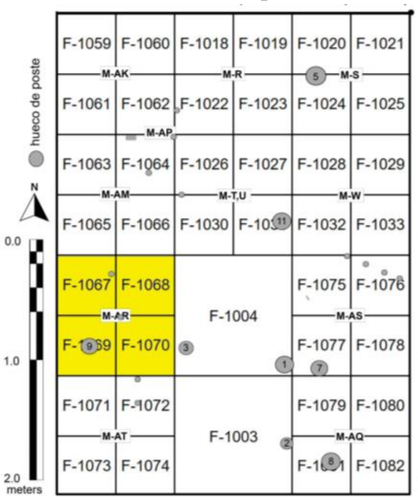
Tangential View



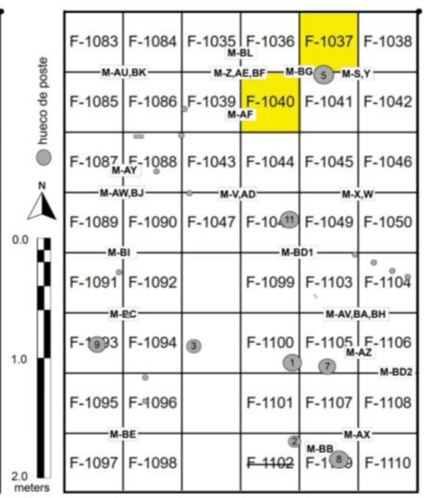
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

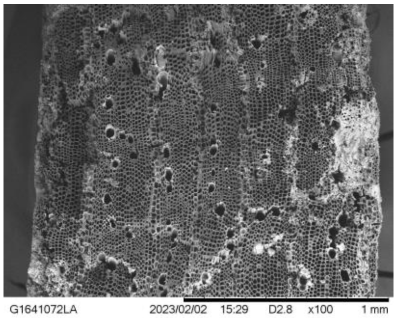


G164 Sitio Bolívar Op. F Nv. 5B



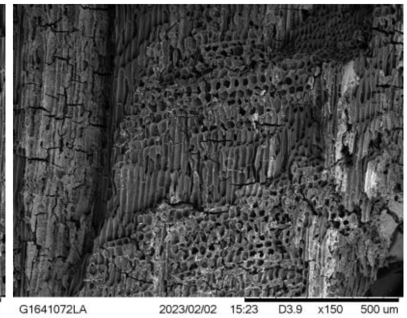
Scientific Name: RUBIACEAE *Faramea* sp.
Common Name: huesito, benjamín, garrotillo, jazmín

Transverse View

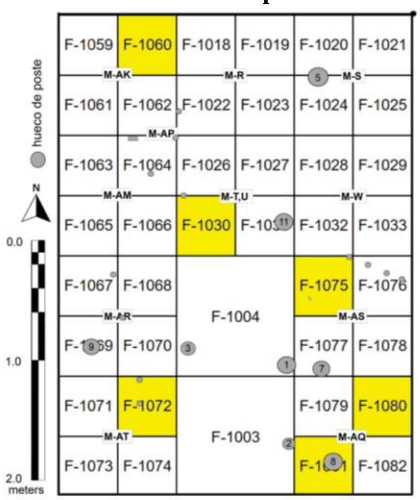


Tangential View

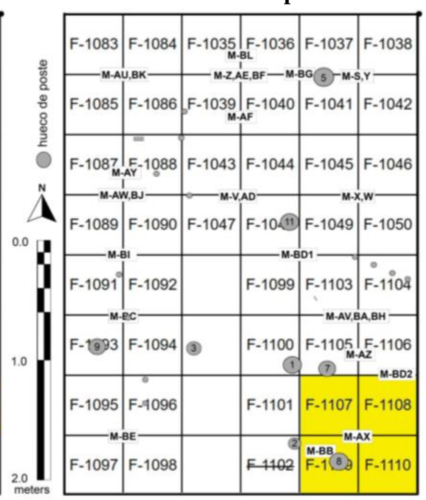
Radial View



G164 Sitio Bolívar Op. F Nv. 5A

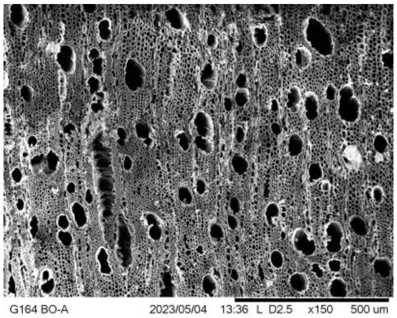


G164 Sitio Bolívar Op. F Nv. 5B

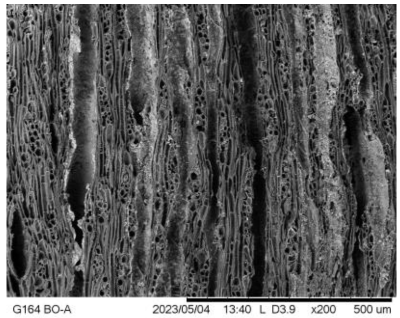


Scientific Name: RUBIACEAE *Genipa americana* L.
Common Name: jagua, genipa

Transverse View

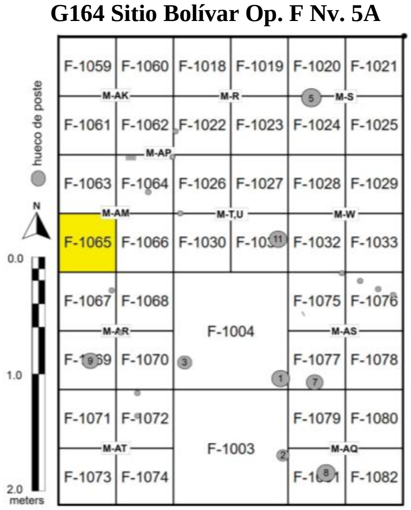


Tangential View

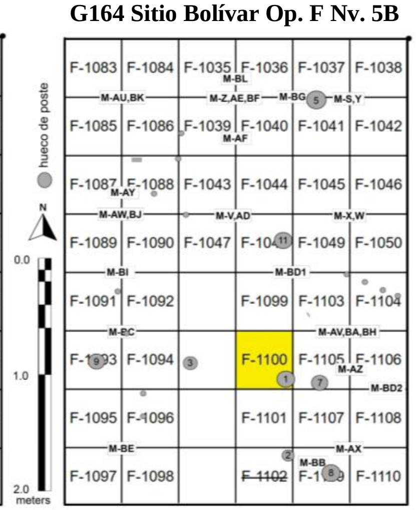


Radial View

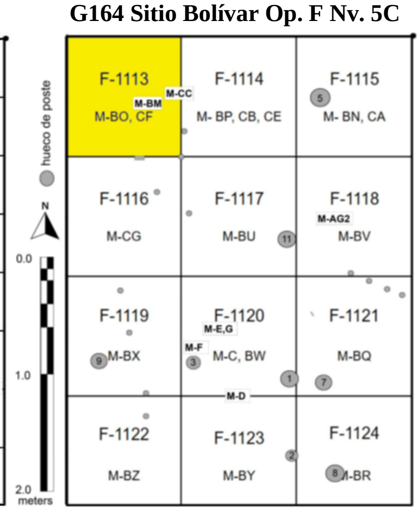
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

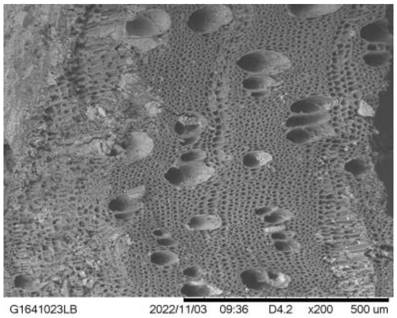


G164 Sitio Bolívar Op. F Nv. 5C

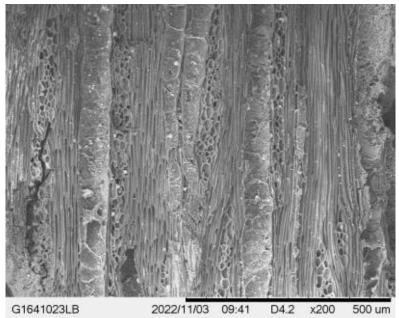


Scientific Name: RUBIACEAE *Hamelia* sp.
Common Name: guayabo negro, canelito

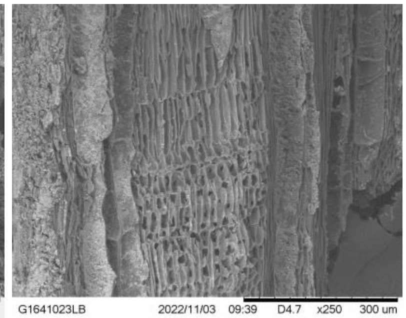
Transverse View



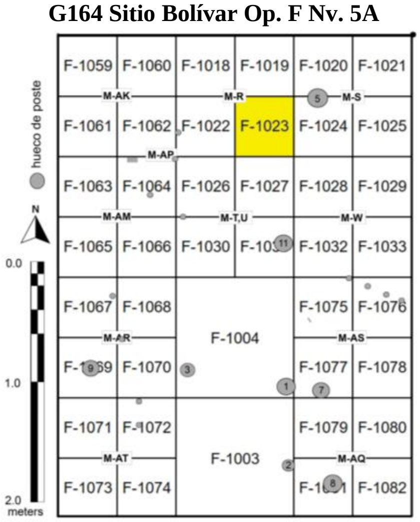
Tangential View



Radial View

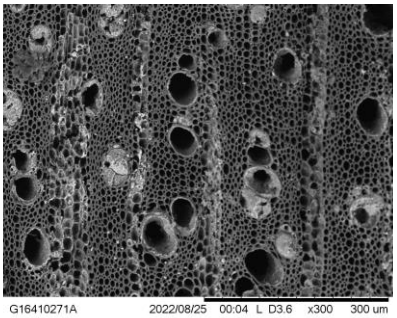


G164 Sitio Bolívar Op. F Nv. 5A

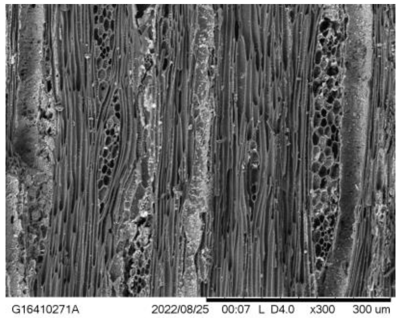


Scientific Name: RUBIACEAE *Palicourea* sp.
Common Name: recadito

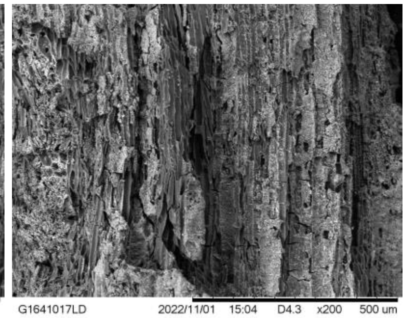
Transverse View



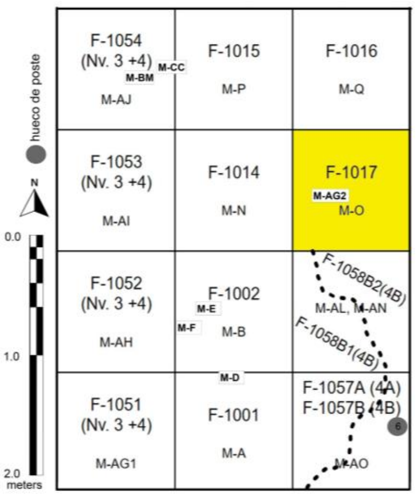
Tangential View



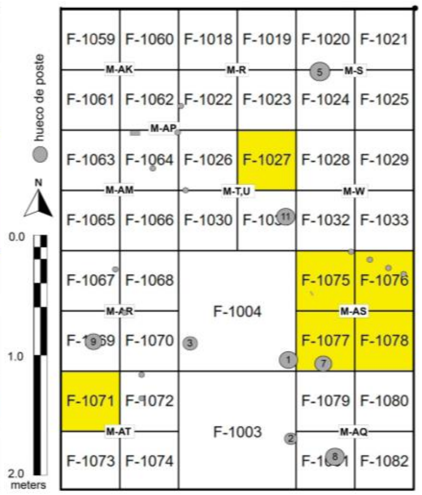
Radial View



G164 Sitio Bolívar Op. F Nv. 4

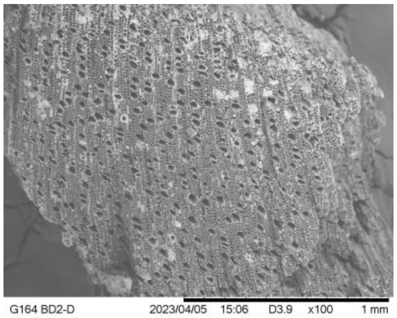


G164 Sitio Bolívar Op. F Nv. 5A

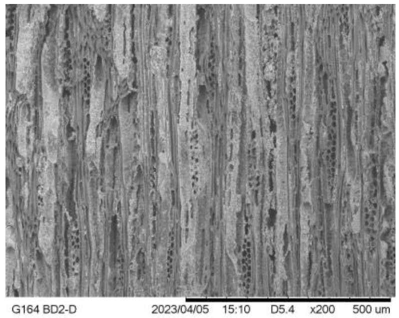


Scientific Name: RUBIACEAE *Psychotria* sp.
Common Name: cafecillo, hot lips, sombrerito de diablo

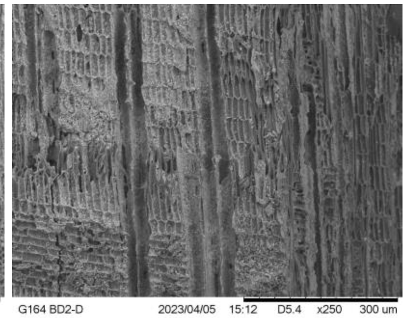
Transverse View



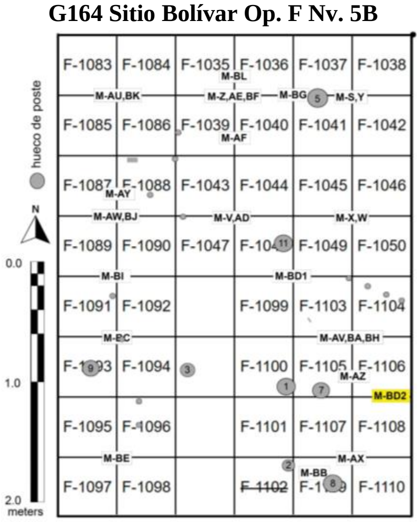
Tangential View



Radial View

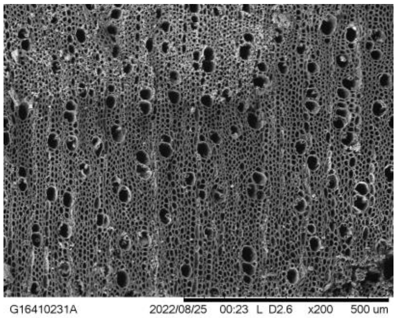


G164 Sitio Bolívar Op. F Nv. 5B

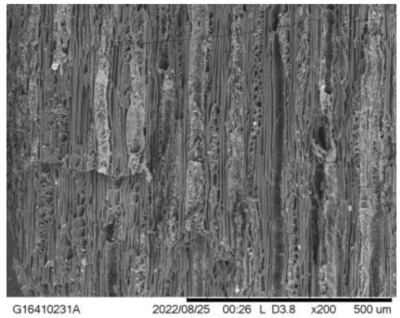


Scientific Name: RUTACEAE *Zanthoxylum* sp.
Common Name: arcabú, tachuelo, pricklyash

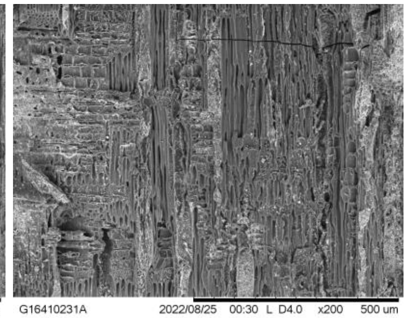
Transverse View



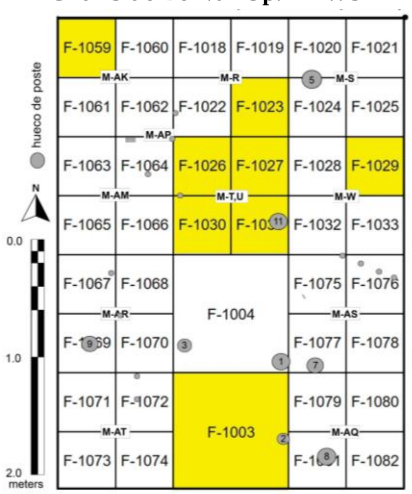
Tangential View



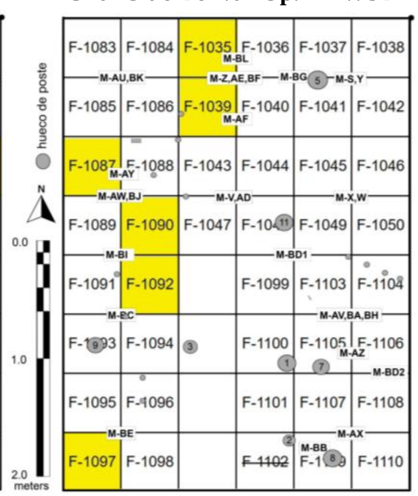
Radial View



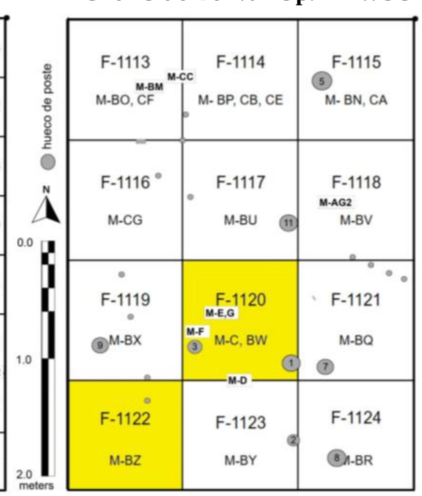
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

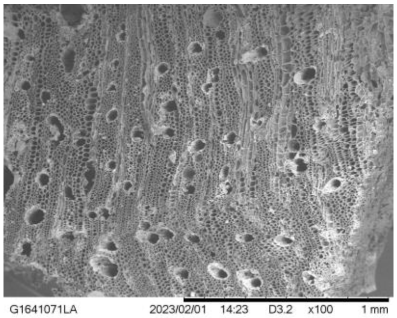


G164 Sitio Bolívar Op. F Nv. 5C

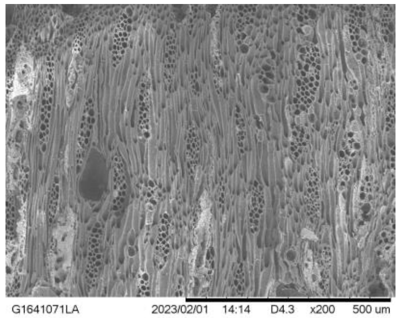


Scientific Name: SABIACEAE *Meliosma* sp.
Common Name: worm head tree

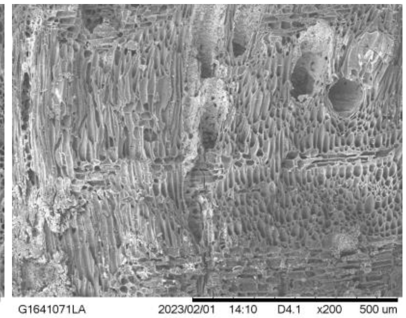
Transverse View



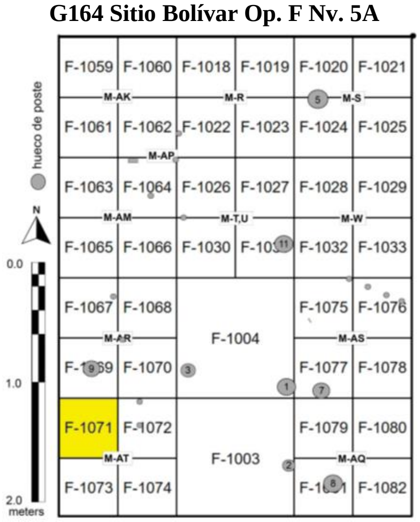
Tangential View



Radial View

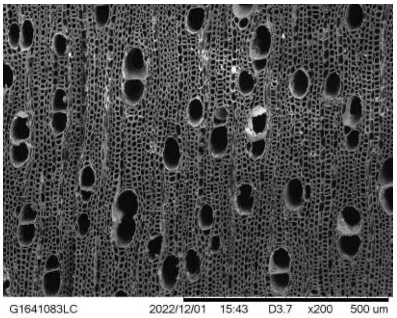


G164 Sitio Bolívar Op. F Nv. 5A

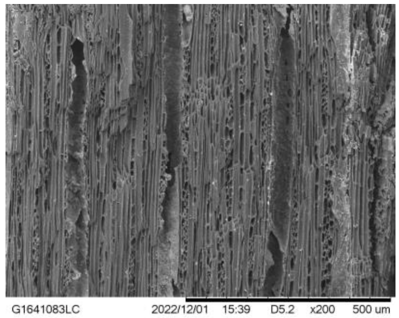


Scientific Name: SALICACEAE *Casearia* sp.
Common Name: corta lengua, pica lengua, manga larga, mauro

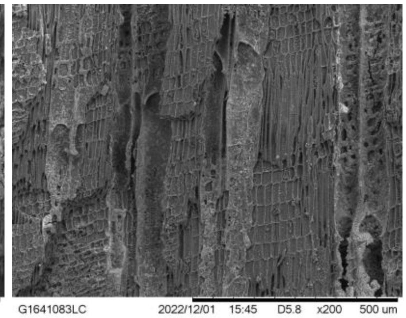
Transverse View



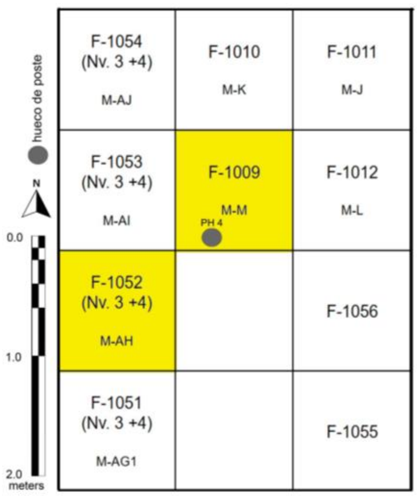
Tangential View



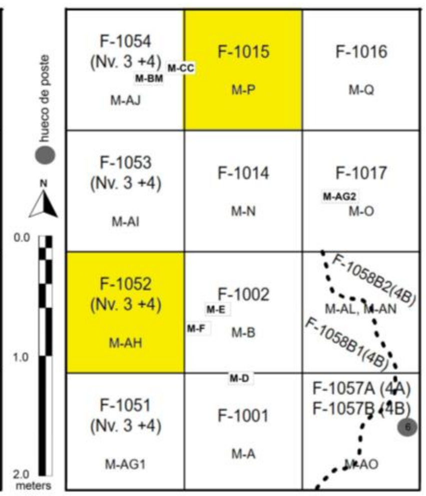
Radial View



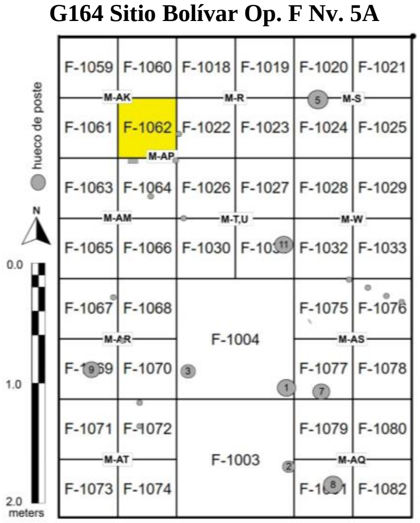
G164 Sitio Bolívar Op. F Nv. 3



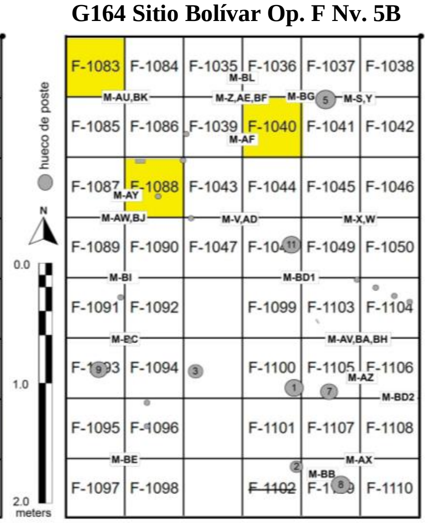
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A

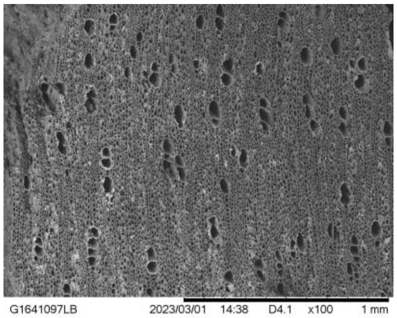


G164 Sitio Bolívar Op. F Nv. 5B

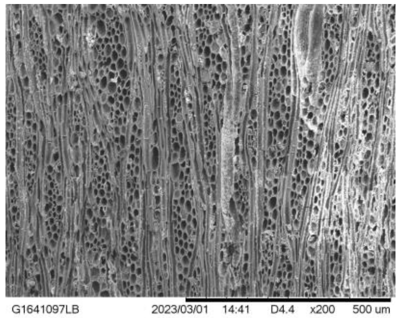


Scientific Name: SALICACEAE *Ryania speciosa* Vahl
Common Name: corta lengua

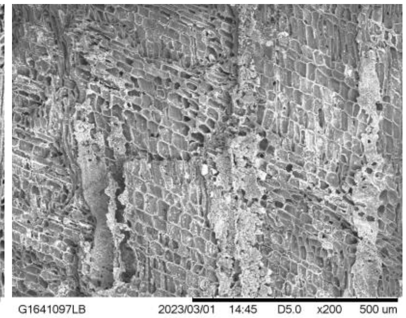
Transverse View



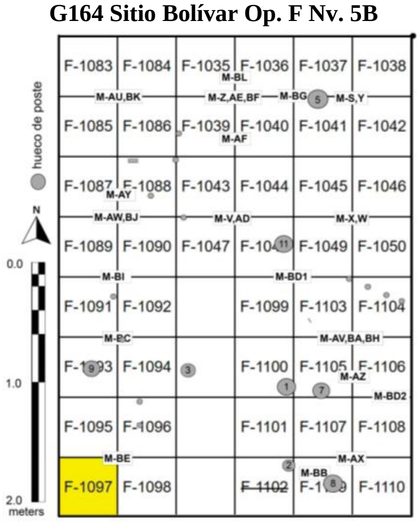
Tangential View



Radial View

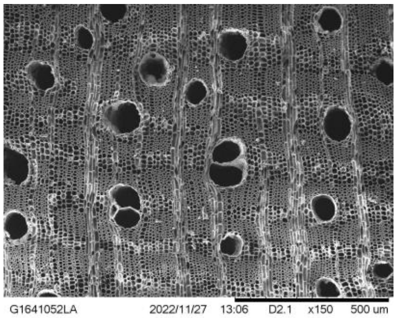


G164 Sitio Bolívar Op. F Nv. 5B

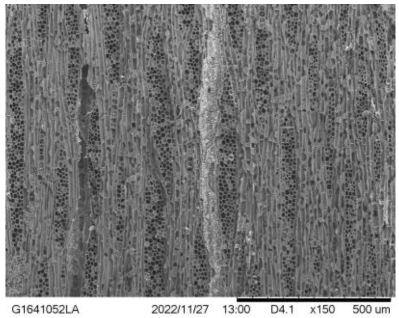


Scientific Name: SAPINDACEAE *Sapindus saponaria* L.
Common Name: jaboncillo, soapberry, yequiti

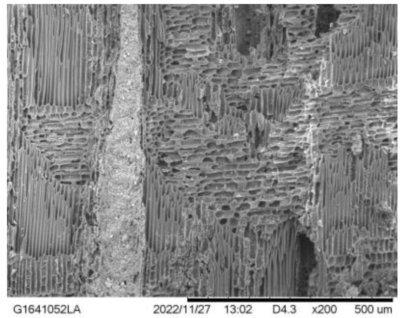
Transverse View



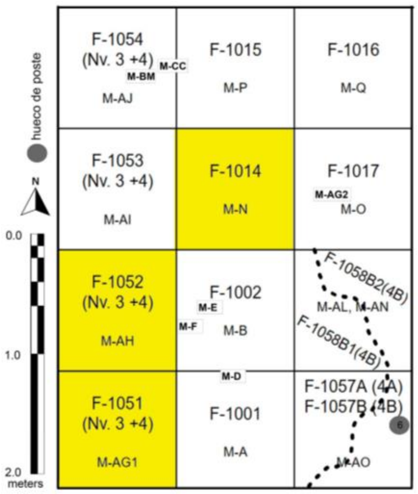
Tangential View



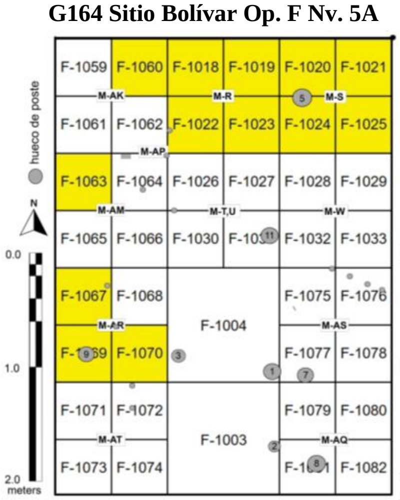
Radial View



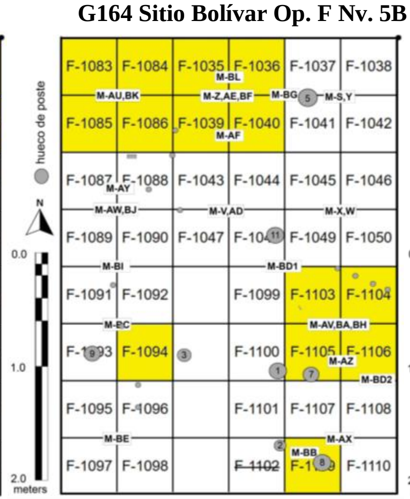
G164 Sitio Bolívar Op. F Nv. 4



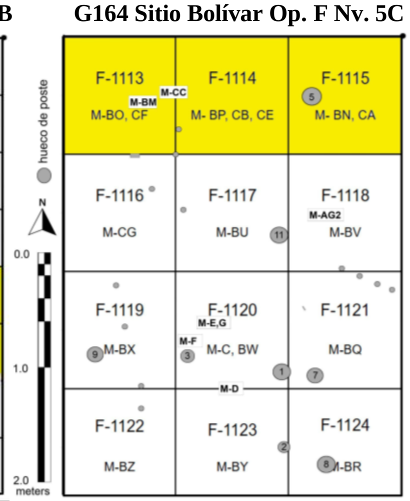
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

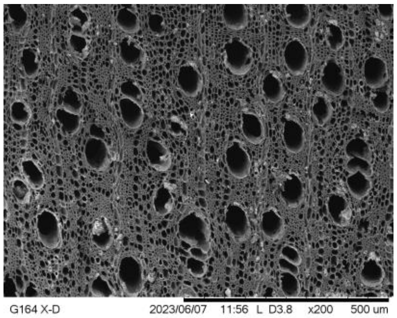


G164 Sitio Bolívar Op. F Nv. 5C

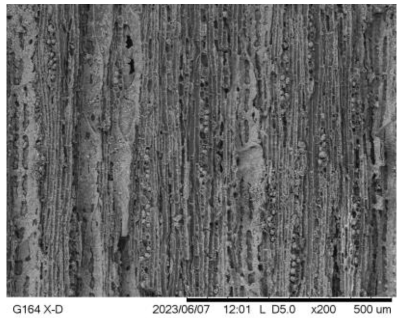


Scientific Name: SAPOTACEAE *Manilkara* sp.
Common Name: mamey, sapodilla, níspero

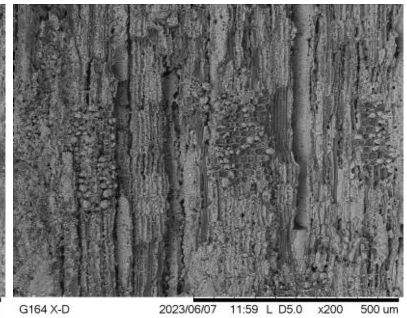
Transverse View



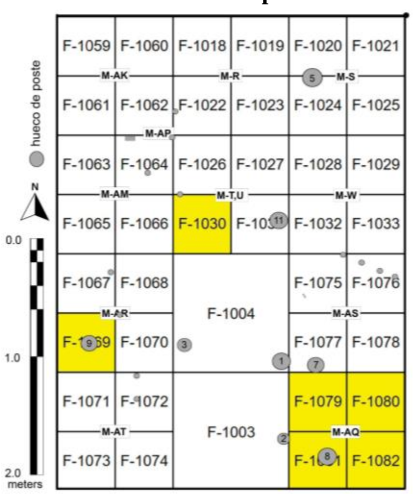
Tangential View



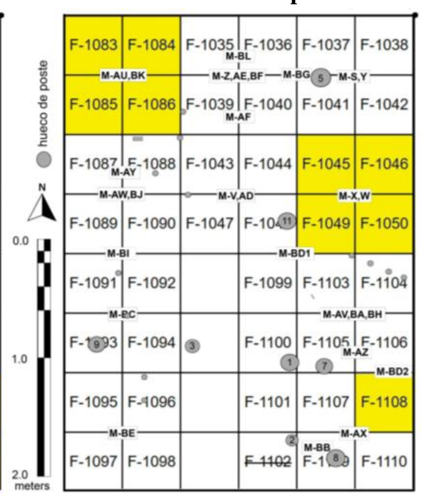
Radial View



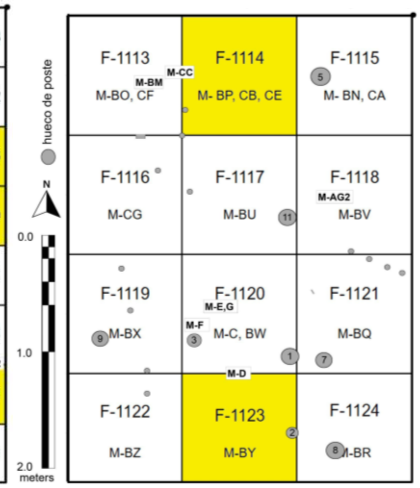
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

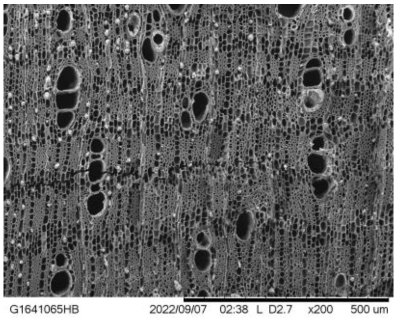


G164 Sitio Bolívar Op. F Nv. 5C

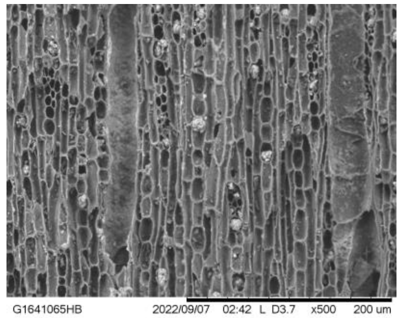


Scientific Name: SAPOTACEAE *Pouteria* sp.
Common Name: mamey, nisperillo, mameicillo, canistel

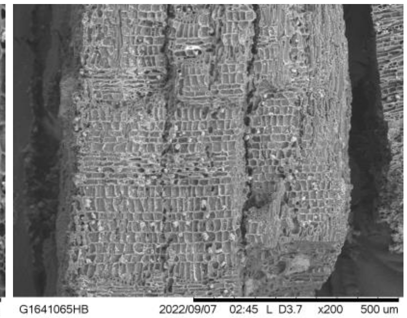
Transverse View



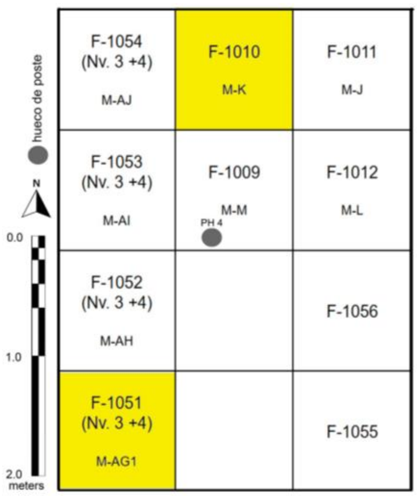
Tangential View



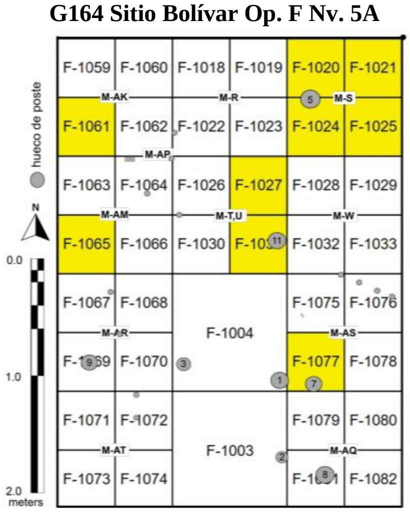
Radial View



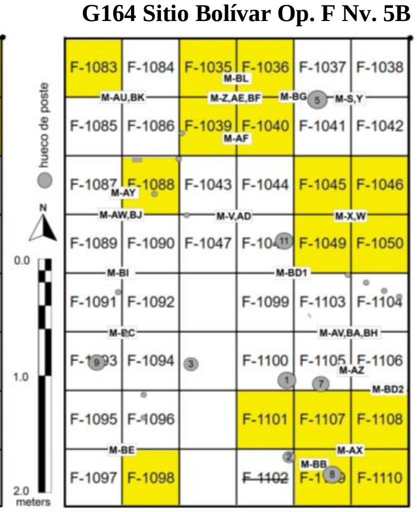
G164 Sitio Bolívar Op. F Nv. 3



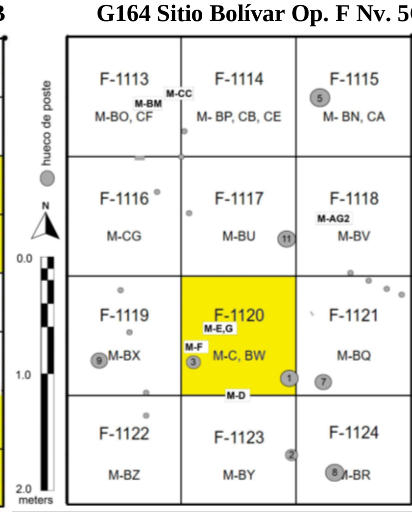
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

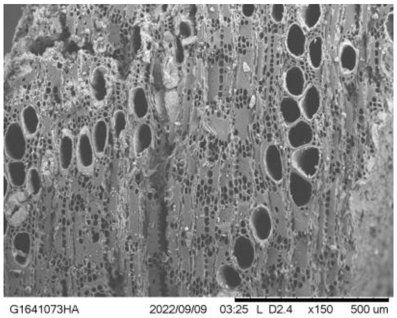


G164 Sitio Bolívar Op. F Nv. 5C

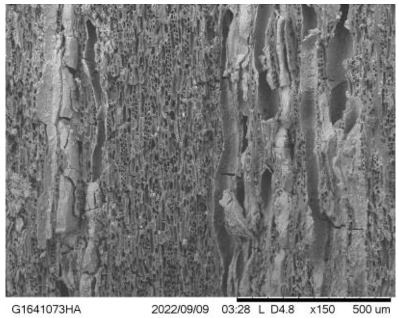


Scientific Name: SAPOTACEAE *Sideroxylon* sp.
Common Name: espino rico

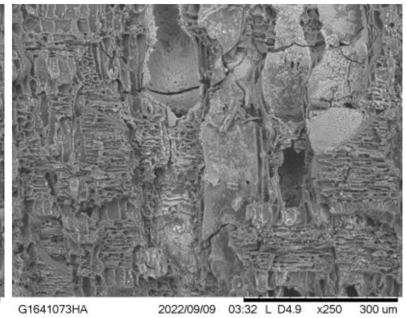
Transverse View



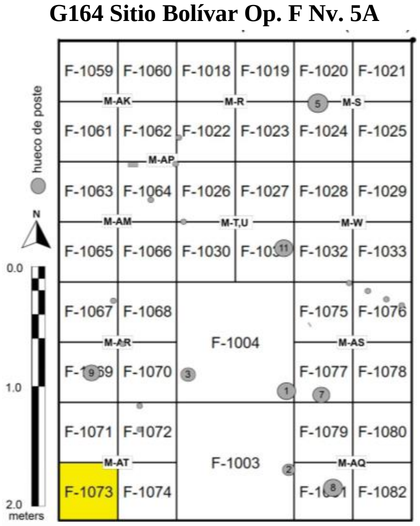
Tangential View



Radial View

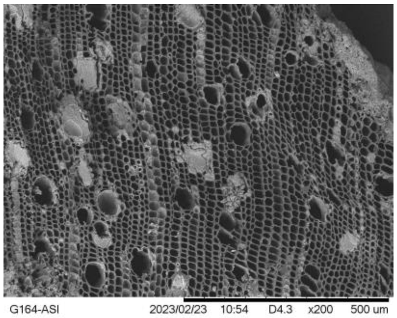


G164 Sitio Bolívar Op. F Nv. 5A

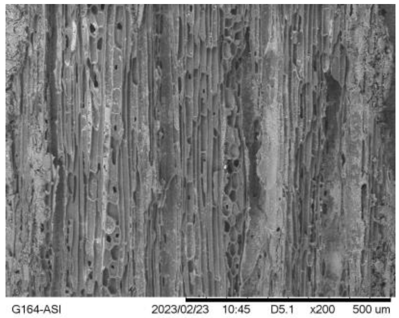


Scientific Name: SCROPHULARIACEAE *Buddleja* sp.
Common Name: butterfly bush

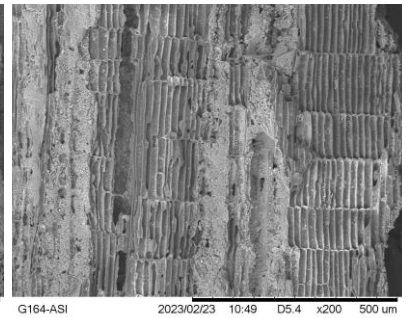
Transverse View



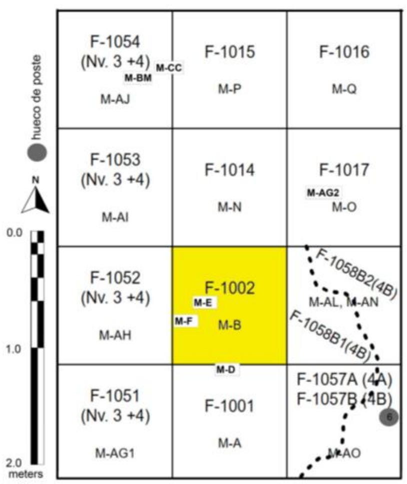
Tangential View



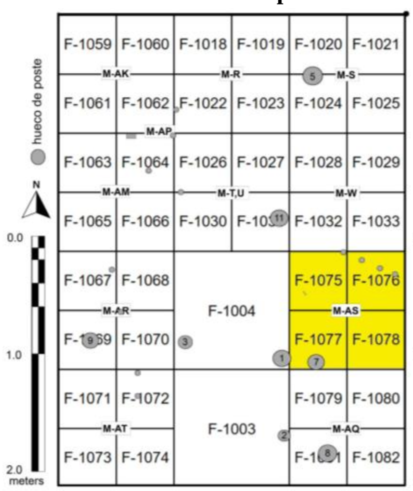
Radial View



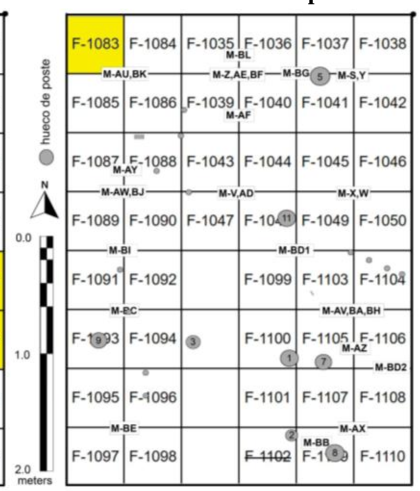
G164 Sitio Bolívar Op. F Nv. 4



G164 Sitio Bolívar Op. F Nv. 5A



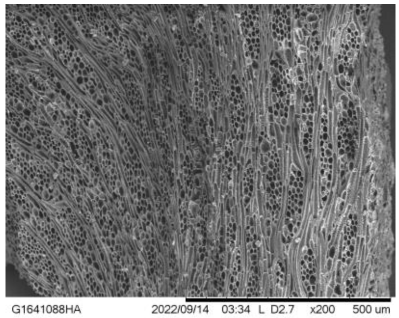
G164 Sitio Bolívar Op. F Nv. 5B



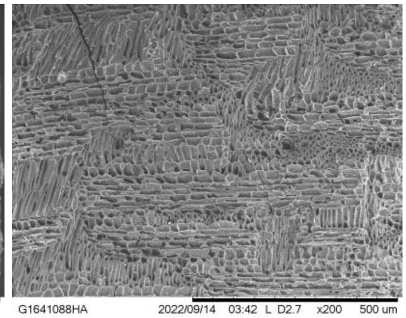
Scientific Name: SIMAROUBACEAE *Simaba* cf. *cedron* Planch.
Common Name: cedron

Transverse View

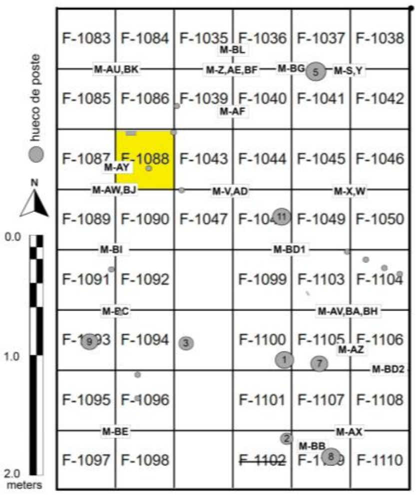
Tangential View



Radial View

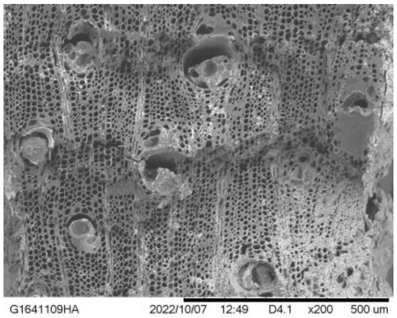


G164 Sitio Bolívar Op. F Nv. 5B

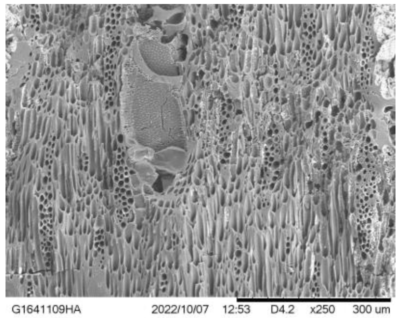


Scientific Name: SIMAROUBACEAE *Simarouba amara* Aubl.
Common Name: aceituno, olivo

Transverse View

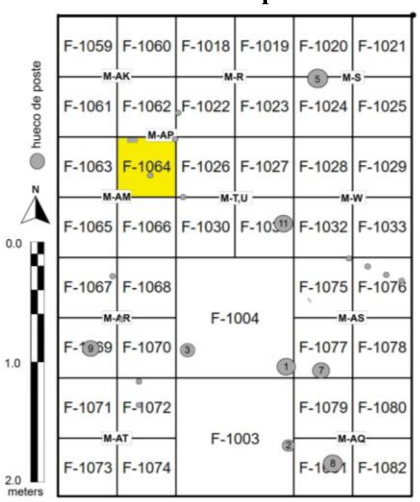


Tangential View

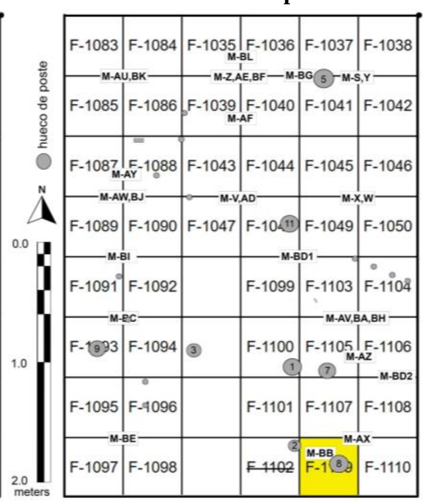


Radial View

G164 Sitio Bolívar Op. F Nv. 5A

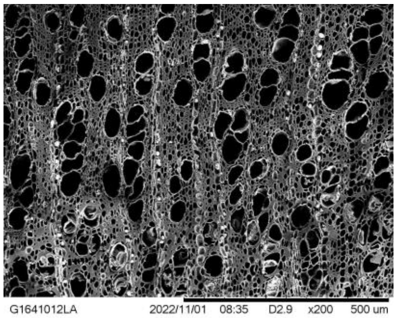


G164 Sitio Bolívar Op. F Nv. 5B

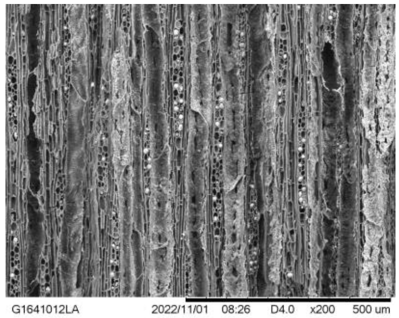


Scientific Name: SIPARUNACEAE *Siparuna* sp.
Common Name: pasmo hediondo, pasmo, limoncillo

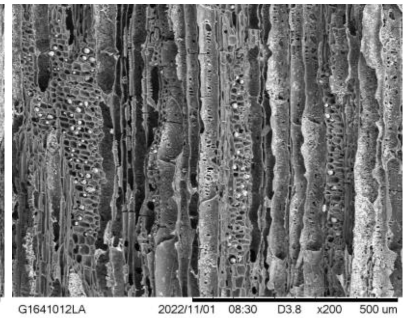
Transverse View



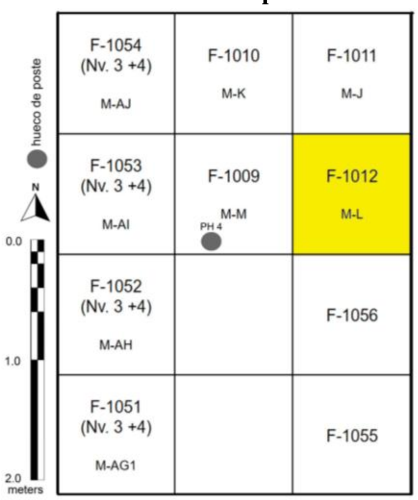
Tangential View



Radial View

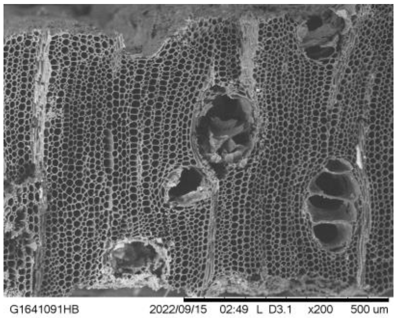


G164 Sitio Bolívar Op. F Nv. 3

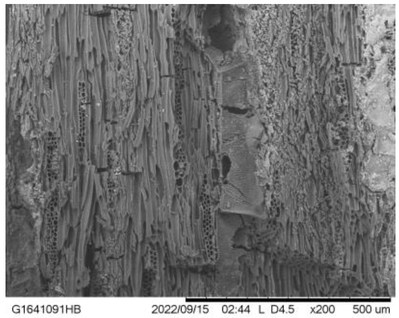


Scientific Name: URTICACEAE *Cecropia* sp.
Common Name: guarumo, trumpet tree

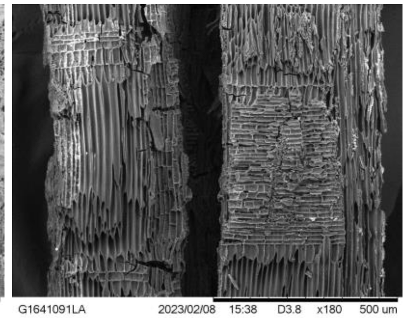
Transverse View



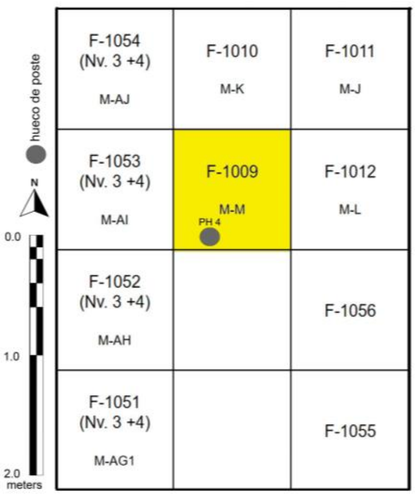
Tangential View



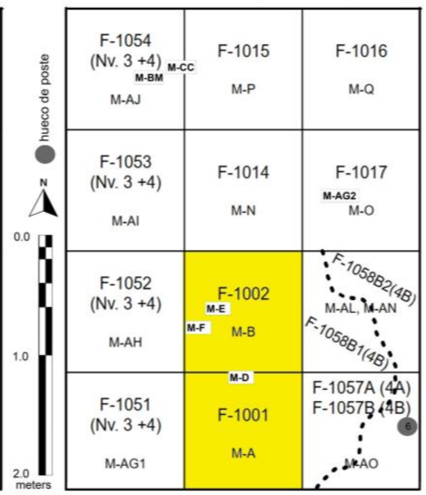
Radial View



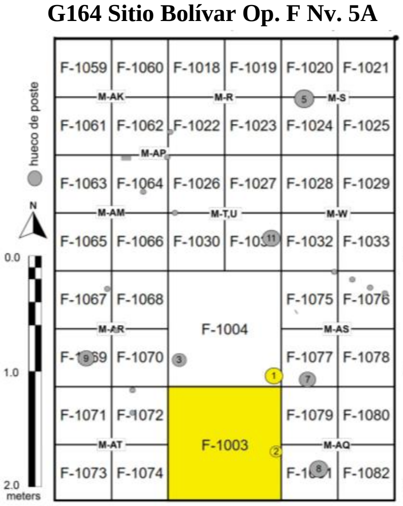
G164 Sitio Bolívar Op. F Nv. 3



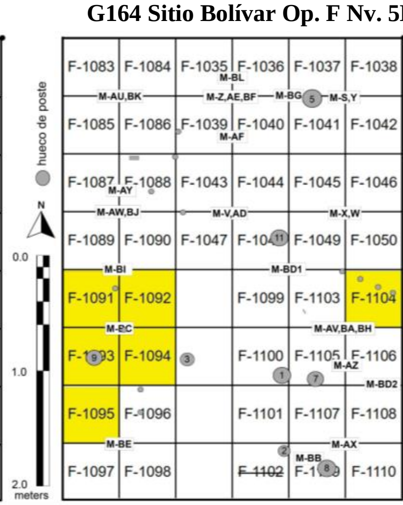
G164 Sitio Bolívar Op. F Nv. 4



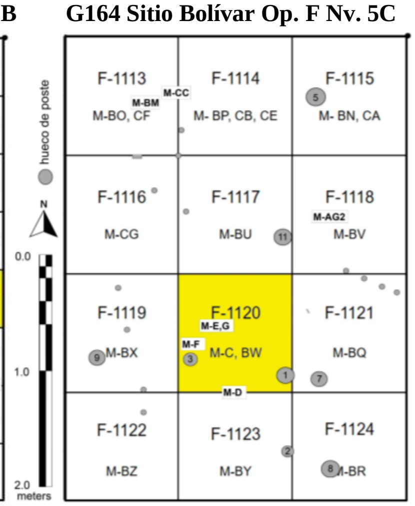
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

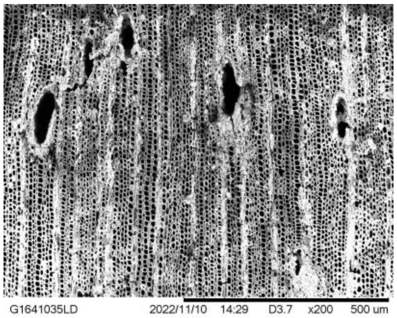


G164 Sitio Bolívar Op. F Nv. 5C

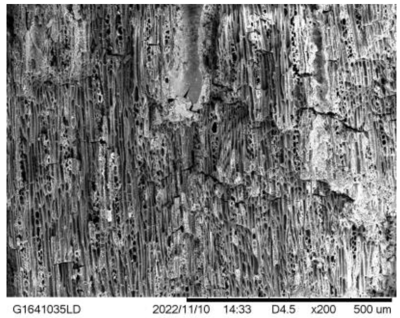


Scientific Name: URTICACEAE *Pourouma* sp.
Common Name: uvito, magabe, guarumo macho

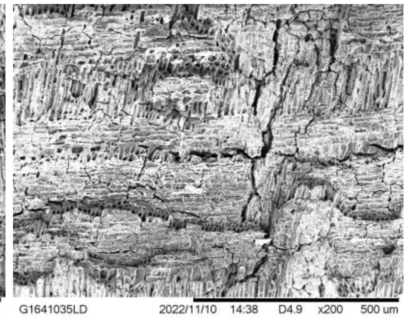
Transverse View



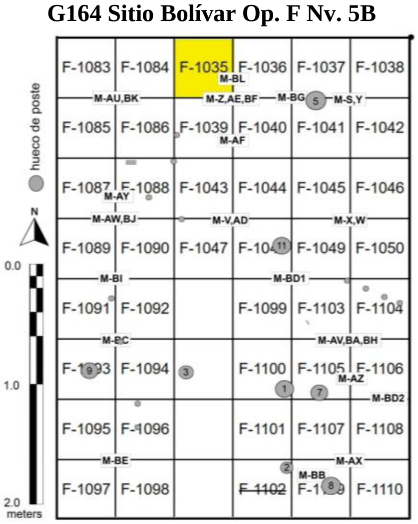
Tangential View



Radial View

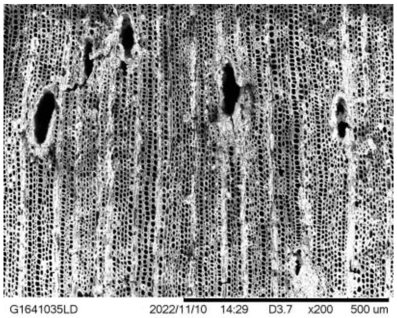


G164 Sitio Bolívar Op. F Nv. 5B

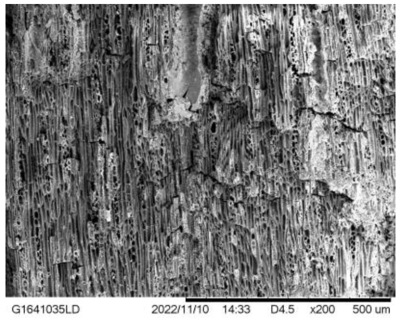


Scientific Name: VOCHYSIACEAE *Vochysia* sp.
Common Name: mayo, flor de mayo, botarrama, tecla

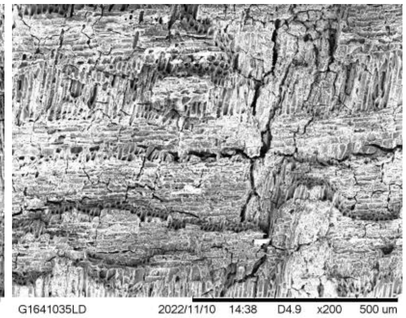
Transverse View



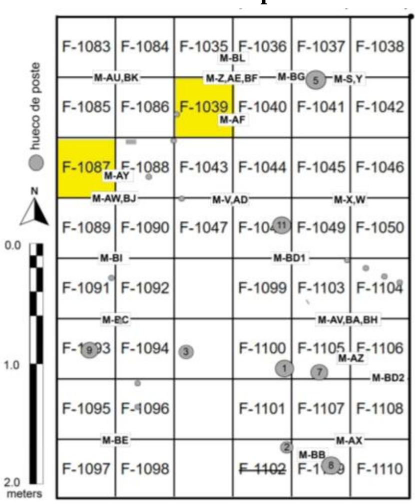
Tangential View



Radial View

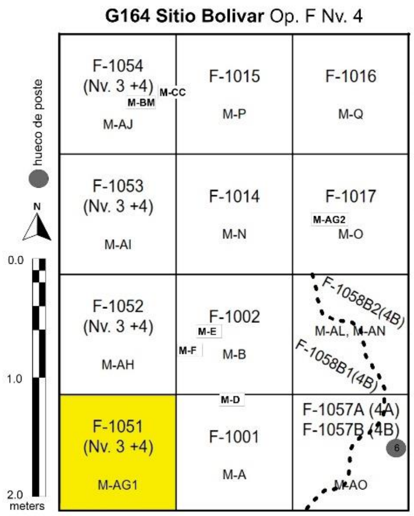


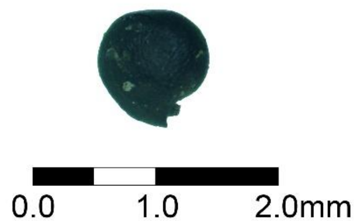
G164 Sitio Bolívar Op. F Nv. 5B



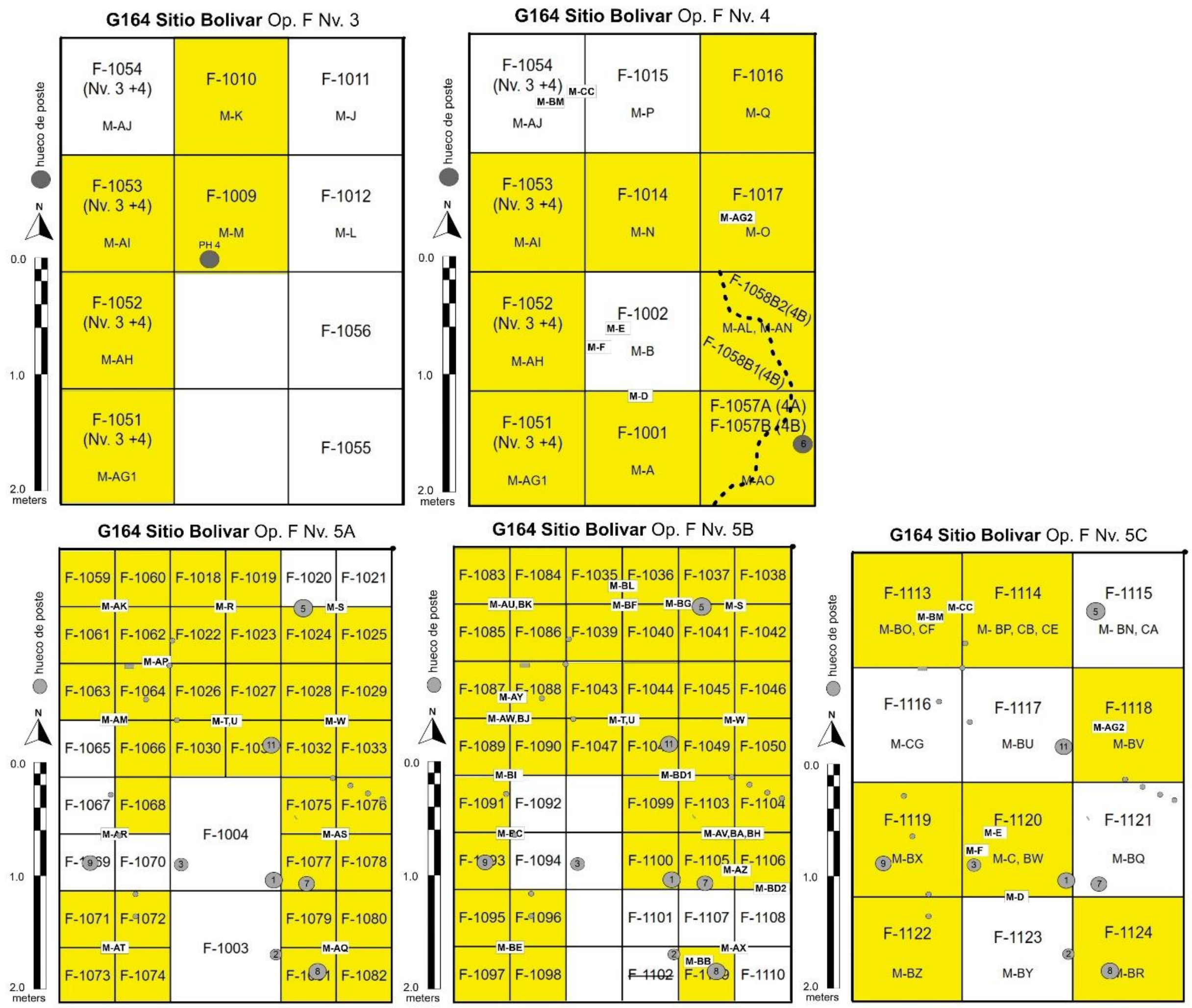
Appendix I:
G164 Sitio Bolívar - Identified Seeds, Fruits, and Geophytes from the 2021 Excavations
Images and Context Maps

Scientific Name: AMARANTHACEAE cf. *Chenopodium* sp.
Common Name: quinoa
Plant Part: seed



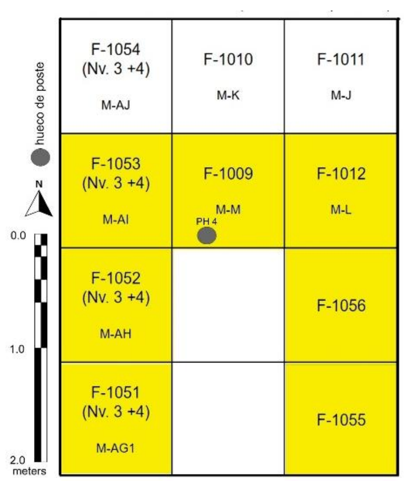


Scientific Name: ARECACEAE *Acrocomia aculeata*
Common Name: coyol
Plant Part: fruit endocarp

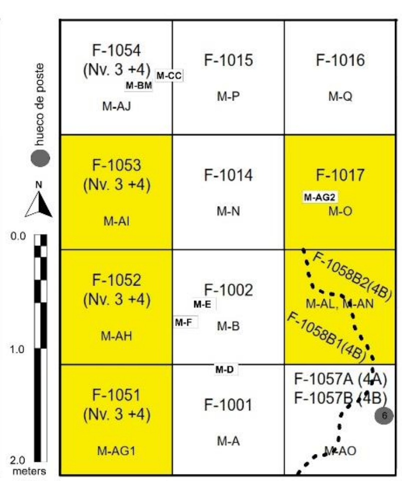


Scientific Name: ASTERACEAE
Common Name: sunflower or composite family
Plant Part: achene

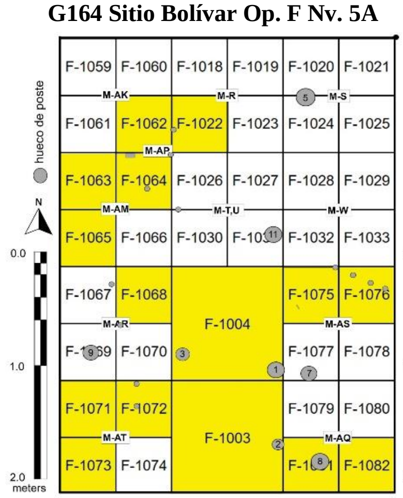
G164 Sitio Bolívar Op. F Nv. 3



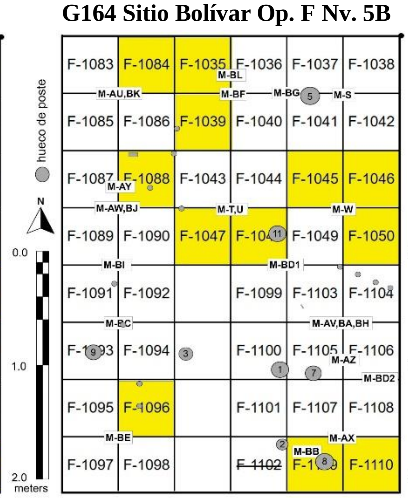
G164 Sitio Bolívar Op. F Nv. 4



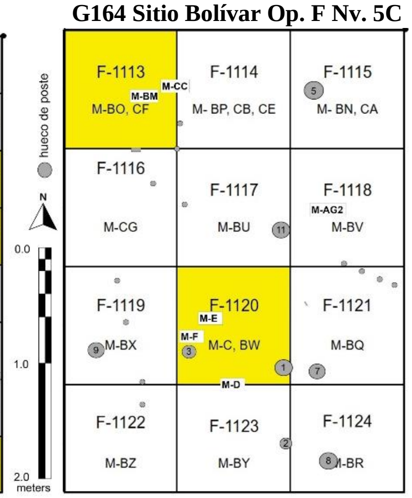
G164 Sitio Bolívar Op. F Nv. 5A



G164 Sitio Bolívar Op. F Nv. 5B

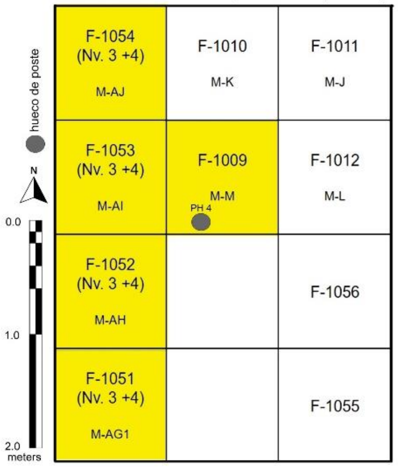


G164 Sitio Bolívar Op. F Nv. 5C

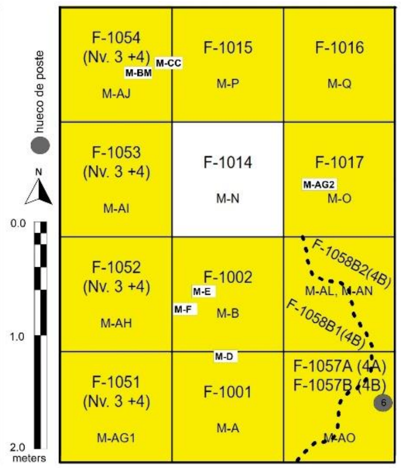


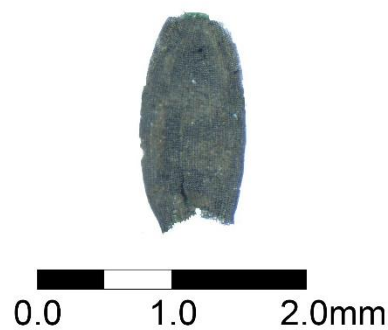
Scientific Name: ASTERACEAE *Acmella* sp.
Common Name: toothache plant, paracress
Plant Part: achene

G164 Sitio Bolívar Op. F Nv. 3

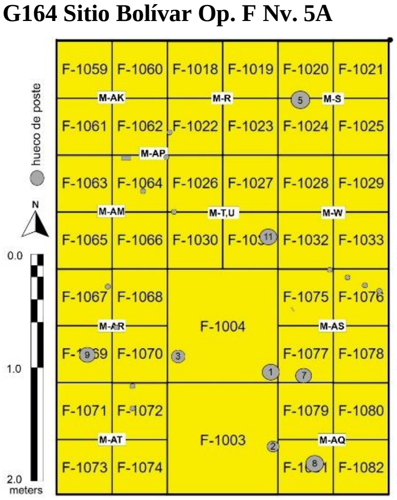


G164 Sitio Bolívar Op. F Nv. 4

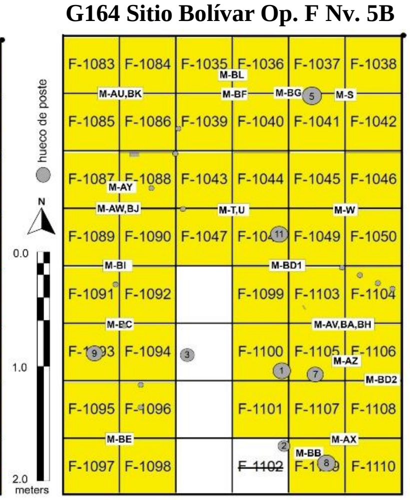




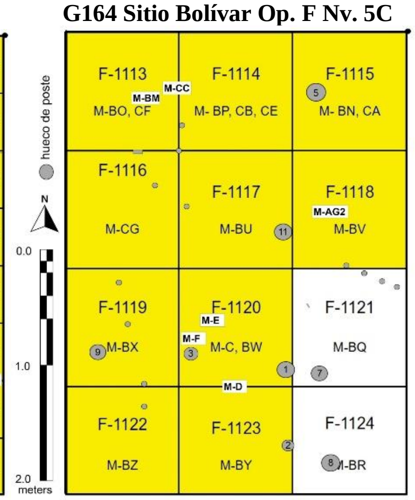
G164 Sitio Bolívar Op. F Nv. 5A



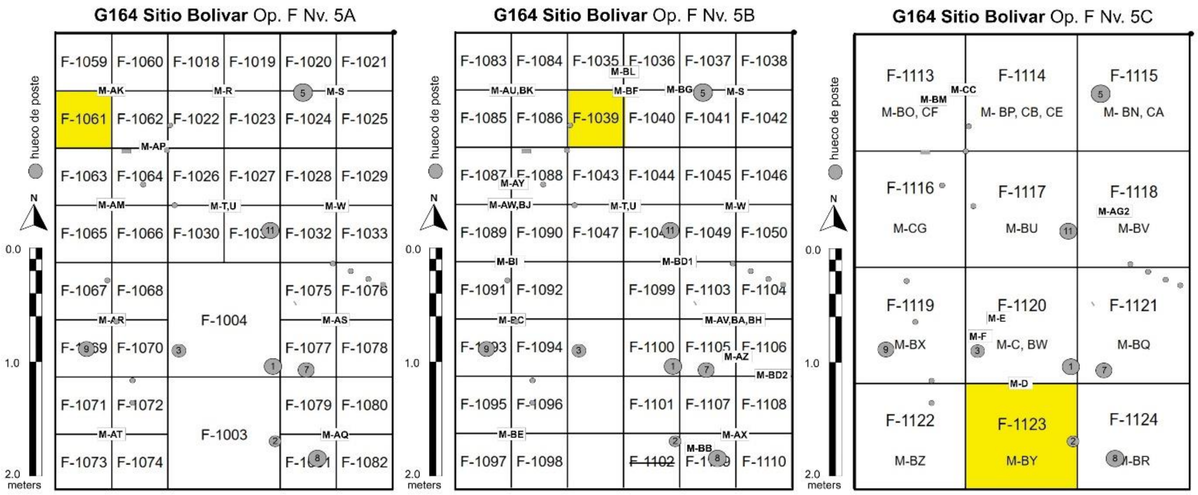
G164 Sitio Bolívar Op. F Nv. 5B



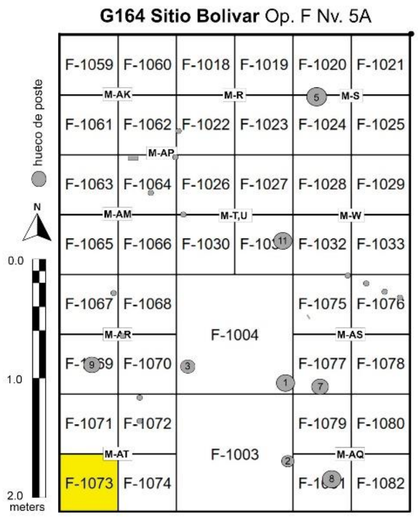
G164 Sitio Bolívar Op. F Nv. 5C

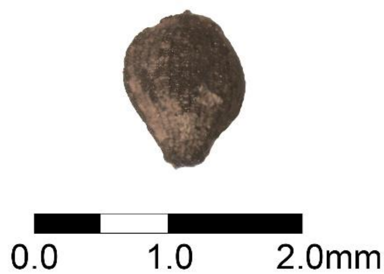


Scientific Name: CUCURBITACEAE
Common Name: squash
Plant Part: rind

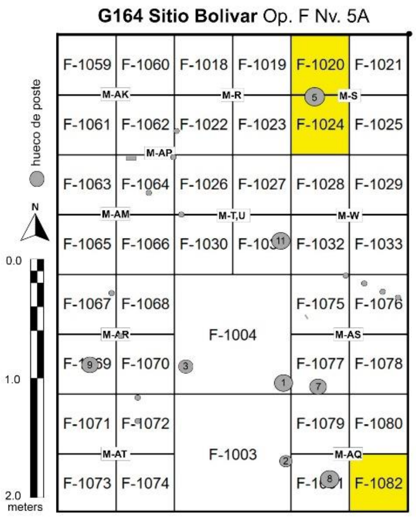


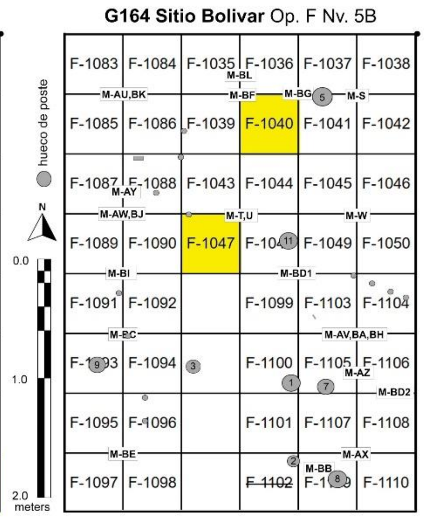
Scientific Name: CYPERACEAE cf. *Fimbristylis* sp.
Common Name: fimbry
Plant Part: seed



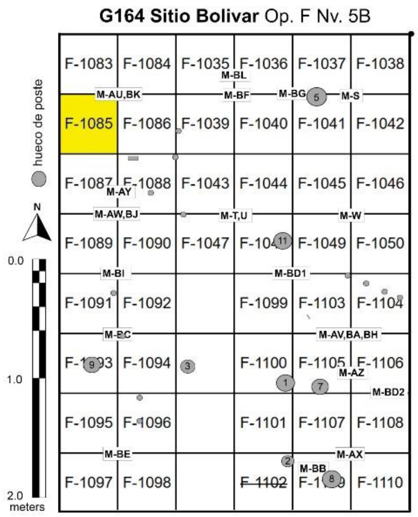


Scientific Name: FABACEAE *Phaseolus* sp.
Common Name: common bean
Plant Part: cotyledon

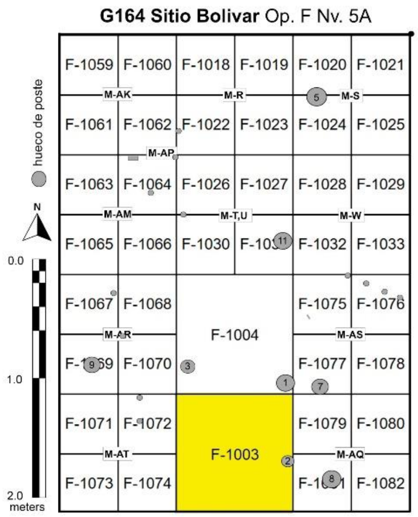


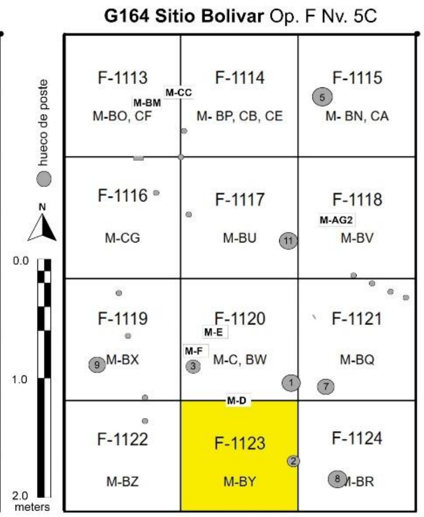


Scientific Name: FABACEAE
Common Name: legume
Plant Part: cotyledon

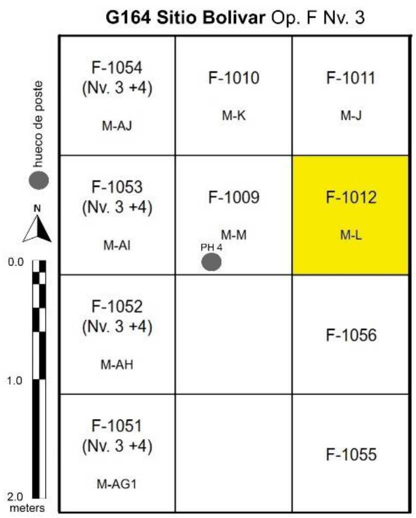


Scientific Name: MOLLUGINACEAE *Mollugo verticillata* L.
Common Name: carpetweed
Plant Part: seed



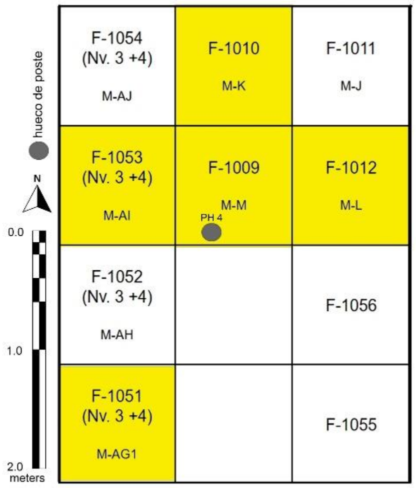


Scientific Name: PASSIFLORACEAE cf. *Passiflora* sp.
Common Name: passion flower / passion fruit
Plant Part: seed

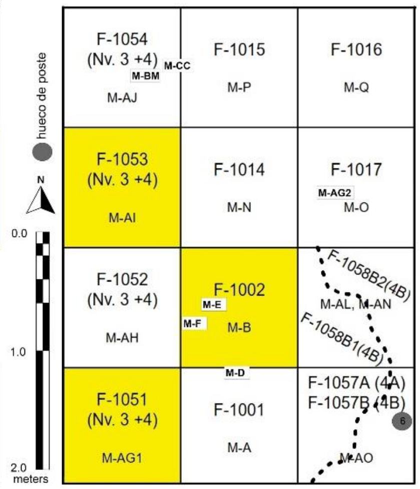


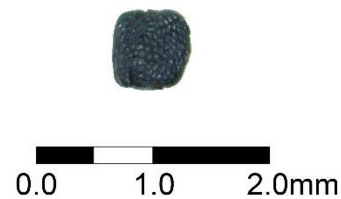
Scientific Name: PIPERACEAE *Piper* sp.
Common Name: hinojo
Plant Part: seed

G164 Sitio Bolívar Op. F Nv. 3

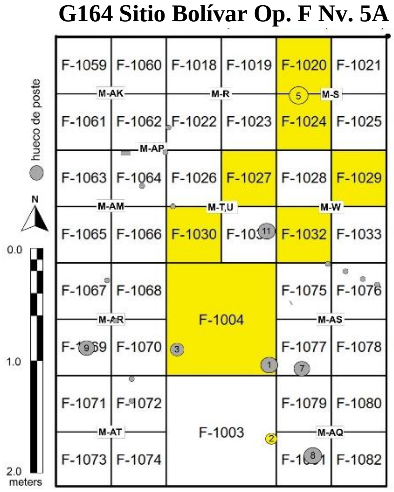


G164 Sitio Bolívar Op. F Nv. 4

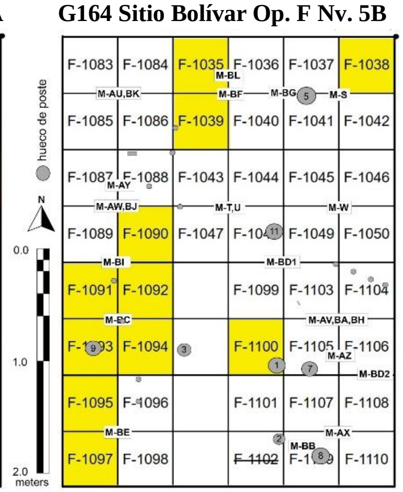




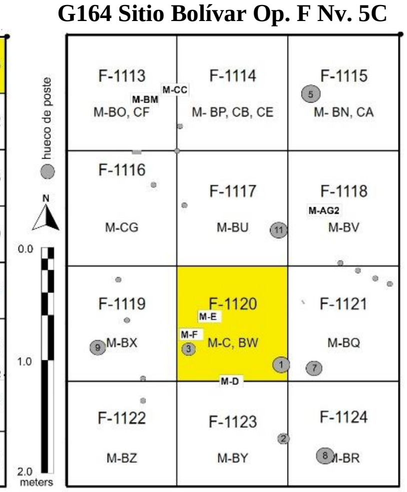
G164 Sitio Bolívar Op. F Nv. 5A



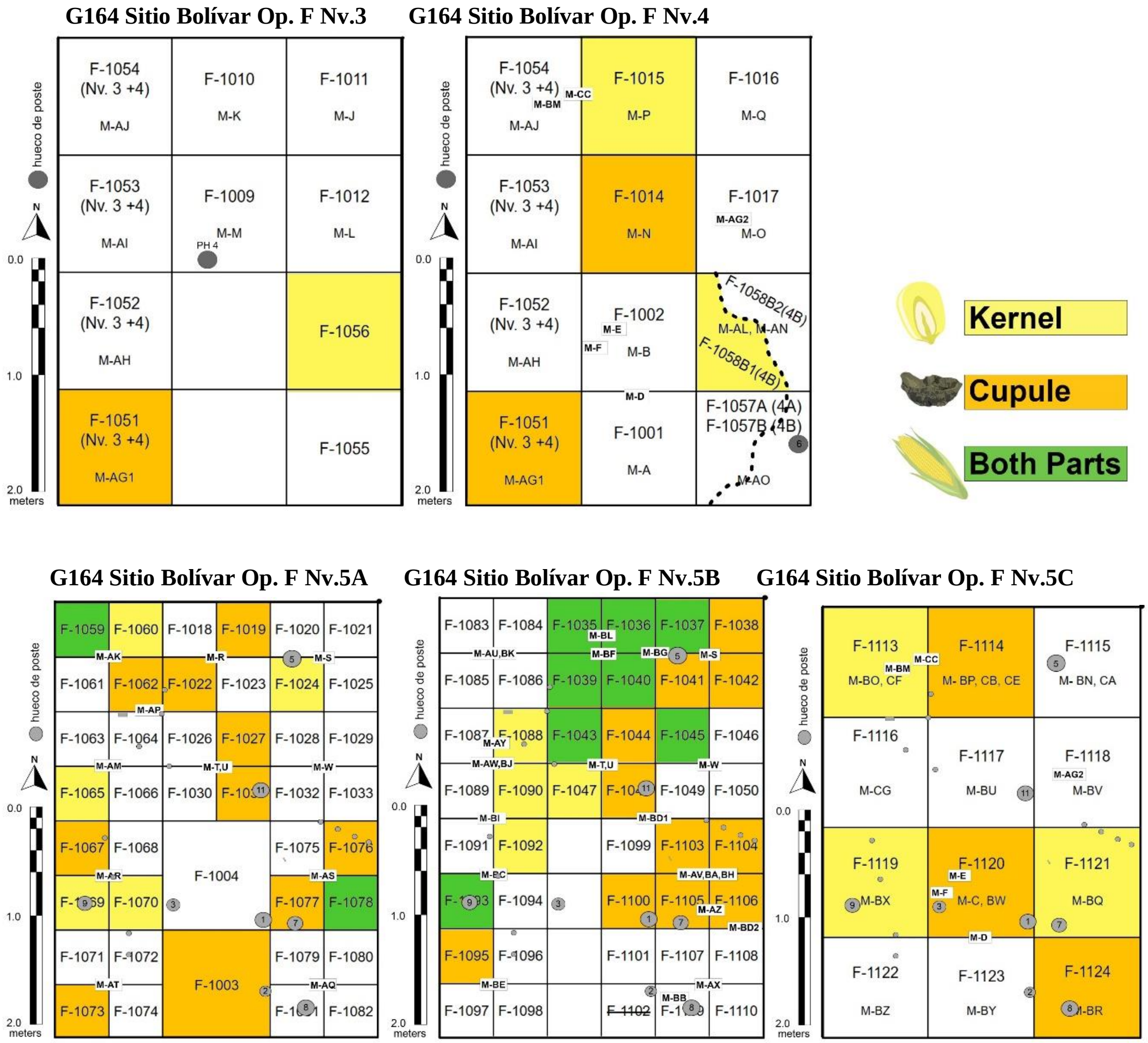
G164 Sitio Bolívar Op. F Nv. 5B

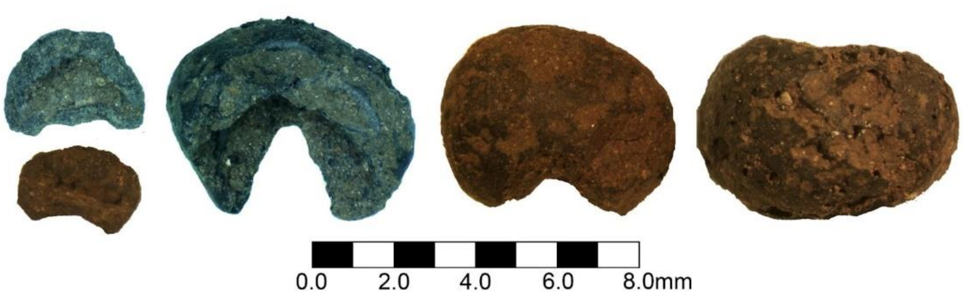


G164 Sitio Bolívar Op. F Nv. 5C

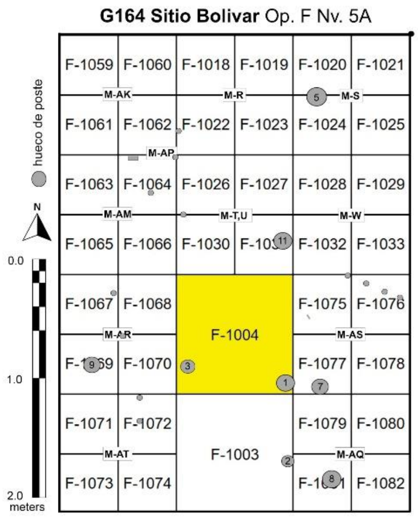


Scientific Name: POACEAE *Zea mays* L.
Common Name: maize
Plant Part: cupules and kernels

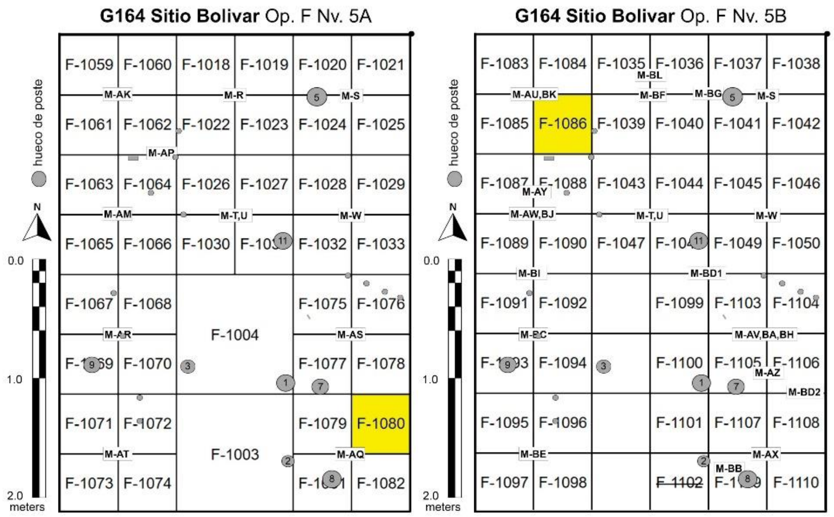


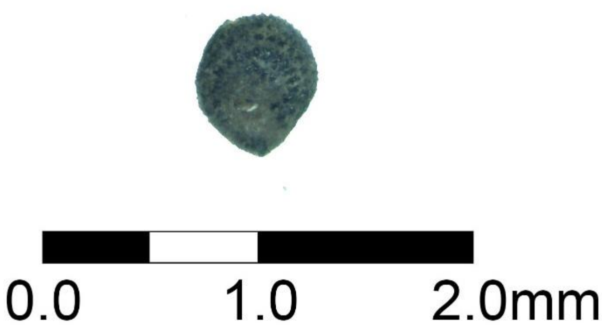


Scientific Name: POACEAE
Common Name: grass
Plant Part: seed

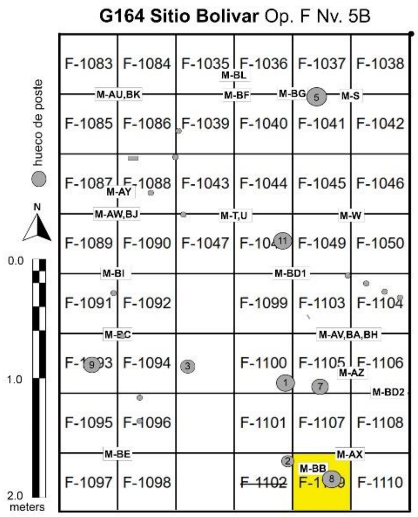


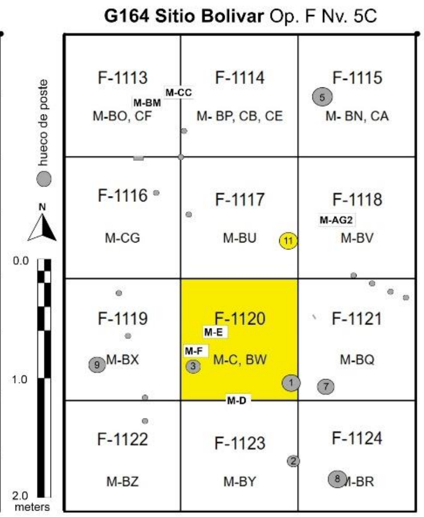
Scientific Name: PORTULACACEAE *Portulaca* cf. *oleracea* L.
Common Name: purslane
Plant Part: seed

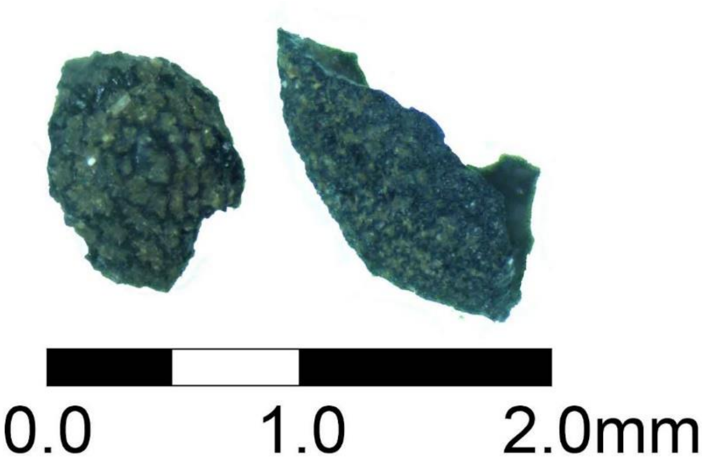




Scientific Name: SOLANACEAE *Nicotiana* sp.
Common Name: tobacco
Plant Part: seed

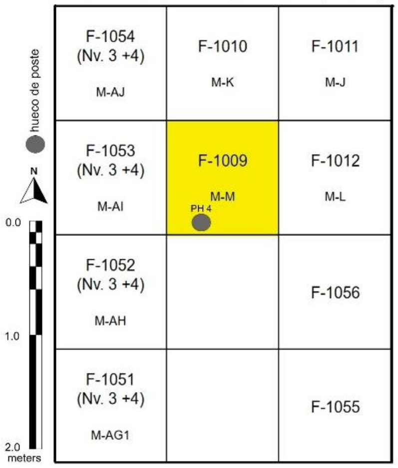




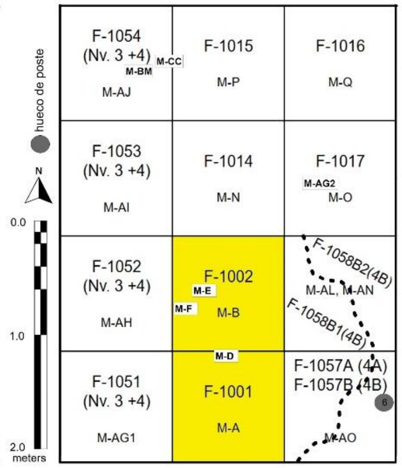


Scientific Name: URTICACEAE *Cecropia* sp.
Common Name: trumpet tree
Plant Part: seed

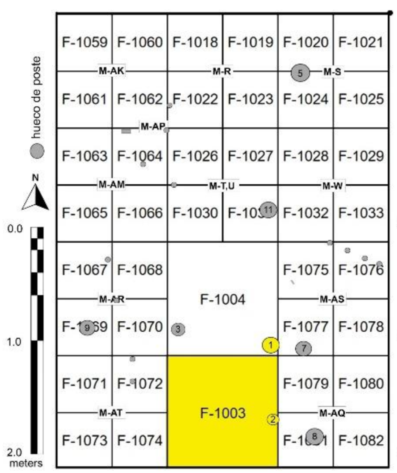
G164 Sitio Bolívar Op. F Nv.3



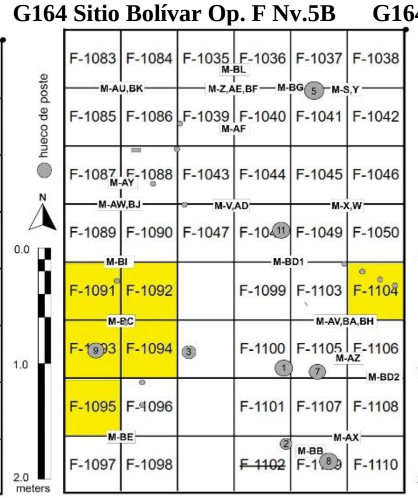
G164 Sitio Bolívar Op. F Nv.4



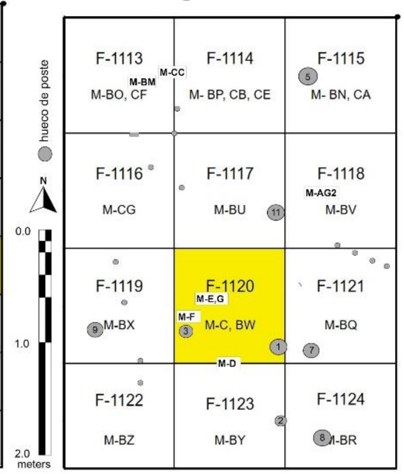
G164 Sitio Bolívar Op. F Nv.5A



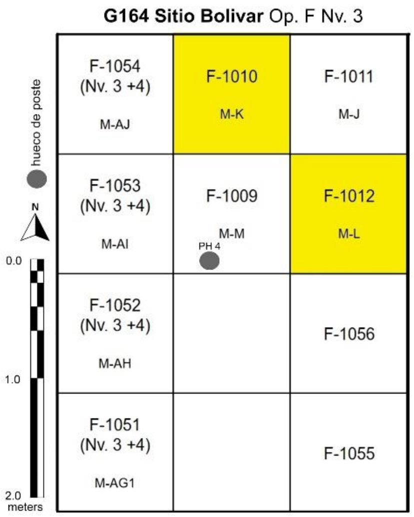
G164 Sitio Bolívar Op. F Nv.5B

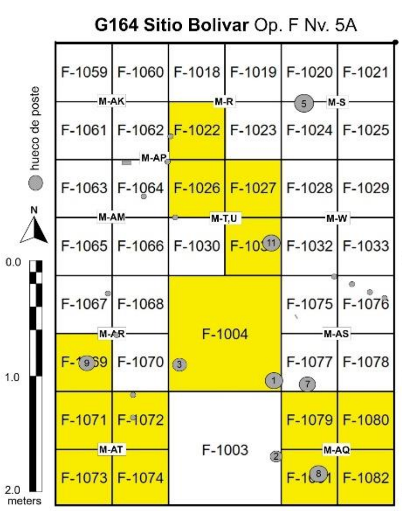


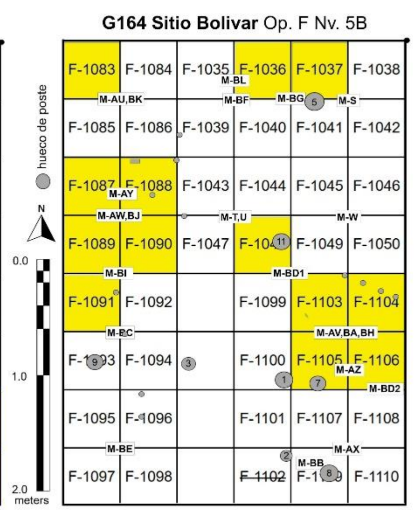
G164 Sitio Bolívar Op. F Nv.5C

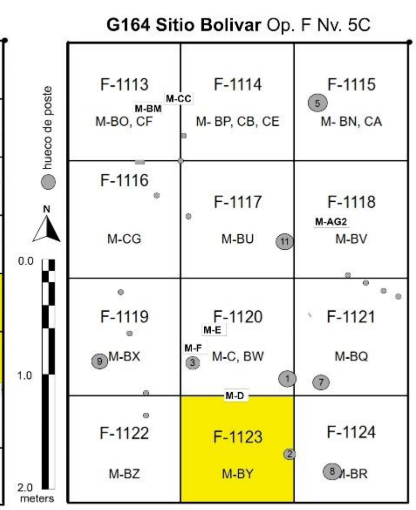


Scientific Name: unidentified
Common Name: geophyte
Plant Part: root or stem

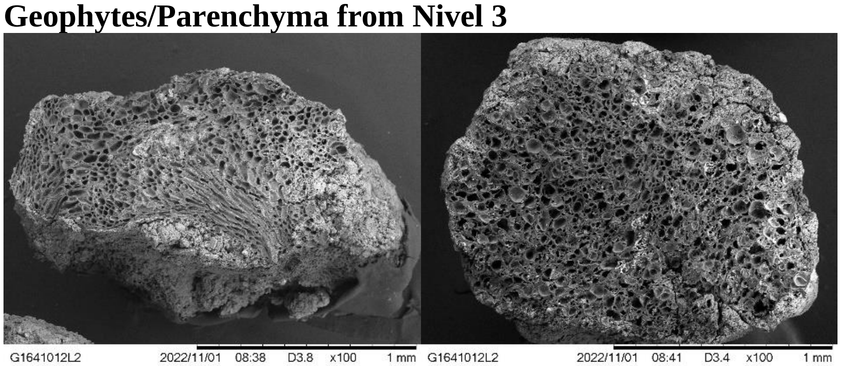




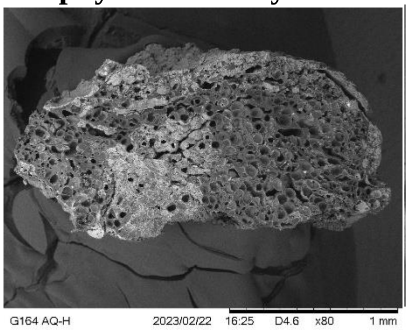


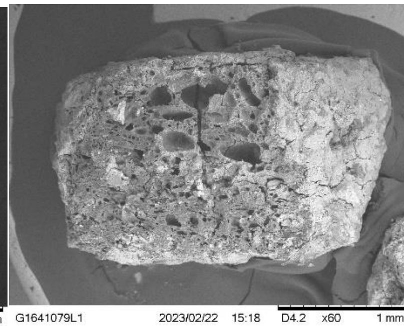


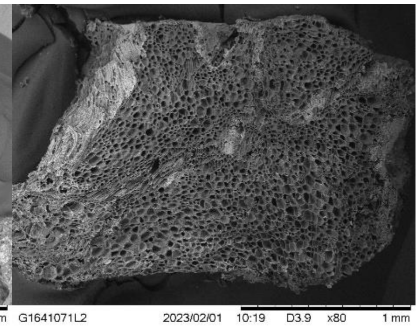
Geophytes/Parenchyma from Nivel 3

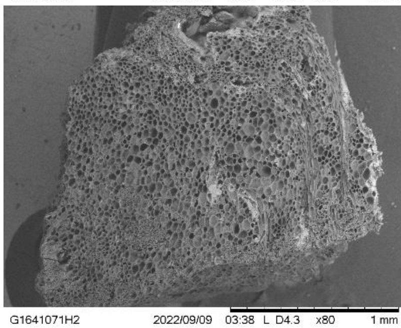


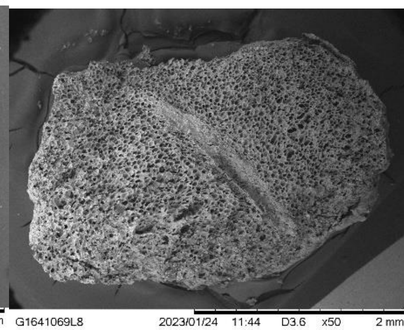
Geophytes/Parenchyma from Nivel 5A

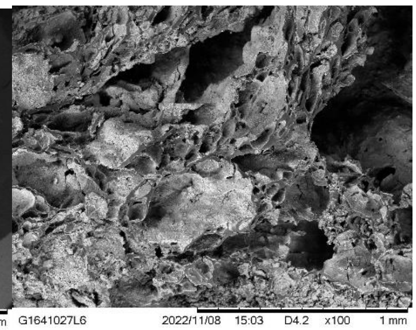




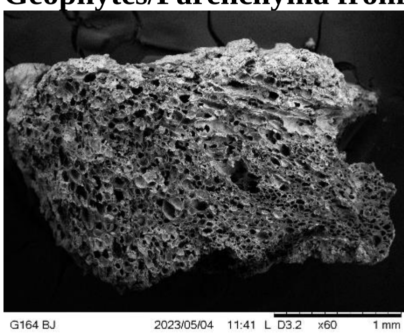


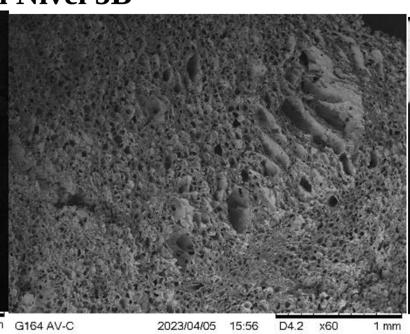


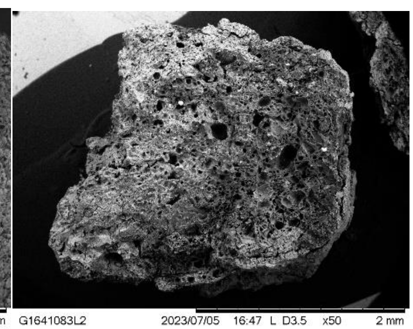


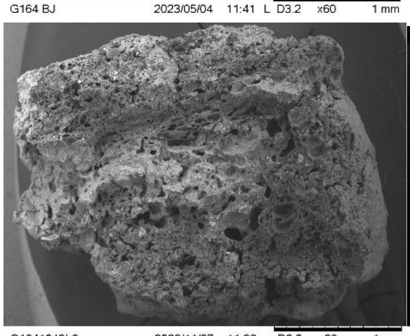


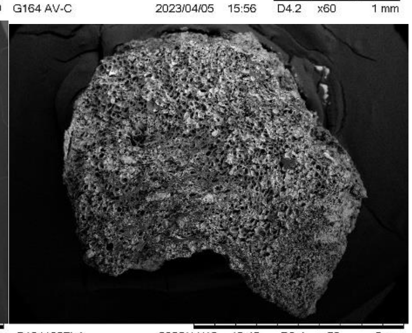
Geophytes/Parenchyma from Nivel 5B



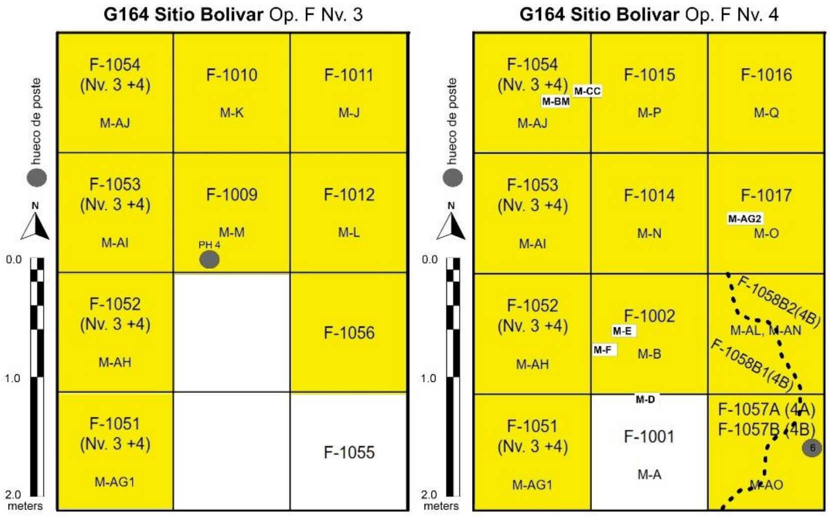


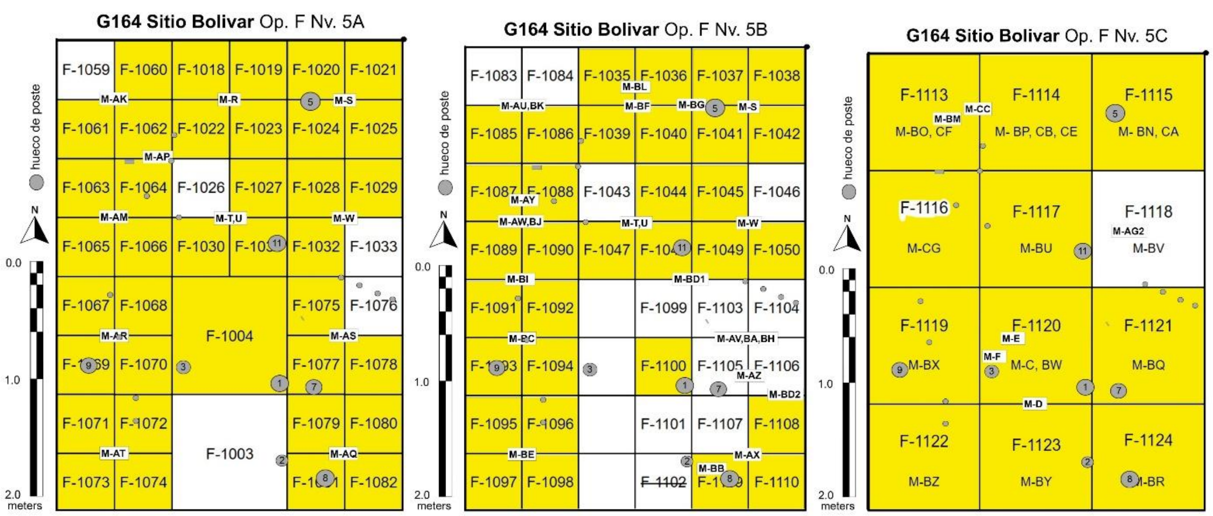




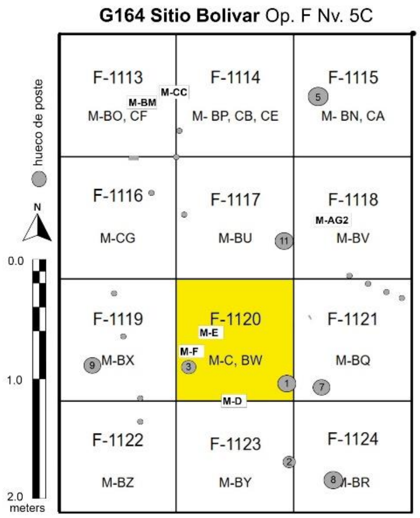


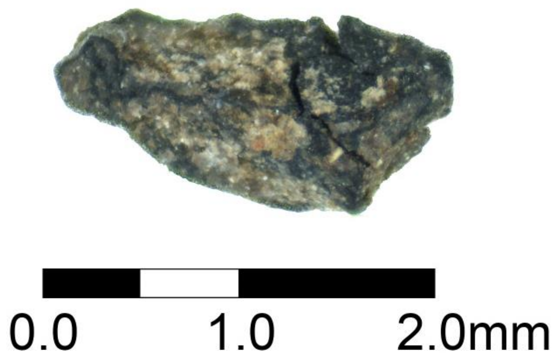
Unidentified Seeds
UNID A



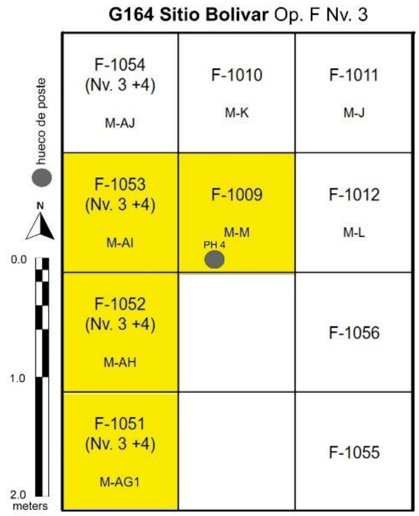


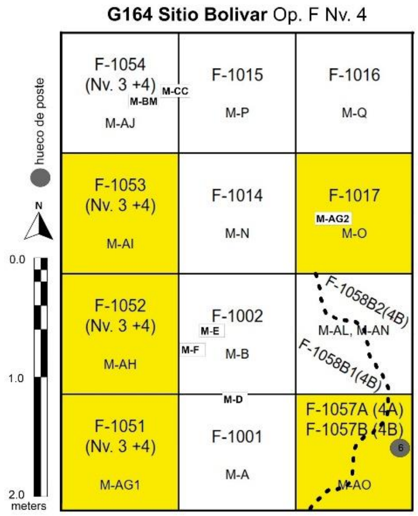
UNID B

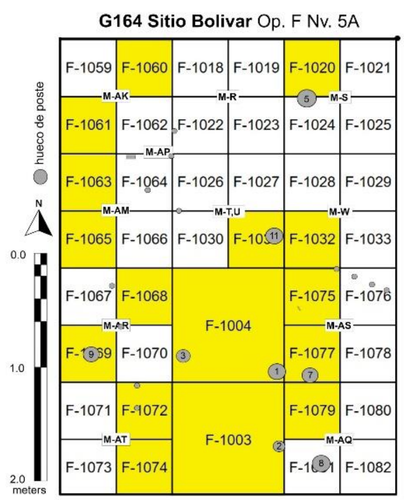

G164 Sitio Bolivar Op. F Nv. 5C
hueco de poste
N
F-1113
M-BO, CF
M-BM
M-CC
F-1114
M- BP, CB, CE
F-1115
M- BN, CA
F-1116
M-CG
F-1117
M-BU
F-1118
M-AG2
M-BV
F-1119
M-BX
F-1120
M-E
M-F
M-C, BW
M-D
F-1121
M-BQ
F-1122
M-BZ
F-1123
M-BY
F-1124
M-BR
0.0
1.0
2.0
meters

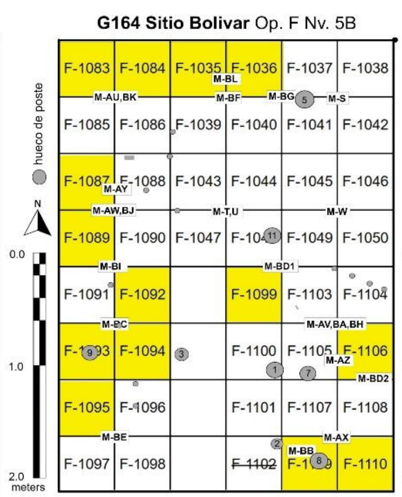

0.0
1.0
2.0mm

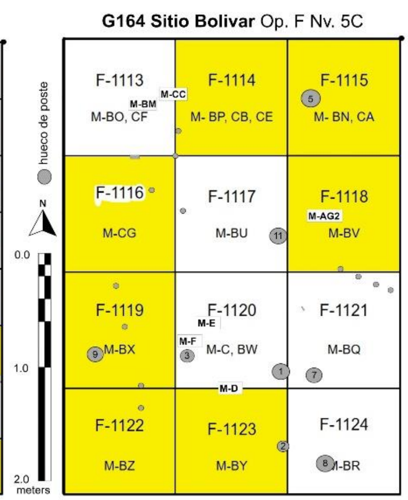
UNID C


G164 Sitio Bolivar Op. F Nv. 3
hueco de poste
N
0.0
1.0
2.0
meters
F-1054 (Nv. 3 +4) M-AJ
F-1010 M-K
F-1011 M-J
F-1053 (Nv. 3 +4) M-AI
F-1009 M-M
PH 4
F-1012 M-L
F-1052 (Nv. 3 +4) M-AH
F-1056
F-1051 (Nv. 3 +4) M-AG1
F-1055


G164 Sitio Bolivar Op. F Nv. 4
hueco de poste
N
0.0
1.0
2.0
meters
F-1054 (Nv. 3 +4) M-BM M-CC M-AJ
F-1015 M-P
F-1016 M-Q
F-1053 (Nv. 3 +4) M-AI
F-1014 M-N
F-1017 M-AG2 M-O
F-1052 (Nv. 3 +4) M-AH
F-1002 M-E M-F M-B
F-1058B2(4B)
M-AL, M-AN
F-1058B1(4B)
M-D
F-1051 (Nv. 3 +4) M-AG1
F-1001 M-A
F-1057A (4A)
F-1057B (4B)
M-AO

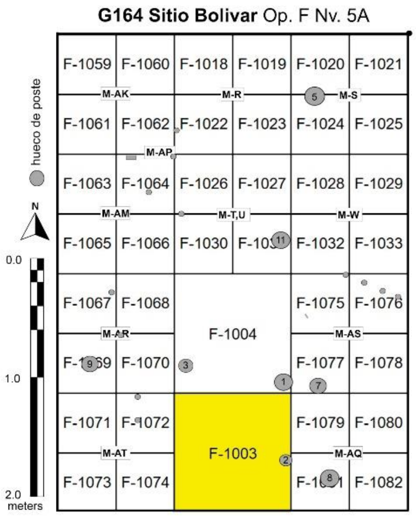

G164 Sitio Bolivar Op. F Nv. 5A
hueco de poste
N
0.0
1.0
2.0
meters
F-1059 F-1060 F-1018 F-1019 F-1020 F-1021
M-AK M-R M-S
F-1061 F-1062 F-1022 F-1023 F-1024 F-1025
M-AP
F-1063 F-1064 F-1026 F-1027 F-1028 F-1029
M-AM M-T,U M-W
F-1065 F-1066 F-1030 F-1032 F-1033
F-1067 F-1068 F-1004 F-1075 F-1076
M-AR M-AS
F-1070 F-1077 F-1078
F-1071 F-1003 F-1079 F-1080
M-AT M-AQ
F-1073 F-1074 F-1082


G164 Sitio Bolivar Op. F Nv. 5B
hueco de poste
N
0.0
1.0
2.0
meters
F-1083 F-1084 F-1035 F-1036 F-1037 F-1038
M-BL
M-AU,BK M-BF M-BG M-S
F-1085 F-1086 F-1039 F-1040 F-1041 F-1042
F-1088 F-1043 F-1044 F-1045 F-1046
M-AY
M-AW,BJ M-T,U M-W
F-1089 F-1090 F-1047 F-1049 F-1050
M-BI M-BD1
F-1091 F-1092 F-1099 F-1103 F-1104
M-BC M-AV,BA,BH
F-1094 F-1100 F-1105 F-1106
M-AZ M-BD2
F-1095 F-1096 F-1101 F-1107 F-1108
M-BE M-AX
M-BB
F-1097 F-1098 F-1102 F-1110


G164 Sitio Bolivar Op. F Nv. 5C
hueco de poste
N
0.0
1.0
2.0
meters
F-1113 M-BM M-CC M-BO, CF
F-1114 M- BP, CB, CE
F-1115 M- BN, CA
F-1116 M-CG
F-1117 M-BU
F-1118 M-AG2 M-BV
F-1119 M-BX
F-1120 M-E M-F M-C, BW
F-1121 M-BQ
M-D
F-1122 M-BZ
F-1123 M-BY
F-1124 M-BR


0.0
1.0
2.0mm

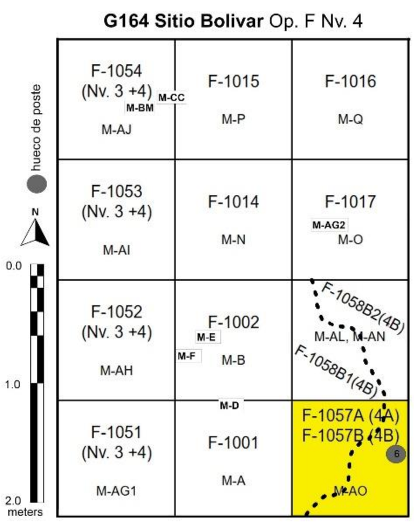
UNID D



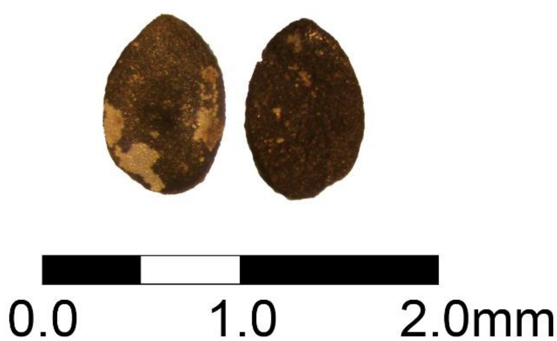
G164 Sitio Bolivar Op. F Nv. 5A
F-1059
F-1060
F-1018
F-1019
F-1020
F-1021
M-AK
M-R
M-S
F-1061
F-1062
F-1022
F-1023
F-1024
F-1025
M-AP
F-1063
F-1064
F-1026
F-1027
F-1028
F-1029
M-AM
M-T,U
M-W
F-1065
F-1066
F-1030
F-1032
F-1033
F-1067
F-1068
F-1004
F-1075
F-1076
M-AR
M-AS
F-1070
F-1077
F-1078
F-1071
F-1072
F-1003
F-1079
F-1080
M-AT
M-AQ
F-1073
F-1074
F-1082
hueco de poste
N
0.0
1.0
2.0
meters

0.0
1.0
2.0mm

UNID E

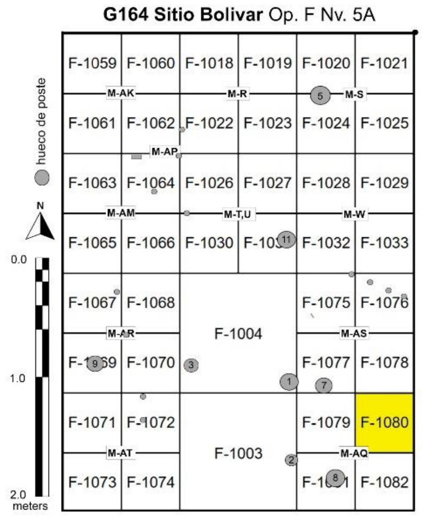


G164 Sitio Bolivar Op. F Nv. 4
F-1054
(Nv. 3 +4)
M-CC
M-BM
M-AJ
F-1015
M-P
F-1016
M-Q
F-1053
(Nv. 3 +4)
M-AI
F-1014
M-N
F-1017
M-AG2
M-O
F-1052
(Nv. 3 +4)
M-AH
F-1002
M-E
M-F
M-B
F-1058B2(4B)
M-AL, M-AN
F-1058B1(4B)
M-D
F-1051
(Nv. 3 +4)
M-AG1
F-1001
M-A
F-1057A (4A)
F-1057B (4B)
M-AO
hueco de poste
N
0.0
1.0
2.0
meters

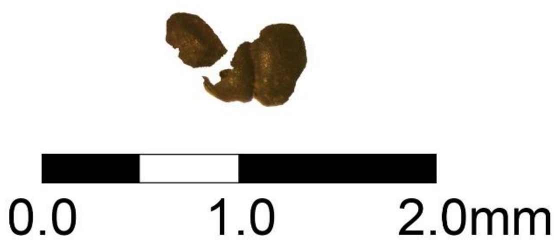


0.0
1.0
2.0mm

UNID F

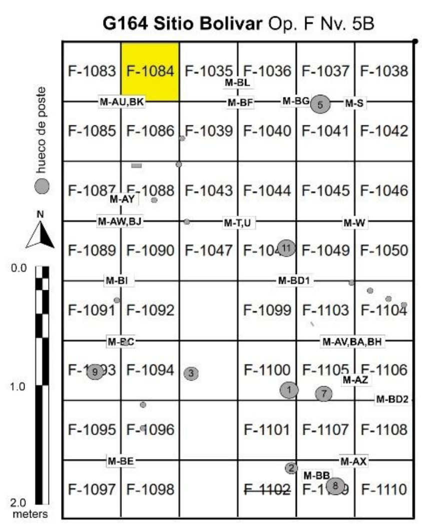


G164 Sitio Bolivar Op. F Nv. 5A
F-1059 F-1060 F-1018 F-1019 F-1020 F-1021
M-AK M-R M-S
F-1061 F-1062 F-1022 F-1023 F-1024 F-1025
M-AP
F-1063 F-1064 F-1026 F-1027 F-1028 F-1029
M-AM M-T,U M-W
F-1065 F-1066 F-1030 F-1032 F-1033
F-1067 F-1068 F-1075 F-1076
F-1004
M-AR M-AS
F-1070 F-1077 F-1078
F-1071 F-1072 F-1079 F-1080
F-1003
M-AT M-AQ
F-1073 F-1074 F-1082
hueco de poste
N
0.0
1.0
2.0
meters

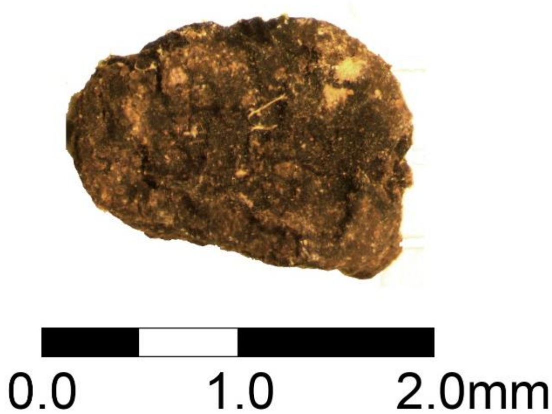


0.0
1.0
2.0mm

UNID G

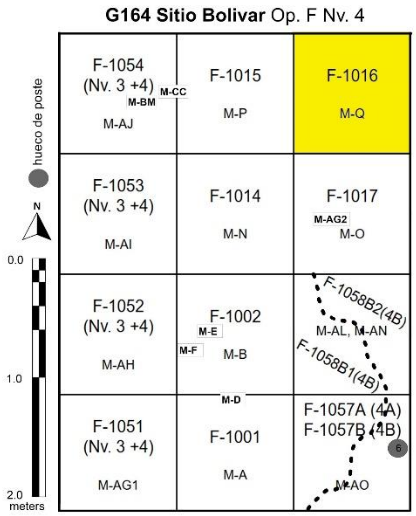


G164 Sitio Bolivar Op. F Nv. 5B
F-1083 F-1084 F-1035 F-1036 F-1037 F-1038
M-BL
M-AU,BK M-BF M-BG M-S
F-1085 F-1086 F-1039 F-1040 F-1041 F-1042
F-1087 F-1088 F-1043 F-1044 F-1045 F-1046
M-AY
M-AW,BJ M-T,U M-W
F-1089 F-1090 F-1047 F-1049 F-1050
M-BI M-BD1
F-1091 F-1092 F-1099 F-1103 F-1104
M-BC M-AV,BA,BH
F-1094 F-1100 F-1106
M-AZ
M-BD2
F-1095 F-1096 F-1101 F-1107 F-1108
M-BE M-AX
M-BB
F-1097 F-1098 F-1102 F-1110
hueco de poste
N
0.0
1.0
2.0
meters

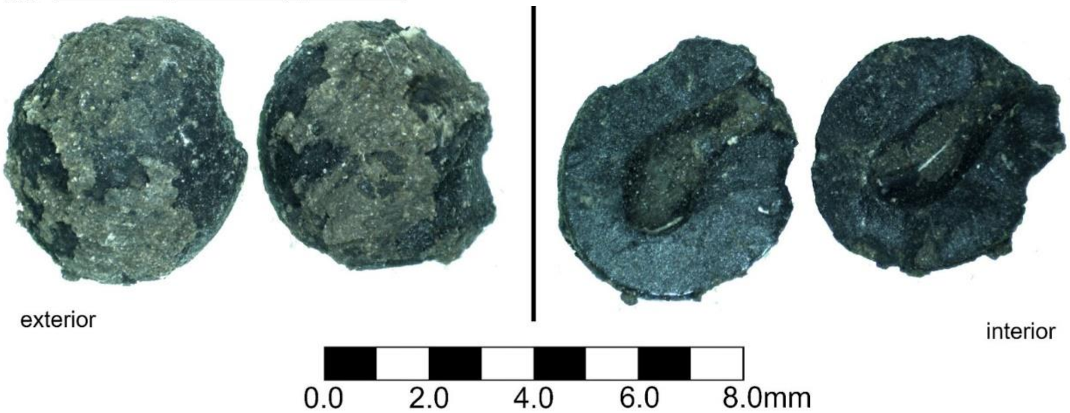


0.0
1.0
2.0mm

UNID H



G164 Sitio Bolivar Op. F Nv. 4
F-1054
(Nv. 3 +4)
M-CC
M-BM
M-AJ
F-1015
M-P
F-1016
M-Q
hueco de poste
F-1053
(Nv. 3 +4)
M-AI
F-1014
M-N
F-1017
M-AG2
M-O
N
0.0
F-1052
(Nv. 3 +4)
M-AH
F-1002
M-E
M-F
M-B
F-1058B2(4B)
M-AL, M-AN
F-1058B1(4B)
1.0
M-D
F-1051
(Nv. 3 +4)
M-AG1
F-1001
M-A
F-1057A (4A)
F-1057B (4B)
6
M-AO
2.0
meters



exterior
interior
0.0
2.0
4.0
6.0
8.0mm

Appendix J: AMS Radiocarbon Dates

All dates are calibrated in OxCal 4.4.4 using the IntCal 20 atmospheric curve (Bronk Ramsey 2021, Rainer et al. 2020).

Table J-1: *G-995 La Chiripa AMS radiocarbon dates.*

Sample #	Level	Context	Distance from Datum	Laboratory Code	Radio-carbon Age (BP)	2δ calibrated range	Source Material	Identification
1005X	Un 54	Above Rasgo 2	South 2.0, East 2.0	UCI AMS-261631	2230±15	376-348 BCE (17.3%) 314-205 BCE (78.1%)	wood charcoal	*Nectandra/Ocotea*
1050-01 HF A	AR 14-9	Above Rasgo 2	South 2.0, East 2.0	UCI AMS-261632	2185±20	358-277 BCE (56.8%) 259-245 BCE (3.0%) 234-170 BCE (35.6%)	wood charcoal	*Aspidosperma* sp.
1097-08 LF	Un 60		South 1.0, West 2.0	UCI AMS-261633		Modern	grass seed	Poaceae
BV-01	Un 60	Above Rasgo 2	Sur 2.0, Este 2.0	UCI AMS-229020	3190±15	1500-1426 BCE (95.4%)	wood charcoal	*Naucleopsis* sp.
BW	Un 60	Rasgo 1	Sur 2.0, Oeste 1.0	UCI AMS-229021	3265±15	1606-1582 BCE (5.4%) 1544-1497 BCE (87.8%) 1474-1460 BCE (2.3%)	wood charcoal	*Astronium graveolens*
1210-02 LF	Un 61	Post Hole 13	South 3.0, West 0.0	UCI AMS-261634	2965±25	1266-1108 BCE (92.7%) 1094-1081 BCE (1.5%) 1068-1056 BCE (1.3%)	achenes	*Acmella* sp.
1214-01 HF B	Un 61	Post Hole 17	South 0.5, West 1.0	UCI AMS-261635	3020±20	1384-1340 BCE (18.9%) 1312-1204 BCE (76.5%)	wood charcoal	*Casearia* sp.
1214-02 LF	Un 61	Post Hole 17	South 0.5, West 1.0	UCI AMS-261636	2995±20	1371-1356 BCE (2.7%) 1294-1156 BCE (85.6%) 1146-1126 BCE (7.1%)	achenes	*Acmella* sp.
CL	Un 61	Rasgo 2 (arriba)	Sur 2.0, Este 2.0	UCI AMS-229022	3015±15	1380-1346 BCE (11.9%) 1304-1207 BCE (83.5%)	wood charcoal	*Calycophyllum candidissimum*
CO	Un 61	Rasgo 2 (medio)	Sur 2.0, Este 2.0	UCI AMS-229023	2990±15	1280-1156 BCE (87.3%) 1146-1126 BCE (8.2%)	wood charcoal	*Dendropanax* sp.
CR	Un 61	Rasgo 2 (abajo)	Sur 2.0, Este 2.0	UCI AMS-229024	2995±15	1368-1359 BCE (1.2%) 1284-1190 BCE (83.3%) 1180-1158 BCE (5.6%) 1145-1128 BCE (5.4%)	wood charcoal	*Calycophyllum candidissimum*
1127-02 HF	Un 61	Rasgo 2	South 1.5, East 2.5	UCI AMS-261638	3070±20	1407-1270 BCE (95.4%)	fruit	*Terminalia* sp.
1179-02/1171	Un 61	exterior	South 3.5, West 0.5	UCI AMS-261639	3145±15	1492-1480 BCE (4.0%) 1451-1392 BCE (89.2%) 1334-1325 BCE (2.3%)	geophyte	dicot stem
1149-01	Un 61	floor	Sur 0.5, Este 1.0	UCI AMS-229025	3305±15	1616-1530 BCE (93.2%) 1524-1519 BCE (2.2%)	wood charcoal	*Swietenia* sp.
1147 -01	Un 61	adjacent to tobacco seeds	South 3.5, East 1.5	UCI AMS-261637	3220±15	1510-1442 BCE (95.4%)	wood charcoal	*Perrottetia* sp.

- Radiocarbon concentrations are given as fractions of the Modern standard, D14C, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).
- Sample preparation backgrounds have been subtracted, based on measurements of 14C-free wood.

- All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with d13C values measured on prepared graphite using the AMS spectrometer. These can differ from d13C of the original material, and are not shown.
- These samples were treated with acid-base-acid (1N HCl and 1N NaOH, 75°C) prior to combustion.

Figure J-1: *The calculated probability distributions for each dated sample from G995 La Chiripa, shown with their 2-sigma standard deviation and median intercept.*

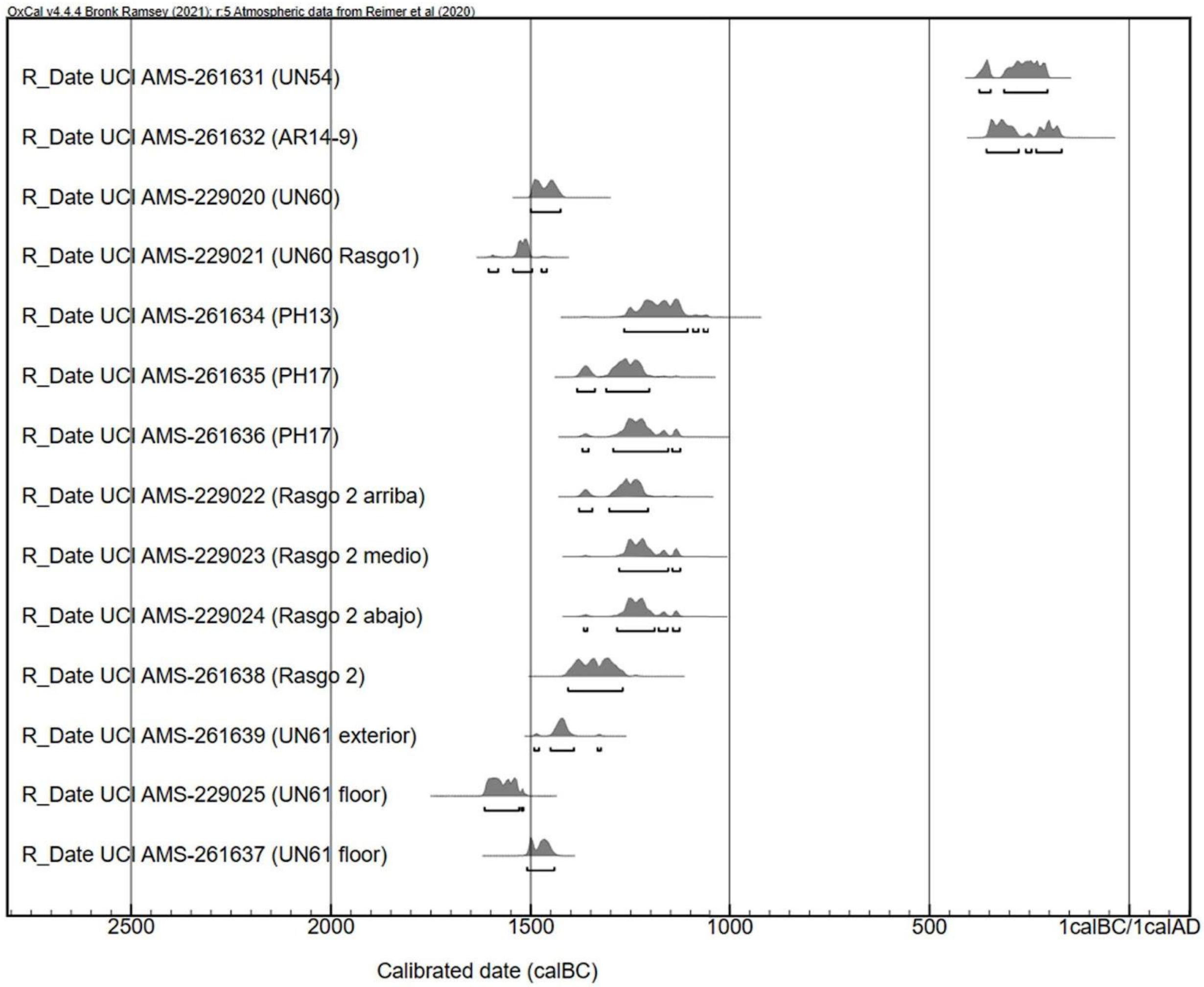
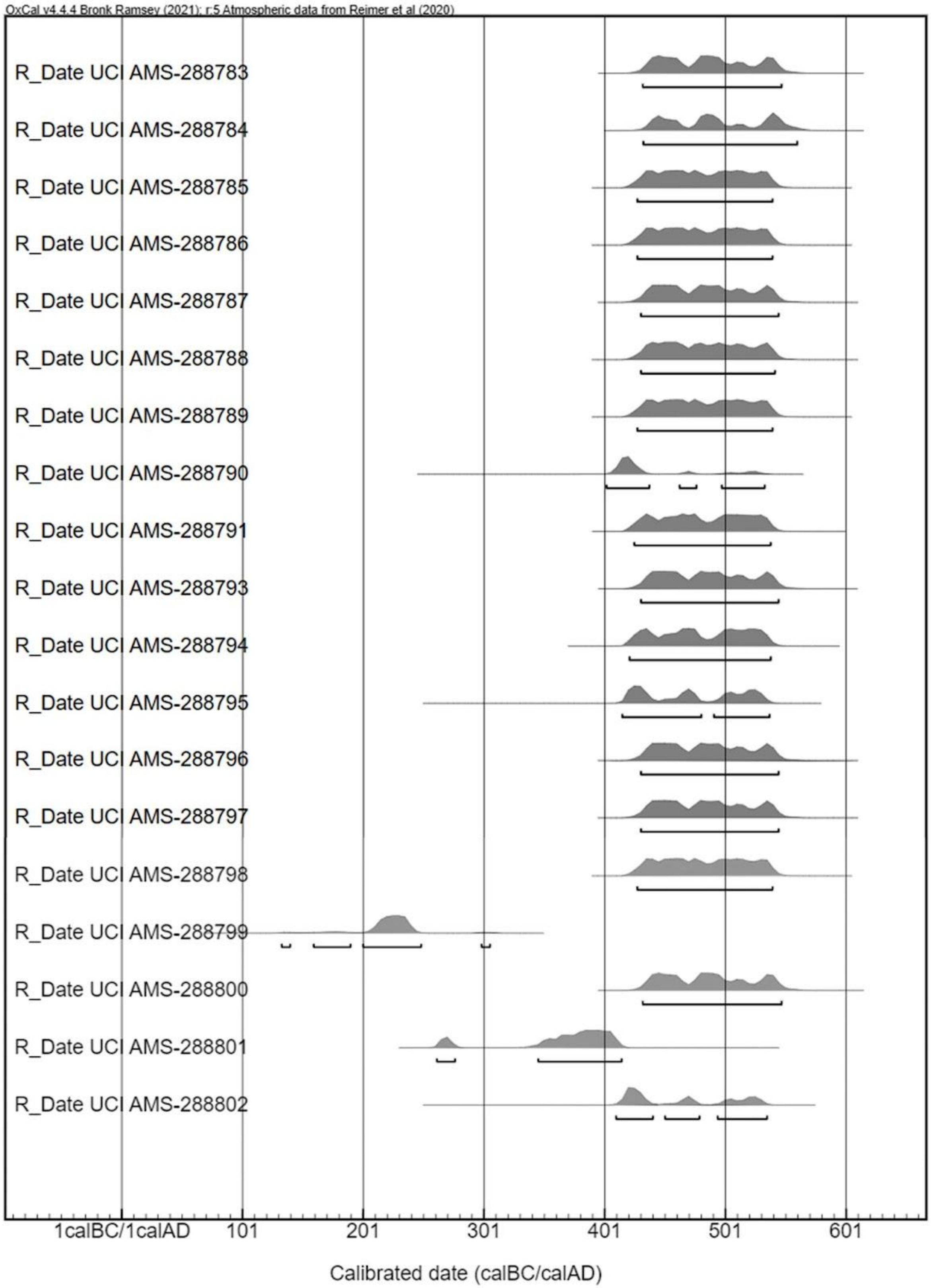


Table J-2: *G-164 Sitio Bolívar AMS radiocarbon dates.*

Sample #	Level	Context	Laboratory Code	Radio-carbon Age (BP)	2δ calibrated range	Source Material	Identification
I-A	2	Op. F Subop. 2 SE	UCI AMS-288783	1575±15	AD 432-547 (95.4%)	wood charcoal	*Terminalia* cf. *buceras*
K-C	3	Op. F Subop. 2 NW	UCI AMS-288784	1565±15	AD 432-560 (95.4%)	palm endocarp	ARECACEAE
J-B	3	Op. F Subop. 2 NE	UCI AMS-288785	1590±15	AD 428-540 (95.4%)	palm charcoal	ARECACEAE
Q-D	4	Op. F Subop. 2 NE	UCI AMS-288786	1590±15	AD 428-540 (95.4%)	wood charcoal	*Jacaranda* sp.
O-I	4	Op. F Subop. 2 SE	UCI AMS-288787	1580±15	AD 430-544 (95.4%)	palm endocarp	ARECACEAE
1057A-01	4A	Op. F Subop. 3 S	UCI AMS-288788	1585±15	AD 430-542 (95.4%)	wood charcoal	*Terminalia* cf. *buceras*
AN-A	4B	Op. F Subop. 5 S2 W0	UCI AMS-288789	1590±15	AD 428-540 (95.4%)	wood charcoal	*Terminalia* cf. *buceras*
AM-B	5A	Op. F Subop. 5 S1 W2	UCI AMS-288790	1640±15	AD 402-438 (74.6%) AD 462-476 (5.9%) AD 498-533 (14.9%)	wood charcoal	unidentifiable
1082-1A	5A	Op. F Subop. 3 S3.5 E0	UCI AMS-288791	1595±15	AD 425-538 (95.4%)	palm charcoal	ARECACEAE
1061-3	5A	Op. F Subop. 5 S.5 W2.5	UCI AMS-288792	Modern	AD 432-547 (95.4%)	seeds	*Phytolacca*
1030-1A	5A	Op. F Subop. 2 S1.5 W1.5	UCI AMS-288793	1580±15	AD 430-544 (95.4%)	wood charcoal	*Cornus* sp.
AE-E	5B	Op. F Subop. 2 NW	UCI AMS-288794	1600±15	AD 421-538 (95.4%)	wood charcoal	*Bourreria* sp.
AX-F	5B	Op. F Subop. 3 S3 E0	UCI AMS-288795	1615±15	AD 415-480 (55.0%) AD 491-537 (40.4%)	wood charcoal	*Pouteria* sp.
1088-4	5B	Op. F Subop. 5 S1W2	UCI AMS-288796	1580±15	AD 430-544 (95.4%)	maize kernel	*Zea mays*
BP-B	5C	Op. F Subop. 2 NO	UCI AMS-288797	1580±15	AD 430-544 (95.4%)	wood charcoal	*Terminalia* cf. *buceras*
BW-D	5C	Op. F Subop. 1 S2 W1	UCI AMS-288798	1590±15	AD 428-540 (95.4%)	wood charcoal	unidentifiable
1120-3	5C	Op. F Subop. 1 S2 W1	UCI AMS-288799	1830±15	AD 133-140 (1.0%) AD 160-190 (6.3%) AD 200-248 (87.0%) AD 298-306 (1.1%)	seeds	*Acmella*
D-D	5C	Op. F Subop. 1 S3 W1.5	UCI AMS-288800	1575±15	AD 432-547 (95.4%)	palm endocarp	ARECACEAE
BR-A	6	Op. F Subop. 3 S3 E0	UCI AMS-288801	1690±15	AD 262-276 (10.7%) AD 346-414 (84.8%)	wood charcoal	*Capparis* sp.
BR-D	6	Op. F Subop. 3 S4 E0	UCI AMS-288802	1625±15	AD 410-440 (45.1%) AD 410-440 (17.3%) AD 494-535 (33.1%)	palm endocarp	ARECACEAE

- Radiocarbon concentrations are given as fractions of the Modern standard, D14C, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).
- Sample preparation backgrounds have been subtracted, based on measurements of 14C-free wood.
- All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with d13C values measured on prepared graphite using the AMS spectrometer. These can differ from d13C of the original material, and are not shown.
- These samples were treated with acid-base-acid (1N HCl and 1N NaOH, 75°C) prior to combustion.

Figure J-1: *The calculated probability distributions for each dated sample from G-164 Sitio Bolívar, shown with their 2-sigma standard deviation and median intercept.*



Appendix K: Stratigraphy Descriptions of Sitio Bolívar

Op. F Nivel 1

Within Op. F, the first level of excavations was removed one quadrant at a time within each sub operation until there was a noticeable soil change. This strata exhibited very dark soil (Munsell # 10YR 2/1 Black). Additionally, because these uppermost layers do not date to a time period of interest for this study and are likely disturbed as part of the plow zone from prior farming activity on the peninsula, it was more efficient to combine them into one single level of excavation. This level was removed using shovels and ended approximately 40-50 cm below the modern surface. The soil from Nivel 1 was difficult to screen due to its abundance in modern roots from vegetation.

Op. F Nivel 2

The second stratum of excavations consisted of a very dark gray silty clay loam (Munsell# 10 YR 3/1). This level was excavated using a shovel and had an average thickness of 13 cm. Nivel 2 ended between 50 and 70 cm below the modern surface. The stratum exhibited a noticeable increase in artifact fragments, both ceramic and lithic.

Op. F Nivel 3

The third stratum of excavations consisted of a black sandy clay loam (Munsell # 10YR 2/1 with 2% very fine inclusions of 2.5Y 5/3). Beginning with this level, excavations began to use trowels instead of shovels, screening of soil switched from the larger 2cm screen to the finer 4mm screen, and paleoethnobotanical samples were collected from every square meter. Carbon began to be noticeably present in this stratum as well and was collected in vials when encountered during excavation or at the screening station. The northern side of subop. 2 revealed dark streaks of soil during this level that likely represent bioturbation from a tree root.

Op. F Nivel 4

The fourth stratum of excavations consisted of a very dark brown sandy clay (Munsell # 10YR 2/2 with 2% very fine inclusions of 10YR 4/3 and 3% very fine to medium ceramic of 2.5YR 4/8).The end of this stratum was noticeably more compacted, which likely indicates the presence of the structural floor beginning with the next level. Nivel 4 exhibited a noticeable increase in carbon material.

Two post holes were discovered within this stratum, post hole # 4 within subop. 2 and post hole # 6 within subop. 3. A soil change aligned well with the two post holes. To the west of the post holes the soil was a black clay loam without any inclusions (Munsell # 10YR 2/1). To the east of the post holes the soil was a more compacted dark brown sandy clay (Munsell # 7.5YR 3/3) with 2% very fine yellowish brown inclusions. Due to the compaction of the soil to the east of the post holes, it is estimated that if these post holes represent a structure, the interior is on the eastern side. The presence of these post holes and noticeable soil change led to a distinction within subop. 3 of Nivel 4A and 4B, above and below the post holes. This will help differentiate the soil samples and artifacts recovered from this area from above and below the structure. Within Nivel 4A of subop. 3 all of the soil was a continuous black clay loam. The soil change was observed within Nivel 4B of subop. 3.

Within sub-operations 4 and 5 along the western edge of the excavation it was impossible to distinguish between Niveles 3 and 4. Both levels were a thin layer along this entire side of the excavation and proved difficult to excavate separately, thus they were combined for sampling and artifact collection purposes. Nivel 3 especially appeared to be only about 1 to 2 cm thick in certain areas.

Op. F Nivel 5

The fifth stratum of excavations represents the floor of the domestic structure and consisted of a black clay (Munsell # 7.5YR 2/1). The soil had multiple inclusions: 5% very fine 10YR 6/2 and 2% very fine 2.5YR 4/8). Due to the thickness of this level, it was split into arbitrary sub levels of 5A, 5B, and 5C. This allowed for sampling of paleoethnobotanical remains to be separated based on the top of the level versus the middle and bottom to show change through time as this level represents the arenal phase, which could potentially date to a timespan of over 1000 years in total. Nivel 5A was the top of the stratum and was completed arbitrarily when it reached a thickness of approximately 10cm. Nivel 5B was the middle section of the stratum and was also completed arbitrarily after the next 10cm in depth. Nivel 5C was not completed in all sub-operations due to lack of time at the end of the project. Excavation of Nv. 5C was only completed within sub-operations 1, 2, and 3, but time did not permit to complete this level in sub-operations 4 and 5. On the eastern edge of the operation Nv. 5 had a depth of approximately 40 cm and on the western edge of subop. 2 it reached a depth of approximately 60 cm in thickness.

Nivel 5 was the main stratum of interest for this archaeological project since it contains the remains of an Arenal phase domestic structure. A total of eight post holes were encountered throughout this level that likely represent more than one single structure based on their arrangement (See Figure 4). Post holes 1, 2, 7, and 8 form what is likely a porch or doorway into a structure, which align well with post holes 5 and 11 to form a structure that has an interior in the eastern direction. Post holes 3 and 9 do not align well with the other post holes from this stratum, and therefore likely are from a separate structure. Additionally, fourteen smaller post holes were discovered from this stratum that could be remnants of walls, wind breaks, fencing, or doorways (Figure 9). As can be viewed in the profile of this operation (Figure 7), there was a sharp decline just west of the postholes, demonstrating that the interior of the structure was built upon a flat terrain but the exterior had a steep slope. This terrain further suggests that the interior of the structure was towards the east of the aligned post holes.

The majority of artifacts fragments of the project were recovered from this stratum, as it is the cultural layer during which this site was mainly occupied. Carbon was recovered throughout the level and was quite abundant in all sub-operations. Concentrations of clay deposits, both un fired and poorly fired, were present throughout the operation. The majority were of the orange-red color similar to that of the aguacate formation, but occasional fragments were of a dark grey color. The soil from this entire level had fine to medium inclusions of the orange-red clay, the larger concentrations are noted in red on the plan map of this level (Figure 4). Along the intersection between sub operations 4 and 5 was a particularly high concentration of clay material, along with carbonized remains that are speculated to be from a geophyte. Geophytes can be roots or tubers such as manioc or potato. The identification of this material will be completed further at the McCown Archaeobotany Laboratory.

Op. F Nivel 6 (Un. 65) Aguacate Formation

The sixth stratum of excavations represents Un. 65 and consisted of a dark brown clay (Munsell # 10YR 3/3). Due to its high clay content, this stratum was extremely difficult to excavate. Un. 65 was only detected due to time constraints in sub-operation 3, since this area had the shallowest depth of Un. 54. The entire depth of this level was not discovered, but a test pit in the southeastern corner of the operation demonstrated that it continued for at least 60 cm below the end of Nivel 5.

Appendix L: Ceramic Descriptions from Sitio Bolívar

Analysis of the ceramic material at Sitio Bolívar during the 2021 field season was completed by a group effort by the following volunteers: Maria Lopez Rojas, Johanna Ferber, Andrea Morales, Nicole Quinteros, and Fiorella Zumbado.

Analysis of ceramic materials included the classification and subsequent quantification of the sherds and the ceramic forms recorded include body sherds, rims, supports, handles, and other. Typological identifications found during the field season included the following Arenal phase types: Bocana Incised Bichrome, Cervantes Incised, Charco Black-on-Red, Espinoza Red-Banded, Las Palmas Red-on-Beige, Guinea Incised, Mojica Impressed, Los Hermanos Beige, Los Hermanos Beige Espinoza Variety, Los Hermanos Beige Cervantes Variety, and Red Rimmed-Orange Body. Additionally, it was noted if ceramic fragments were burned, had carbonized residue on their surface, or were simply fragments of poorly fired or raw clay material.

The most frequent form of ceramic sherds recovered from excavations were body sherds (n=3559), followed by rims (n=574), unformed clay (n=147), supports, other unique forms (n=48), and handles (n=14). The vast majority of the ceramic fragments were recovered from Nv. 5, the level with the Late Arenal phase structure.

Table L-1. *Overall summary of ceramic forms recovered in total from the 2021 excavations at G164 Sitio Bolívar, including both Operations F and G.*

	Decorated	**Not Decorated**	**Total**
Body sherds	n=453 (10.02%)	n=3355 (74.24%)	**3795 (83.98%)**
Rims	n=510 (11.29%)	n=95 (2.10%)	**605 (13.39%)**
Supports	n=5 (0.11%)	n=52 (1.15%)	**57 (1.26%)**
Handles	n=3 (0.07%)	n=57 (1.26%)	**14 (0.31%)**
Other			**48 (1.06%)**
Overall Total	**971 (21.43%)**	**3559 (78.56%)**	**4519 (100%)**

Table L-2. *Overall summary of ceramic forms recovered from Op. F from the 2021 excavations at G164 Sitio Bolívar.*

	Bodies	**Rims**	**Supports**	**Handles**	**Other**	**Daub**	**Total**
Nv. 1	185	23	0	0	0	0	**208**
Nv. 2	227	34	2	0	4	3	**270**
Nv. 3	127	23	0	0	4	6	**160**
Nv. 4	631	103	15	0	7	12	**768**
Nv. 5	2374	386	39	13	33	126	**2971**
Nv. 6	15	5	0	1	0	0	**21**
Total	**3559**	**574**	**56**	**14**	**48**	**147**	**4398**

Table L-3. *Overall summary of ceramic typological identifications recovered from Op. F from the 2021 excavations at G164 Sitio Bolívar.*

Stratigraphic Level	**Bocona Incised Bichrome**	**Charco Black-on-Red**	**Las Palmas Red-on-Beige**	**Guinea Incised**	**Mojica Impressed**	**Los Hermano Beige**	**Los Hermanos Beige- Espinoza**	**Los Hermanos Beige - Cervantes**	**Red Rimmed - Orange Body**	**Total**
Nv. 1	0	3	3	2	4	8	0	1	0	**21**
Nv. 2	0	6	3	2	9	15	3	0	3	**41**
Nv. 3	0	6	2	4	7	16	0	0	2	**37**
Nv. 4	0	26	10	9	21	65	6	7	5	**149**
Nv. 5	1	79	23	25	75	230	11	3	15	**462**
Nv. 6	0	1	1	0	0	2	0	0	0	**4**
Total	**1**	**121**	**42**	**42**	**116**	**336**	**20**	**11**	**25**	**714**

All diagnostic ceramic types recovered were identified to the Arenal Phase. The same findings by Hoopes (1994) at Sitio Bolívar were true for the 2021 excavations within Op. F: excavations collected a large assemblage that was dominated by Los Hermanos Beige (n=336). Second, both Charco Black on Red (n=121) and Mojica Impressed (n=116) were quite prevalent in the assemblage. Neither Cervantes Incised or Espinoza Red Banded were identified within the assemblage.

<u>Bocana Incised Bichrome:</u>

This type is a marker type of Early Arenal Phase assemblages (Hoopes 1987:346-356) and is considered to have derived from incised types in the Tronadora Phase (Hoopes 1994). It is commonly associated with La Palmas Red on beige as well as Los Hermanos Beige Espinoza Variety, both of which were also identified within the assemblage. Bocana Incised Bichrome is characterized by grooved, vertical incisions in combination with zoned red slipping on a beige, unslipped surface (Hoopes 1994: 178). Only one ceramic fragment of this type was identified this season and it came from Nv. 5 (Un.54).

Figure L-1. *Bocana Incised Bichrome fragment from Op. F Subop. 5 Nv. 5B North.*

Charco Black-on-Red:

This type is characterized by black line decoration on a red slip (Hoopes 1994: 185). Decorative motifs include multiple brush wavy lines, triangular elements, and both vertical and horizontal narrow lines. Charco is more typical of the Early Arenal Phase.

Figure L-2. *A selection of Charco Black on Red fragments recovered from Op. F.*

Las Palmas Red-on-Beige:

This type is characterized by multiple brushed wavy lines or solid triangles of red ochre pigment on an unslipped surface (Hoopes 1994: 181). Forty two diagnostic sherds of this type were found in Operation F, roughly half of which come from Nv. 5 or Un. 54.

Figure L-3. *A selection of Las Palmas Red on Beige fragments recovered from Op. F.*

<u>Guinea Incised:</u>

This type is characterized by red and orange surface finishes, resist decoration, and incision. Guinea Incised represents the Late Arenal Phase (Hoopes 1994: 182).

Figure L-4. *A selection of Guinea Incised fragments recovered from Op. F.*

<u>Mojica Impressed:</u>

This type is characterized by stamped rows of small marks on unslipped vessels and is present throughout both Early and Late Arenal Phases (Hoopes 1994: 181). The type is thought to have been primarily used for storage because of its large size.

Figure L-5. *A selection of Mojica Impressed fragments recovered from Op. F*

Los Hermanos Beige, (Espinoza Variety and Cervantes Variety):

This type is characterized by a red rimmed beige jar and has been documented for a long duration in the Northwestern Cordillera as it is common throughout both the Early and Later Arenal phases (Hoopes 1994: 185). The Espinoza variety has broad strokes of red painted and polished vertical bands on a natural colored base. The Cervantes Variety is characterized by heavy incision, punctation and occasionally applique decoration. The Cervantes Variety is a principal diagnostic of the Late Arenal Phase (Hoopes 1994: 188). 10 of the 13 Cervantes Variety ceramic fragments within Un. 54 were recovered from Nv. 5C, which represents the bottommost layer of this strata.

The category Red Rimmed - Orange Body was added to our list of types during the 2021 laboratory analysis. These sherds likely are part of the Los Hermanos Beige assemblage, but were separated due to their orange colored body rather than beige as had been described previously for the type by Hoopes.

Figure L-6. *A selection of Los Hermanos Beige fragments recovered from Op. F*

Ceramics - Op. G

Operation G was a test unit that did not reveal evidence of a domestic structure, however many ceramic sherd fragments were recovered from this Operation. A total of 268 ceramic sherds were recovered from Op. G that amounted to a total of 3350 grams. Two raw clay fragments were recovered from Nivel 4. A total of 43 ceramic fragments exhibited evidence of being burned or had charcoal residue on their surface, the majority of which were recovered from Niveles 3 and 4. These levels do not directly correspond with those of Operation F, because Op. G was a test pit with levels excavated arbitrarily in depths of 20cm each.

Table L-4. *Overall summary of ceramic forms recovered from Op. G during the 2021 excavations at G164 Sitio Bolívar.*

Ceramic Form	Nv. 1	Nv. 2	Nv. 3	Nv. 4	Nv. 5	Total
Bodies	17	27	92	92	8	**236**
Rims	2	6	9	12	2	**31**
Supports	-	-	1	-	-	**1**
Unformed Clay	-	-	-	2	-	**2**
Total	**19**	**33**	**102**	**106**	**10**	**268**

Table L-5. *Overall summary of ceramic typological identifications recovered from Op. G during the 2021 excavations at G164 Sitio Bolívar.*

Ceramic Type	Nv. 1	Nv. 2	Nv. 3	Nv. 4	Nv. 5	Total
Bocana Incised Bichrome	1	-	-	-	-	**1**
Charco Black-on-Red	1	-	2	5	-	**8**
Las Palmas Red-on-Beige	-	-	-	1	-	**1**
Guinea Incised	-	-	1	-	-	**1**
Mojica Impressed	1	1	2	-	-	**4**
Los Hermanos Beige	-	3	6	4	-	**13**
Los Hermanos Beige: Espinoza	-	-	-	1	-	**1**
Red Rimmed-Orange Body	1	-	1	3	1	**6**
Total	**4**	**4**	**12**	**14**	**1**	

Appendix M: Lithic artifacts from G164 Sitio Bolívar
Lithic Analysis at G164 Sitio Bolívar was completed by project volunteers Anthony Azofeifa and Nicole Quinteros.

The total lithic material collected from all operations G and F at Sitio Bolívar was 444 elements. Of those, only 7 elements came from Operation G and 437 were collected in the excavations of Operation F. Initially, the count and classification of each element was carried out according to the stage of manufacture in which it was found at the time of collection (carving waste, artifacts, fragments of artifacts, boiling stones). Additionally, the categories of natural (those rocks collected that did not present alteration by human activities) and 'other' (a stone that could not be defined if it was modified by human activities or not) were added. This classification is presented in Table M-1. The largest proportion of lithic material collected corresponds to the boiling stones (73.87%), followed by debitage with 16.89%. A much smaller proportion are found in knives, scrapers and natural rocks.

Table M-1. Classification of lithic material according to the stage of manufacture at Sitio Bolívar (G-164).

Frequencies	**Debitage**	**Boiling stones**	**Knives/ Scrapers**	**Other**	**Fragments**	**Total**
Absolute Frequencies	75	328	21	1	2	444
Relative Frequencies	16.89%	73.87%	4.95%	0.22%	0.45%	100%

Operation G

Only 7 lithic elements were recovered in this operation. Of which 4 were debitage, 2 were classified as knives or scrapes, and 1 as a boiling stone.

Operation F

Of the 437 elements collected in this operation, the overwhelming majority corresponded to boiling stones (n=329). The remaining lithic materials included debitage (n=71) knives or scrapers (n=21), natural stones (n=15). Artifacts belonging to the percussion-flaked lithic technology dominate the sample with 81.8%, followed by the chopped lithic with 13.6% and finally with 4.5% the polished lithic was recorded. The classification by functional types allowed us to identify 7 functional types, which are broken down below in Table M-2.

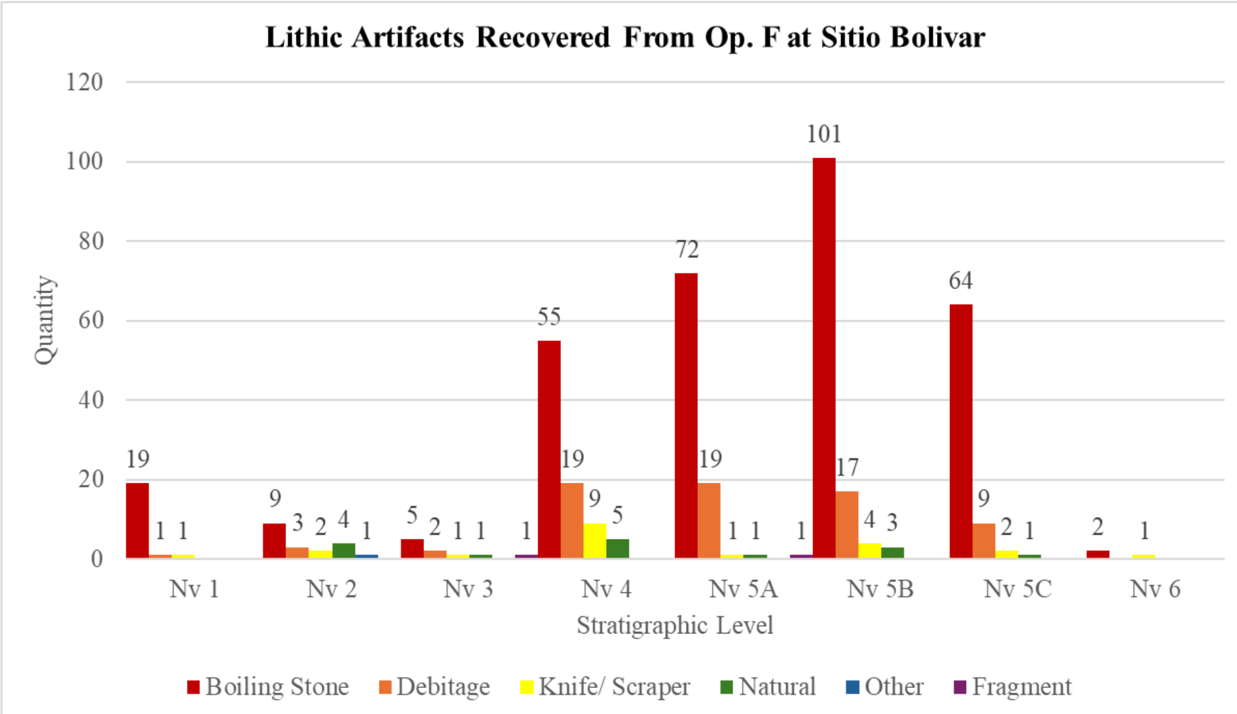
Table M-2. Absolute and relative frequencies of the lithic assemblage collected in Operation F according to identified functional types at Sitio Bolívar.

Functional type	**Absolute Frequency**	**Relative Frequency**
Knife	6	27.3%
Pendant	1	4.5%
Mano	1	4.5%
Penknife	2	9.1%
Scraper	10	45.4%
Grinding artifact fragment	1	4.5%
Groundstone fragment	1	4.5%
Total	**22**	**100%**

Table M-3. Distribution of lithic elements according to levels excavated in Operation F at Sitio Bolívar.

Level	**Boiling Stone**	**Debitage**	**Knife/ Scraper**	**Natural**	**Other**	**Fragment**
Nv 1	19	1	1			
Nv 2	9	3	2	4	1	
Nv 3	5	2	1	1		1
Nv 4	55	19	9	5		
Nv 5A	72	19	1	1		1
Nv 5B	101	17	4	3		
Nv 5C	64	9	2	1		
Total Nv 5	237	46	7	5	0	1
Nv 6	2		1			
Totals	**328**	**71**	**21**	**15**	**1**	**2**

Figure M-1. Distribution of lithic elements according to the levels excavated, Op. F



It is clear that of the excavated levels, Nv. 5 is the one with the largest amount of lithic stone, followed by Nv. 4, which both correspond to structural floors of ancient dwellings. The characteristics of the lithic artifacts of each level will be detailed below.

Op F. Nivel 1
A total of 21 elements were collected, of which 19 correspond to boiling stones, 1 was classified as debitage and finally 1 knife.

Op F. Nivel 2
For this level, 19 elements were registered. Of these 9 are boiling stones, 3 are debitage, 4 natural rocks, and 1 cataloged as 'other'. The 'other' fragment was a flat rock of reddish brown color with a polished surface, but it was not possible to identify if the polishing is due to anthropogenic activity. Finally, 2 artifacts were counted that correspond to a scraper and a grinding implement (mano) in the form of a bar, which is likely to have been handheld and used for grinding food.

Op F. Nivel 3
A total of 10 elements were counted, of which 5 are boiling stones, 3 debitage elements, a natural stone, a groundstone fragment, and a scraper. The scraper had two active cutting edges on its surface. The groundstone fragment was in the shape of an arch (donut style), it is likely a fragment of a metate handle or a sculpture (the part of the arms).

Op F. Nivel 3-4
This level had a total of 25 elements: 21 boiling stones, 3 debitage fragments, and one knife. The knife with a tip that showed wear, which suggests that it was a knife that was also used in drilling activities.

Op F. Nivel 4
It is the second most populous level regarding lithic artifacts, containing 63 elements: 34 boiling stones, 16 debitage fragments, 5 natural stones, and 3 knives, and 5 scrapers. One of the scrapers was made from a white raw material (possibly quartzite).

Op F. Nivel 5
This level presented the largest number of lithic elements with 296 specimens, which reflects that this level contained the structural floor of the dwelling and Late Arenal phase village. Of these 237 were classified as boiling stones, 46 debitage elements, 5 natural stones, 3 scrapers, 3 knives, and a pendant. There was also an artifact fragment of a stone with a porous texture with clear traces of use by food milling, suggesting that it was part of an artifact made for that purpose (possibly metate or mano). It is important to note that the pendant was a preform that was not finished, as it seems that it fragmented in the distal area during the touch-ups, also the cavity to pass the cord was not finished. One of the scrapers stood out for its translucent raw material. Finally, two of the knives may have been used as boiling stones since they present thermal alteration.

Op F. Nivel 6
This level was only present in sub-operation 3. In addition, it is the one that had the least amount of lithic with only 3 specimens: 2 boiling stones and a scraper. The scraper has micropolishes on the edge (possibly due to use). In addition, the retouching by percussion for its manufacture is evident, finally it should be noted that, possibly, this scraper was exposed to fire, since it presents a small area with a change of coloration from gray to orange.

Functional analysis of lithic material
The function assigned to the different artifacts was designated based on morphological evaluation, identification of certain traces of uses (at the macroscopic level). The evaluation of these criteria allowed us to define a total of 7 functional types. Next, a detailed description of the functional types and morphological aspects found in the excavated sample will be made, then the functional sets into which these types were grouped will be described.

<u>Boiling Stones:</u>
Stones that would have been used to cook foods were the most common lithic material recovered at Sitio Bolívar (n=328). These elements were identified by their irregular shape and the presence of thermal alteration or discoloration. Boiling stones would have been heated up in a hearth and then added to a container filled with water and food ingredients to cook a meal. The high presence of boiling stones throughout the excavations indicate that this space was often used to prepare meals for the household or village.

Knives and Scrapers:
Knives recovered at the site had an elongated and narrow shape that had its edge worn bifacially while the other side is thicker and blunt. Additionally, the sharp edge is greater than 5cm. A total of 30.4% of the artifacts collected consisted of knives, the presence of translucent and white raw materials in the elaboration of this type of artifacts. Two of these knives were classified as flake knives whose edge was less than 5 cm. Scrapers consist of an instrument made from a flake, generally discoidal in shape, with a percussion-produced or beaten edge, the retouching on its edge was always unifacial. This type of artifact had a proportion of 47.8%. It should be noted that in some specimens the scrapers had more than one active edge. Knives and scrapers could be used for cutting actions, the grinding hand and the fragment of grinding artifact are grouped into artifacts for food processing, scrapers in general are associated with the processing of different materials (hides, hardwoods and bone).

Pendant:
The collected pendant is similar to the category of "miscellaneous pendant" described by Chenault (1994, 280), it is a pendant that could not be assigned to any of the others described by that author, in addition its raw material is in very dark green stone, also the dimensions are quite similar since it is 3.4 cm long, 2cm wide and 0.4cm thick. The excavated specimen shows the beginnings of a conical perforation in the proximal area. The pendant can be interpreted as an artifact that may indicate some kind of social differentiation.

Bar-Shaped Mano:
This is a hand similar to the "Bar Manos" described by Chenault (1994, 266) and coincides quite a bit in terms of the raw material as it is a moderately vesicular rock, and one of its ends has a pecked surface while the other is completely smooth.

Grinding Artifact Fragment:
The artifact fragment was a porous rock with clear traces of use by food milling, suggesting that it was part of an artifact made for that purpose (possibly metate or grinding hand).

Groundstone Fragment:
This is an arch-shaped (doughnut-style) vesicular raw material artifact fragment, likely a fragment of a metate handle or sculpture (the arm part). Due to its size, it was impossible to know with certainty what type of device it belonged to.The fragment of groundstone belonged to a sculpture, this could be another indicator of the beginnings of social differentiation.

Appendix N: Ubiquity Measures and Economic Uses of Identified Taxa

Ubiquity measures and uses of all macrobotanical remains identified to the genus level from G-995 La Chiripa and G-164 Sitio Bolívar within each sampled stratigraphic level. If the plant produces edible parts, the following symbols denote which part of the plant is edible: fruits, seeds, leaves or young shoots, wood/bark, roots, sap, gum, or latex, and flowers. Other uses are as follows: medicinal, fuel, construction or timber, dye, tannin, resin, oil, fiber (such as rope, cordage, or twine), basketry, soil or erosion control, insect repellent, or as an ornamental or decoration.

Botanical Identification	Site	Stratigraphic Level and Ubiquity						
ACANTHACEAE								
Avicennia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
mangle salado, black mangrove		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
ADOXACEAE								
Viburnum sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
viburnum		5.88%	0.00%	0.00%	0.00%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	9.30%	0.00%		**3.36%**
AMARANTHACEAE								
Chenopodium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
quinoa		0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		10.00%	0.00%	0.00%	0.00%	0.00%		**0.84%**
ANACARDIACEAE								
Amphipterygium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cuachalalate		5.88%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Anacardium spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cashew, marañón		0.00%	0.00%	0.00%	4.76%	4.55%	2.94%	**2.33%**

	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	9.52%	2.33%	0.00%		**5.04%**
Astronium graveolens	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
zorro, ron-ron, tigrillo, tolerante, cucaracho		0.00%	0.00%	0.00%	9.52%	9.09%	0.00%	**2.33%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	4.76%	13.95%	8.33%		**8.40%**
Campnosperma panamense	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
orey		0.00%	0.00%	0.00%	9.52%	9.09%	0.00%	**2.33%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	8.33%		**1.68%**
cf. *Mosquitoxylum jamaicense*	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
Pasak'		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
Schinus cf. *terebinthifolius*	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
pepper tree		0.00%	4.55%	0.00%	4.76%	4.55%	0.00%	**1.74%**
Spondias spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
jobo, mope, hogplum		0.00%	18.18%	0.00%	19.05%	22.73%	4.41%	**9.30%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	9.52%	0.00%	0.00%		**4.20%**
Tapirira sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
caobilla		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
ANNONACEAE								
Annona sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cherimoya, toreta, canelo, guanabana		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	19.05%	13.95%	0.00%		**12.61%**
APOCYNACEAE								

Aspidosperma spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
aracanga, alcarreto, volador, remo caspi		5.88%	9.09%	4.55%	47.62%	54.55%	4.41%	**16.86%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	2.38%	4.65%	8.33%		**4.20%**
Lacmellea sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
leche de vaca, lagarto negro		0.00%	0.00%	9.52%	0.00%	0.00%		**3.36%**
Tabernaemontana sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
milkwood		0.00%	0.00%	0.00%	9.52%	22.73%	4.41%	**5.81%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Thevetia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
yellow oleander		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
ARALIACEAE								
Dendropanax sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
vaquero		0.00%	13.64%	0.00%	19.05%	9.09%	1.47%	**5.81%**
Schefflera sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
mangabé		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
ARECACEAE								
ARECACEAE	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
palm		0.00%	45.45%	4.55%	33.33%	54.55%	2.94%	**18.60%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		70.00%	83.33%	88.10%	76.74%	58.33%		**78.99%**
Acrocomia aculeata	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
coyol		50.00%	75.00%	80.95%	86.05%	58.33%		**77.31%**

Attalea sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
cohune		0.00%	0.00%	2.38%	0.00%	0.00%	0.00%	**0.84%**
Bactris sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
pejibaye		0.00%	0.00%	0.00%	2.33%	0.00%	0.00%	**0.84%**
ASTERACEAE								
Acmella sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
toothache plant, paracress		0.00%	0.00%	9.09%	57.14%	68.18%	36.76%	**31.40%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		50.00%	91.67%	100.00%	100.00%	83.33%		**93.28%**
Melampodium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
blackfoot daisy, butter daisy		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
BIGNONIACEAE								
Crescentia spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
calabash, jicaro		0.00%	4.55%	0.00%	0.00%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	0.00%	0.00%	0.00%		**0.84%**
Handroanthus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
poui, pau d'arco, or ipê		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		20.00%	0.00%	0.00%	0.00%	0.00%		**1.68%**
Jacaranda sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
jacaranda, nazareno, guabanday, chingala, gobaja, para-para		0.00%	13.64%	0.00%	9.52%	4.55%	2.94%	**4.65%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	25.00%	42.86%	23.26%	0.00%		**26.05%**
Parmentiera sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
arbol de vela		0.00%	0.00%	0.00%	9.52%	9.09%	0.00%	**2.33%**

Tabebuia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
roble de sabana		0.00%	4.55%	0.00%	0.00%	9.09%	0.00%	**1.74%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	9.30%	0.00%		**4.20%**
Tecoma stans	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
yellow elder		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
BIXACEAE								
Bixa cf. *orellana*	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
achiote, annatto		0.00%	9.09%	0.00%	4.76%	22.73%	0.00%	**4.65%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	16.67%	11.90%	20.93%	16.67%		**15.13%**
BORAGINACEAE								
Bourreria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
canalú		0.00%	0.00%	0.00%	42.86%	27.27%	1.47%	**9.30%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	9.52%	37.21%	0.00%		**16.81%**
BURSERACEAE								
cf. *Protium* sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
copal, chutra, alconfor, kerosín		0.00%	0.00%	0.00%	9.30%	0.00%		**3.36%**
Tetragastris panamensis	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
anime, chutra, kerosin		0.00%	0.00%	0.00%	9.52%	0.00%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	2.33%	0.00%		**1.68%**
CANNABACEAE								
Celtis sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
hackberry		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**

Trema sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
jordancillo, capulin		0.00%	0.00%	0.00%	9.52%	4.55%	0.00%	**1.74%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	11.90%	16.28%	0.00%		**10.08%**
CAPPARACEAE								
Capparis sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
caper bush		0.00%	4.55%	0.00%	4.76%	4.55%	1.47%	**2.33%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	9.52%	0.00%	8.33%		**5.04%**
Crateva sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guaco, perguetano, mongo		0.00%	0.00%	0.00%	9.52%	0.00%	0.00%	**1.16%**
CARYOPHYLLACEAE								
Drymaria cordata	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
chickweed		11.76%	9.09%	0.00%	0.00%	4.55%	0.00%	**2.91%**
CELASTRACEAE								
Cheiloclinium cognatum	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
fruta de mono, cocora		0.00%	9.09%	0.00%	4.76%	4.55%	0.00%	**2.33%**
Maytenus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
mayten		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	0.00%	8.33%		**0.84%**
Salacia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
salacia		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
Wimmeria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
no common name		0.00%	4.55%	0.00%	0.00%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**

CHLORANTHACEAE								
Hedyosmum sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
sauquillo, limoncillo		0.00%	9.09%	0.00%	0.00%	4.55%	1.47%	**2.33%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	26.19%	0.00%	0.00%		**10.08%**
CHRYSOBALANACEAE								
Hirtella sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
camaron, garrapato, conejo		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
Licania sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
corocillo, garrapato, raspa, rasca, rascador, sapote, sangre		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
CLUSIACEAE								
Clethra sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
nancito, nancillo, nance macho, memeicillo, pepperbush		0.00%	0.00%	0.00%	9.52%	0.00%	0.00%	**1.16%**
Garcinia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
madroño, chaparrón, sastra		0.00%	4.55%	0.00%	0.00%	9.09%	0.00%	**1.74%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	25.00%	23.81%	20.93%	0.00%		**18.49%**
Symphonia globulifera	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cerillo, cero, barillo		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
COMBRETACEAE								
Buchenavia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
amarillo, amarillo de pepita		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
Terminalia spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
tropical almond, guayabillo, roble amarillo		0.00%	50.00%	4.55%	57.14%	68.18%	0.00%	**22.67%**

	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		80.00%	91.67%	88.10%	93.02%	91.67%		**89.92%**
CORNACEAE								
Cornus spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
lloró, mata hombro, dogwood		5.88%	27.27%	4.55%	38.10%	59.09%	5.88%	**19.19%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	7.14%	2.33%	0.00%		**4.20%**
CUNONIACEAE								
Weinmannia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
white myrtle, bastard braziletto, arrayán		0.00%	0.00%	0.00%	4.76%	18.18%	4.41%	**4.65%**
CYPERACEAE								
cf. *Fimbristylis* sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
fimbry		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
DILLENIACEAE								
cf. *Curatella americana*	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
chumico		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
DIPENTODONTACEAE								
Perrottetia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
olomea		0.00%	0.00%	0.00%	0.00%	4.55%	2.94%	**1.74%**
EBENACEAE								
Diospyros sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
sapote negro		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
ELAEOCARPACEAE								
Sloanea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
carabeen, terciopelo, mameicillo		0.00%	18.18%	4.55%	9.52%	9.09%	7.35%	**8.14%**

ERICACEAE								
Gaultheria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
uvita, mortiño		0.00%	0.00%	0.00%	14.29%	13.64%	1.47%	**4.07%**
ESCALLONIACEAE								
Escallonia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
madrono, corontillo		5.88%	9.09%	0.00%	4.76%	0.00%	1.47%	**2.91%**
EUPHORBIACEAE								
Acalypha sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
palito feo, prende-prende		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
Adelia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
bagre		0.00%	0.00%	4.55%	0.00%	0.00%	0.00%	**0.58%**
Alchornea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
Achiotillo		0.00%	0.00%	0.00%	14.29%	0.00%	0.00%	**1.74%**
Croton sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
sangrillo		0.00%	0.00%	0.00%	9.52%	0.00%	1.47%	**1.74%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	0.00%	8.33%		**0.84%**
Hura crepitans	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
nuno, tronador, havillo, ceibo, sandbox tree		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	0.00%	8.33%		**0.84%**
Mabea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
casiquillo		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
Manihot sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
manioc		0.00%	0.00%	0.00%	9.52%	4.55%	0.00%	**1.74%**

Sapium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
milktree, gumtree		0.00%	4.55%	0.00%	0.00%	4.55%	0.00%	**1.16%**
Sebastiania sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
milkwood		0.00%	0.00%	0.00%	9.52%	9.09%	0.00%	**2.33%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	13.95%	0.00%		**5.04%**
FABACEAE								
Abarema sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
abarema		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
Acacia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
acacia		0.00%	4.55%	0.00%	19.05%	4.55%	1.47%	**4.07%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	0.00%	0.00%	0.00%		**0.84%**
Andira inermis	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
almendro de río, harino, quira		0.00%	9.09%	0.00%	0.00%	9.09%	0.00%	**2.33%**
Calliandra sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
gallito		0.00%	4.55%	0.00%	4.76%	4.55%	0.00%	**1.74%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	26.19%	0.00%	0.00%		**9.24%**
Cassia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
casia amarilla, carao		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	11.63%	0.00%		**4.20%**
Copaifera sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cabimo, camíbar		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**

Taxon	Site							
Crotalaria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
rattlebox		5.88%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.58%**
Dalbergia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
rosewood, cocobolo		0.00%	4.55%	0.00%	4.76%	4.55%	0.00%	**1.74%**
Diphysa sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
guachipel, macano, cacique		0.00%	0.00%	7.14%	11.63%	0.00%		**6.72%**
Enterolobium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
corotú, guanacaste		0.00%	0.00%	0.00%	9.52%	4.55%	0.00%	**1.74%**
Gliricidia sepium	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
balo, madero negro		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
Hymenaea sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
algarrobo, guapinol		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
Inga sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guama, guaba, paterna, ice cream bean		0.00%	9.09%	0.00%	19.05%	13.64%	1.47%	**5.81%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	16.67%	2.38%	11.63%	16.67%		**8.40%**
Lonchocarpus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
chaperno, guabito, frijolillo, malvecino, zorro		0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	**0.58%**
cf. *Myroxylon balsamum*	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
bálsamo, bálsamo de tolú, sándalo		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
Parkinsonia aculeata	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
árbol sarigua, palo verde		0.00%	0.00%	0.00%	4.76%	18.18%	1.47%	**3.49%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**

Peltogyne sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
amaranto, el nazareno		0.00%	0.00%	0.00%	9.52%	0.00%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Phaseolus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
common bean		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	7.14%	4.65%	0.00%		**4.20%**
Platymiscium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
granadillo, quira		0.00%	0.00%	0.00%	4.76%	9.09%	1.47%	**2.33%**
Prioria copaifera	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
cativo		0.00%	0.00%	0.00%	2.33%	8.33%		**1.68%**
cf. *Pterocarpus* sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
bloodwood		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
Samanea saman	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
guachapalí, cenízaro, rain tree		0.00%	8.33%	0.00%	0.00%	0.00%		**0.84%**
cf. *Swartzia* sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
naranjita, naranjo de monte, limoncillo, cutarro, malvecino		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
cf. *Tachigali* sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
tachi		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
Zygia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guabito cansa boca, guabito de río, pichindé		0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	**0.58%**
LACISTEMATACEAE								
Lacistema aggregatum	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
huesito		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**

LAURACEAE								
Beilschmiedia sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
aguacatillo, torpedo		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Cinnamomum sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
sigua blanca		0.00%	0.00%	2.38%	2.33%	0.00%		**1.68%**
Nectandra/Ocotea	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
sigua		0.00%	13.64%	0.00%	9.52%	18.18%	0.00%	**5.23%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	16.67%	26.19%	20.93%	25.00%		**21.01%**
Persea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
avocado, aguacate		0.00%	4.55%	0.00%	0.00%	22.73%	0.00%	**3.49%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		10.00%	25.00%	30.95%	2.33%	8.33%		**15.97%**
LECYTHIDACEAE								
Couratari cf. *scottmorii*	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
coquito, condon de mono, zorro, carapelo, congolo		0.00%	0.00%	0.00%	0.00%	8.33%		**0.84%**
MAGNOLIACEAE								
Magnolia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
candelilla, poas magnolia, baco		0.00%	0.00%	0.00%	28.57%	18.18%	0.00%	**5.81%**
MALPIGHIACEAE								
Bunchosia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cerezo de monte		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	9.30%	0.00%		**3.36%**
cf. *Byrsonima* sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
nance, nancillo		0.00%	0.00%	0.00%	4.76%	0.00%	1.47%	**1.16%**

MALVACEAE								
Apeiba sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
peinecillo, monkeys comb		0.00%	0.00%	0.00%	4.76%	0.00%	1.47%	**1.16%**
Cavanillesia platanifolia	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
pijio, bongo, cuipo, petrino		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
Ceiba sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
kapok, ceibo		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
Heliocarpus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
majaguillo/majagua		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	4.76%	0.00%	0.00%		**1.68%**
Herrania sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cacao de monte		0.00%	0.00%	0.00%	o	4.55%	0.00%	**0.58%**
Quararibea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guayabillo		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
Theobroma sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cacao		5.88%	9.09%	4.55%	4.76%	36.36%	8.82%	**11.05%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	16.67%	9.52%	0.00%	0.00%		**5.04%**
MELASTOMATACEAE								
Bellucia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
coronillo		0.00%	0.00%	0.00%	9.52%	13.64%	1.47%	**3.49%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	9.52%	2.33%	0.00%		**4.20%**
Clidemia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
soapbush, canillo		0.00%	9.09%	9.09%	23.81%	40.91%	5.88%	**12.79%**

	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	0.00%	0.00%	8.33%		**1.68%**
Miconia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
canillo, dos caras, papelillo		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
Tibouchina sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
glory bush, lasiandra		0.00%	0.00%	9.52%	0.00%	8.33%		**4.20%**
MELIACEAE								
Cabralea sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
canjerana		0.00%	0.00%	0.00%	18.60%	0.00%		**6.72%**
Carapa sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
tangaré, cedro bateo, andiroba		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
Cedrela sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cedro		0.00%	0.00%	0.00%	4.76%	9.09%	0.00%	**1.74%**
Swietenia spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
caoba, mahogany		0.00%	9.09%	0.00%	19.05%	27.27%	1.47%	**7.56%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	4.76%	11.63%	8.33%		**7.56%**
Trichilia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
conejo colorado, fosforito, alfajía colorado, alfaje, terciopelo		0.00%	9.09%	0.00%	9.52%	4.55%	2.94%	**4.07%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	9.52%	4.65%	8.33%		**6.72%**
MOLLUGINACEAE								
Mollugo verticillata	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
carpetweed		0.00%	4.55%	0.00%	0.00%	0.00%	1.47%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	8.33%		**1.68%**

MORACEAE								
Brosimum sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
breadnut, ramon, berbá, sande		5.88%	9.09%	0.00%	0.00%	4.55%	1.47%	**2.91%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Ficus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
fig, higuerón		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	0.00%	8.33%		**0.84%**
Maclura tinctoria	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
moro, mora, amarillo		0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	**0.58%**
Maquira costaricana	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
palo de pico		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
Naucleopsis sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
palo de pico		0.00%	0.00%	0.00%	14.29%	0.00%	0.00%	**1.74%**
Poulsenia armata	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
chilamate, chanchama, mastate		0.00%	0.00%	0.00%	4.76%	0.00%	1.47%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	0.00%	0.00%	0.00%		**0.84%**
Trophis sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
lija		5.88%	4.55%	0.00%	0.00%	4.55%	0.00%	**1.74%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	8.33%		**1.68%**
MUn.TINGIACEAE								
Muntingia calabura	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
capulin, jamaican cherry		0.00%	4.55%	0.00%	4.76%	0.00%	0.00%	**1.16%**

MYRICACEAE								
Morella sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
southern bayberry		0.00%	0.00%	0.00%	14.29%	4.55%	0.00%	**2.33%**
MYRISTICACEAE								
cf. *Otoba* sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
miguelario, velario, fruta dorada		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Virola sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
baboonwood, ucuhuba		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**
MYRSINACEAE								
Ardisia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
coralberry		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	16.67%	0.00%	2.33%	0.00%		**2.52%**
MYRTACEAE								
Eugenia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
pitanga, escobillo blanco		0.00%	0.00%	0.00%	4.76%	9.09%	1.47%	**2.33%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
Psidium sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guava, guayaba		0.00%	0.00%	0.00%	23.81%	59.09%	2.94%	**11.63%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	16.67%	9.52%	11.63%	8.33%		**10.08%**
NYCTAGINACEAE								
cf. *Neea* sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
canela, canelito		0.00%	0.00%	0.00%	4.76%	0.00%	0.00%	**0.58%**

OCHNACEAE								
Ouratea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
ouratea		0.00%	0.00%	0.00%	9.52%	18.18%	0.00%	**3.49%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	0.00%	0.00%	0.00%		**0.84%**
OLACACEAE								
Heisteria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
sombrerito, ajicillo, chorola		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
OXALIDACEAE								
Oxalis sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
wood sorrel		0.00%	4.55%	0.00%	4.76%	4.55%	0.00%	**1.74%**
PASSIFLORACEAE								
Passiflora sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
Passionfruit, maracuya		0.00%	0.00%	0.00%	0.00%	9.09%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		10.00%	0.00%	0.00%	0.00%	0.00%		**0.84%**
PHYLLANTHACEAE								
Hieronyma alchorneoides	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
zapatero, pilón, palo chancho, piedro		0.00%	4.55%	0.00%	0.00%	13.64%	0.00%	**2.33%**
Margaritaria nobilis	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
clavito		0.00%	0.00%	4.55%	4.76%	9.09%	1.47%	**2.91%**
PIPERACEAE								
Piper cf. *aduncum*	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
hinojo		50.00%	25.00%	16.67%	25.58%	8.33%		**22.69%**
POACEAE								
Zea mays	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
maize		0.00%	4.55%	0.00%	33.30%	22.73%	0.00%	**7.56%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**

		20.00%	33.33%	40.48%	53.49%	33.33%		**42.02%**
POLYGONACEAE								
cf. *Rumex* sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
sorrel		0.00%	0.00%	4.55%	0.00%	0.00%	2.94%	**1.74%**
Coccoloba sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
uvito, sea grape, uvero		0.00%	4.55%	0.00%	9.52%	4.55%	1.47%	**2.91%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
PORTULACACEAE								
Portulaca oleracea	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
purslane		0.00%	0.00%	2.38%	2.33%	0.00%		**1.68%**
ROSACEAE								
Prunus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cherry		0.00%	0.00%	0.00%	4.76%	0.00%	1.47%	**1.16%**
RUBIACEAE								
Calycophyllum candidissimum	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
madroño, alazano, lluvia de plato, degame, lemonwood		0.00%	0.00%	0.00%	14.29%	9.09%	0.00%	**2.91%**
Cosmibuena sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
tabaquillo		0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	0.00%	0.00%	0.00%		**0.84%**
Coussarea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
huesito		0.00%	0.00%	0.00%	9.52%	0.00%	2.94%	**2.33%**
Coutarea/Exostema	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
azulejo, quina		0.00%	0.00%	0.00%	19.05%	31.82%	1.47%	**6.98%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**

		0.00%	0.00%	9.52%	4.65%	0.00%		**5.04%**
Faramea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
huesito, benjamín, garrotillo, jazmín		0.00%	0.00%	0.00%	14.29%	13.64%	1.47%	**4.07%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	14.29%	9.30%	8.33%		**9.24%**
Genipa americana	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
jagua		0.00%	0.00%	0.00%	0.00%	4.55%	1.47%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	2.33%	8.33%		**2.52%**
Hamelia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guayabo negro, canelito		0.00%	18.18%	0.00%	4.76%	0.00%	0.00%	**2.91%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
Macrocnemum roseum	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
palo cuadrado, madroño, canaleto		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
Palicourea sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
recadito		0.00%	18.18%	0.00%	4.76%	9.09%	1.47%	**4.65%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	8.33%	14.29%	0.00%	0.00%		**5.88%**
Psychotria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cafecillo, sombrerito de diablo		0.00%	4.55%	0.00%	9.52%	31.82%	0.00%	**5.81%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Randia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
rosetillo, jagua macho, mostrenco		0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	**0.58%**

Warszewiczia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
wakamy, sanguinaria, cresta de gallo, orinera		5.88%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.58%**
RUTACEAE								
Erythrochiton sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
erythrochiton		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
Zanthoxylum sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
arcabú, tachuelo, pricklyash		11.76%	9.09%	0.00%	38.10%	50.00%	2.94%	**14.53%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	19.05%	13.95%	16.67%		**13.45%**
SABIACEAE								
Meliosma sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
worm head tree		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
SALICACEAE								
Casearia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
corta lengua, manga larga, mauro		0.00%	9.09%	0.00%	38.10%	50.00%	0.00%	**12.21%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		20.00%	16.67%	2.38%	6.98%	0.00%		**6.72%**
Hasseltia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
parimontón, corta lengua, raspa lengua		0.00%	0.00%	0.00%	9.52%	9.09%	0.00%	**2.33%**
Ryania speciosa	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
corta lengua		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**

SAPINDACEAE								
Allophylus sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
esquitillo		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
Cupania sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
candelillo, gorgojero, gorgojo, pava		0.00%	9.09%	0.00%	0.00%	9.09%	0.00%	**2.33%**
Sapindus saponaria	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
jaboncillo, soapberry, yequiti		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	25.00%	30.95%	32.56%	25.00%		**27.73%**
SAPOTACEAE								
Manilkara sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
mamey, sapodilla, níspero		0.00%	0.00%	0.00%	0.00%	0.00%	1.47%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	14.29%	20.93%	16.67%		**14.29%**
Pouteria sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
mamey, nisperillo, mameicillo		0.00%	4.55%	0.00%	28.57%	18.18%	0.00%	**6.40%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		20.00%	0.00%	21.43%	37.21%	8.33%		**23.53%**
Sideroxylon sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
espino rico, tempisque		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	0.00%	0.00%		**0.84%**
SCROPHULARIACEAE								
Buddleja sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
butterfly bush		0.00%	8.33%	9.52%	2.33%	0.00%		**5.04%**

SIMAROUBACEAE								
Simaba cf. cedron	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
cedron		0.00%	0.00%	0.00%	0.00%	4.55%	0.00%	**0.58%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**
Simarouba spp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
aceituno, olivo		0.00%	0.00%	0.00%	4.76%	27.27%	2.94%	**5.23%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	2.38%	2.33%	0.00%		**1.68%**
SIPARUNACEAE								
Siparuna sp.	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
pasmo hediondo, pasmo, limoncillo		10.00%	0.00%	0.00%	0.00%	0.00%		**0.84%**
SOLANACEAE								
Nicotiana sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
tobacco		0.00%	0.00%	0.00%	0.00%	0.00%	2.94%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	16.67%		**2.52%**
URTICACEAE								
Cecropia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
guarumo, trumpet tree		0.00%	0.00%	0.00%	9.52%	27.27%	1.47%	**5.23%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		10.00%	16.67%	4.76%	13.95%	8.33%		**10.08%**
Pourouma sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
uvito, magabe, guarumo macho		0.00%	0.00%	0.00%	4.76%	4.55%	0.00%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	2.33%	0.00%		**0.84%**

VOCHYSIACEAE								
Vochysia sp.	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
mayo, flor de mayo, botarrama, tecla		0.00%	0.00%	0.00%	4.76%	0.00%	1.47%	**1.16%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		0.00%	0.00%	0.00%	4.65%	0.00%		**1.68%**
geophyte	G995	AR 16-15	Un. 54	AR 14-9	Hearth + Post Holes	Un. 60	Un. 61	**Total**
root or tuber		0.00%	9.09%	0.00%	47.62%	50.00%	5.88%	**15.70%**
	G164	Nv. 3	Nv. 4	Nv. 5A	Nv. 5B	Nv. 5C		**Total**
		20.00%	0.00%	33.33%	30.23%	8.33%		**25.21%**

Appendix O: Arboreal Taxa Forest Types

Scientific Name	**Common Name**	**Primary**	**Secondary**	**Tropical Moist**	**Tropical Dry**	**Pioneer**	**Disturbed**	**Coastal**	**Open Forest**	**Savanna**	**Mixed Forest**	**Riparian**	**Montane**	**Lowland**
ACANTHACEAE														
Avicennia sp.	mangle negro					●		●						●
ADOXACEAE														
Viburnum sp.	viburnum		●	●			●		●				●	
AMARANTHACEAE														
Chenopodium sp.	quinoa		●				●		●				●	
ANACARDIACEAE														
Amphipterygium sp.	cuachalalate				●									●
Anacardium spp.	cashew, marañón		●	●	●	●	●	●	●	●		●		●
Astronium graveolens	tolerante, cucaracho	●	●	●	●		●						●	●
Campnosperma panamense	orey	●		●			●	●	●		●	●		●
cf. *Mosquitoxylum jamaicense*	pasak'			●									●	
Schinus cf. *terebinthifolius*	pepper tree			●	●	●	●		●	●		●	●	
Spondias spp.	jobo, mope, hogplum		●	●			●							●
Tapirira sp.	caobilla		●	●		●				●	●	●		●
ANNONACEAE														
Annona sp.	cherimoya, guanabana		●	●	●			●				●	●	●
APOCYNACEAE														
Aspidosperma spp.	aracanga, alcarreto	●		●	●			●		●		●	●	●
Lacmellea sp.	leche de vaca	●		●									●	●
Tabernaemontana sp.	milkwood	●	●	●							●	●	●	●
Thevetia sp.	yellow oleander	●	●	●	●		●		●			●	●	●
ARALIACEAE														
Dendropanax sp.	vaquero	●	●	●	●						●		●	●
Schefflera sp.	mangabé		●	●		●	●	●	●	●			●	

Scientific Name	**Common Name**	**Primary**	**Secondary**	**Tropical Moist**	**Tropical Dry**	**Pioneer**	**Disturbed**	**Coastal**	**Open Forest**	**Savanna**	**Mixed Forest**	**Riparian**	**Montane**	**Lowland**
ARECAEAE														
Attalea sp.	cohune			●										●
Bactris sp.	pejibaye	●		●			●					●		
Acrocomia aculeata	coyol	●	●	●	●		●	●					●	●
ASTERACEAE														
Acmella sp.	paracress			●			●						●	
Melampodium sp.	blackfoot daisy								●					
BIGNONIACEAE														
Crescentia spp.	calabash, jicaro			●		●								●
Handroanthus sp.	poui	●	●	●	●	●			●					●
Jacaranda sp.	jacaranda, nazareno	●	●	●	●		●			●		●		●
Parmentiera sp.	arbol de vela		●	●	●		●							●
Tabebuia sp.	roble de sabana			●	●		●	●	●	●				●
Tecoma stans	yellow elder			●	●		●		●					●
BIXACEAE														
Bixa cf. *orellana*	achiote, annatto			●			●	●						●
BORAGINACEAE														
Bourreria sp.	canalú			●				●					●	●
BURSERACEAE														
cf. *Protium* sp.	copal, kerosín	●	●	●						●		●	●	●
Tetragastris panamensis	anime, kerosín	●		●	●						●		●	●
CANNABACEAE														
Celtis sp.	hackberry			●	●	●								●
Trema sp.	jordancillo, capulin		●	●	●	●	●		●				●	●
CAPPARACEAE														
Capparis sp.	caper bush			●	●			●					●	●
Crateva sp.	guaco			●	●	●		●	●	●		●		●

Scientific Name	Common Name	Primary	Secondary	Tropical Moist	Tropical Dry	Pioneer	Disturbed	Coastal	Open Forest	Savanna	Mixed Forest	Riparian	Montane	Lowland
CARYOPHYLLACEAE														
Drymaria cordata	chickweed		●	●			●			●			●	●
CELASTRACEAE														
Cheiloclinium cognatum	fruta de mono, cocora			●	●					●				●
Maytenus sp.	mayten	●		●	●				●					●
Salacia sp.	salacia		●	●	●					●			●	
Wimmeria sp.	no common name			●	●				●			●	●	
CHLORANTHACEAE														
Hedyosmum sp.	sauquillo, limoncillo			●							●		●	
CHRYSOBALANACEAE														
Hirtella sp.	camaron, garrapato	●		●								●	●	●
Licania sp.	corocillo, garrapato	●		●	●					●			●	●
CLETHRACEAE														
Clethra sp.	nancito, memeicillo		●	●	●	●	●		●			●	●	
CLUSIACEAE														
Garcinia sp.	madroño, chaparrón	●				●								●
Symphonia globulifera	cerillo, cero, barillo			●				●			●			●
COMBRETACEAE														
Buchenavia sp.	amarillo			●	●			●		●			●	●
Terminalia spp.	tropical almond, guayabillo		●	●	●			●				●	●	●
CORNACEAE														
Cornus spp.	lloró, dogwood			●	●								●	
CUNONIACEAE														
Weinmannia sp.	white myrtle, arrayán			●							●		●	
CYPERACEAE														
cf. *Fimbristylis* sp.	fimbry						●			●			●	

Scientific Name	Common Name	Primary	Secondary	Tropical Moist	Tropical Dry	Pioneer	Disturbed	Coastal	Open Forest	Savanna	Mixed Forest	Riparian	Montane	Lowland
DILLENIACEAE														
cf. *Curatella americana*	chumico				●				●	●				●
DIPENTODONTACEAE														
Perrottetia sp.	olomea		●	●			●		●			●	●	
EBENACEAE														
Diospyros sp.	sapote negro			●	●						●	●	●	●
ELAEOCARPACEAE														
Sloanea sp.	carabeen, terciopelo	●	●	●	●		●		●			●		●
ERICACEAE														
Gaultheria sp.	uvita, mortiño			●			●						●	
ESCALLONIACEAE														
Escallonia sp.	madrono, corontillo			●	●		●		●				●	
EUPHORBIACEAE														
Acalypha sp.	prende-prende			●			●					●	●	●
Adelia sp.	bagre			●	●									●
Alchornea sp.	achiotillo	●	●	●	●	●		●				●	●	●
Croton sp.	sangrillo		●	●	●		●						●	●
Hura crepitans	nuno, havillo, ceibo			●	●		●	●				●		●
Mabea sp.	casiquillo		●	●		●				●				●
Manihot sp.	manioc			●	●									●
Sapium sp.	milktree, olivo, gumtree	●	●	●	●	●	●		●	●			●	●
Sebastiania sp.	milkwood				●									●
FABACEAE														
Abarema sp.	abarema	●								●			●	●
Acacia sp.	acacia	●	●	●		●			●	●				●
Andira inermis	almendro de río, quira			●	●		●			●		●		●
Calliandra sp.	gallito			●	●	●	●						●	●

Scientific Name	Common Name	Primary	Secondary	Tropical Moist	Tropical Dry	Pioneer	Disturbed	Coastal	Open Forest	Savanna	Mixed Forest	Riparian	Montane	Lowland
Cassia sp.	casia amarilla, carao		●			●	●		●					●
Copaifera sp.	cabimo, camíbar	●		●		●						●	●	●
Crotalaria sp.	rattlebox						●			●		●	●	●
Dalbergia sp.	rosewood, cocobolo			●	●		●						●	●
Diphysa robinioides	guachipel, macano, cacique			●	●								●	●
Enterolobium sp.	corotú, guanacaste	●		●			●		●					●
Gliricidia sepium	balo, madero negro			●	●	●	●	●				●		●
Hymenaea sp.	algarrobo, guapinol	●		●	●				●			●		●
Inga sp.	guama, guaba, paterna	●	●	●	●	●	●					●	●	●
Lonchocarpus sp.	chaperno, zorro			●	●					●		●		●
Myroxylon balsamum	bálsamo, sándalo			●										●
Parkinsonia aculeata	árbol sarigua, palo verde				●		●			●			●	●
Peltogyne sp.	amaranto, el nazareno			●								●		●
Phaseolus sp.	common bean				●		●							
Platymiscium sp.	granadillo, quira		●	●	●		●	●		●	●	●	●	●
Prioria copaifera	cativo			●				●				●		●
cf. *Pterocarpus* sp.	bloodwood	●	●	●		●		●					●	●
Samanea saman	guachapalí, cenízaro				●	●		●	●	●				●
cf. *Swartzia* sp.	naranjo de monte, limoncillo	●		●								●		●
cf. *Tachigali* sp.	tachi			●							●			●
Zygia sp.	guabito, pichindé		●					●	●			●	●	●
LACISTEMATACEAE														
Lacistema aggregatum	huesito		●	●	●				●	●		●	●	●
LAURACEAE														
Beilschmiedia sp.	aguacatillo, torpedo	●		●									●	
Cinnamomum sp.	sigua blanca		●	●	●								●	
Nectandra/Ocotea	sigua		●	●	●	●	●		●	●			●	●

Scientific Name	**Common Name**	**Primary**	**Secondary**	**Tropical Moist**	**Tropical Dry**	**Pioneer**	**Disturbed**	**Coastal**	**Open Forest**	**Savanna**	**Mixed Forest**	**Riparian**	**Montane**	**Lowland**
Persea sp.	avocado, aguacate			●									●	●
LECYTHIDACEAE														
Couratari cf. *scottmorii*	coquito, carapelo	●		●								●		●
MAGNOLIACEAE														
Magnolia sp.	candelilla, poas magnolia					●		●				●	●	●
MALPIGHIACEAE														
Bunchosia sp.	cerezo de monte		●	●	●	●	●	●	●					●
Byrsonima sp.	nance, nancillo			●	●	●	●		●	●				●
MALVACEAE BOMBACOIDEAE														
Cavanillesia platanifolia	pijio, cuipo, petrino			●	●		●							●
Ceiba sp.	kapok, ceibo		●	●	●	●	●							●
Quararibea sp.	molenillo, guayabillo	●		●								●	●	●
MALVACEAE BYTTNERIOIDEAE														
Herrania sp.	cacao de monte	●		●	●							●	●	●
Theobroma sp.	cacao			●										●
MALVACEAE GREWIOIDEAE														
Apeiba sp.	peinecillo	●	●	●	●	●	●	●					●	●
Heliocarpus sp.	majaguillo/majagua						●		●				●	
MELASTOMATACEAE														
Bellucia sp.	coronillo		●	●		●	●	●			●		●	●
Clidemia sp.	soapbush, canillo		●	●					●		●		●	●
Miconia sp.	canillo, papelillo		●	●		●	●					●	●	●
Tibouchina sp.	glory bush, lasiandra	●	●	●									●	
MELIACEAE														
Cabralea sp.	canjerana	●	●	●		●							●	●
Carapa sp.	tangaré, cedro bateo			●								●		●
Cedrela sp.	cedro	●	●	●		●							●	●

Scientific Name	**Common Name**	**Primary**	**Secondary**	**Tropical Moist**	**Tropical Dry**	**Pioneer**	**Disturbed**	**Coastal**	**Open Forest**	**Savanna**	**Mixed Forest**	**Riparian**	**Montane**	**Lowland**
Swietenia spp.	caoba, mahogany			●	●	●	●			●	●	●		●
Trichilia sp.	fosforito, alfaje		●	●	●		●	●				●	●	●
MOLLUGINACEAE														
Mollugo veriticillata	carpetweed			●			●			●		●		●
MORACEAE														
Brosimum sp.	breadnut, ramon, mastate			●	●		●	●	●					●
Ficus sp.	fig, higuerón			●	●	●	●		●	●		●	●	●
Maclura tinctoria	moro, mora, amarillo	●	●	●	●	●		●		●				●
Maquira costaricana	palo de pico			●								●	●	●
Naucleopsis sp.	palo de pico			●									●	●
Poulsenia armata	chilamate, chanchama			●									●	●
Trophis sp.	lija		●	●	●		●		●	●		●	●	●
MUNTINGIACEAE														
Muntingia calabura	capulin, jamaican cherry					●	●							●
MYRICACEAE														
Morella sp.	southern bayberry			●				●	●			●	●	●
MYRISTICACEAE														
cf. *Otoba* sp.	miguelario, velario	●	●	●				●				●	●	
Virola sp.	baboonwood, ucuhuba	●	●	●		●								●
MYRSINACEAE														
Ardisia sp.	coralberry			●	●			●				●	●	●
MYRTACEAE														
Eugenia sp.	pitanga, escobillo blanco			●	●			●			●		●	●
Psidium sp.	guava, guayaba			●	●	●	●	●	●					●
NYCTAGINACEAE														
cf. *Neea* sp.	canela, canelito			●					●	●				●

Scientific Name	**Common Name**	**Primary**	**Secondary**	**Tropical Moist**	**Tropical Dry**	**Pioneer**	**Disturbed**	**Coastal**	**Open Forest**	**Savanna**	**Mixed Forest**	**Riparian**	**Montane**	**Lowland**
OCHNACEAE														
Ouratea sp.	ouratea	●	●	●	●	●			●	●		●	●	●
OLACACEAE														
Heisteria sp.	sombrerito, ajicillo	●						●					●	
OXALIDACEAE														
Oxalis sp.	wood sorrel											●	●	●
PASSIFLORACEAE														
Passiflora sp.	passion flower			●	●		●				●		●	●
PHYLLANTHACEAE														
Hieronyma alchorneoides	zapatero, pilón	●		●	●	●					●	●	●	
Margaritaria nobilis	clavito		●	●		●						●	●	●
PIPERACEAE														
Piper cf. *aduncum*	hinojo			●			●					●	●	
POACEAE														
Zea mays	maize						●						●	●
POLYGONACEAE														
cf. *Rumex* sp.	sorrel												●	●
Coccoloba sp.	uvito, sea grape, uvero		●		●	●	●	●	●	●				●
PORTULCACEAE														
Portulaca oleracea	purslane						●	●					●	●
ROSACEAE														
Prunus sp.	cherry	●	●						●		●		●	
RUBIACEAE														
Calycophyllum candidissimum	madroño, degame	●	●	●	●		●					●		●
Cosmibuena sp.	tabaquillo			●				●					●	●
Coussarea sp.	huesito	●		●	●	●				●				●
Coutarea/Exostema	azulejo, quina	●	●	●	●				●			●		●

Scientific Name	Common Name	Primary	Secondary	Tropical Moist	Tropical Dry	Pioneer	Disturbed	Coastal	Open Forest	Savanna	Mixed Forest	Riparian	Montane	Lowland
Faramea sp.	huesito, garrotillo	●		●	●						●		●	●
Genipa americana	jagua			●				●				●		●
Hamelia sp.	guayabo negro, canelito			●	●		●		●					●
Macrocnemum roseum	palo cuadrado, madroño	●	●	●			●					●	●	●
Palicourea sp.	recadito			●		●	●						●	●
Psychotria sp.	cafecillo, hot lips	●	●	●	●								●	●
Randia sp.	rosetillo, jagua macho			●	●			●				●	●	●
Warszewiczia sp.	wakamy, sanguinaria			●					●			●	●	●
RUTACEAE														
Erythrochiton sp.	erythrochiton			●										●
Zanthoxylum sp.	arcabú, tachuelo	●	●	●	●	●			●		●			●
SABIACEAE														
Meliosma sp.	worm head tree	●	●						●				●	
SALICACEAE														
Casearia sp.	corta lengua, mauro		●	●	●	●	●						●	●
Hasseltia sp.	parimontón, raspa lengua	●	●		●		●		●				●	
Ryania speciosa	corta lengua	●	●	●				●				●	●	●
SAPINDACEAE														
Allophylus sp.	esquitillo		●	●		●			●				●	●
Cupania sp.	candelillo, gorgojero	●	●			●	●		●					●
Sapindus saponaria	jaboncillo, soapberry			●	●	●		●	●					
SAPOTACEAE														
Manilkara sp.	mamey, sapodilla, níspero			●	●			●			●		●	●
Pouteria sp.	mamey, nisperillo		●	●				●					●	●
Sideroxylon sp.	espino rico, tempisque			●	●			●	●	●	●		●	●
SCROPHULARIACEAE														
Buddleja sp.	butterfly bush		●				●		●	●	●	●	●	

Scientific Name	Common Name	Primary	Secondary	Tropical Moist	Tropical Dry	Pioneer	Disturbed	Coastal	Open Forest	Savanna	Mixed Forest	Riparian	Montane	Lowland
SIMAROUBACEAE														
Simaba cf. *cedron*	cedron			●										●
Simarouba spp.	aceituno, olivo	●	●	●	●				●	●		●	●	●
SIPARUNACEAE														
Siparuna sp.	pasmo hediondo	●	●	●			●						●	●
SOLANACEAE														
Nicotiana sp.	tobacco						●		●					
URTICACEAE														
Cecropia sp.	guarumo, trumpet tree		●	●	●	●	●		●				●	●
Pourouma sp.	uvito, magabe		●	●		●							●	●
VOCHYSIACEAE														
Vochysia sp.	mayo, flor de mayo		●				●	●	●				●	●

Appendix P: Summary of Raw Counts and Weights of Botanical Remains

Summary of raw counts (quantity) and weights (g) of plant remains recovered from G-995 La Chiripa and G-164 Sitio Bolívar. At La Chiripa this includes a total of 144 flotation samples, 70 screen samples, and 109 manual samples (amounting to 1,739.5 liters of sediment sampled). At Sitio Bolívar this includes 137 flotation samples and 88 manual/screened samples (amounting to 645 liters of sediment sampled through flotation).

			Wood Charcoal		**Seeds**		**Achenes**		**Fruits**		**Maize Cupules**		**Geophytes**	
			Raw Ct.	**Raw Wt.**	**Raw Ct.**	**Raw Wt.**	**Raw Ct.**	**Raw Wt.**	**Raw Ct.**	**Raw Wt.**	**Raw Ct.**	**Raw Wt.**	**Raw Ct.**	**Raw Wt.**
G995 La Chiripa	Flotation n=144 (1139.5 L)	Total Flotation	2180	20.698	502	0.289	2222	0.184	102	0.57	14	0.173	41	0.355
		Light Fraction	1437	14.020	499	0.278	2222	0.184	78	0.27	5	0.135	27	0.149
		Heavy Fraction	743	6.678	3	0.010	0	0.000	24	0.30	9	0.038	14	0.206
	Screened n=70 (600 L)		457	6.221	13	0.016	7	0.001	24	0.20	2	0.005	4	0.119
G164 Sitio Bolívar	Flotation n=137 (645 L)	Total Flotation	2756	25.553	903	0.404	3641	0.070	85	1.86	51	0.191	42	0.635
		Light Fraction	1345	18.102	890	0.358	3641	0.070	62	1.44	33	0.113	39	0.558
		Heavy Fraction	1411	7.451	13	0.046	0	0.000	23	0.42	18	0.078	3	0.077
	Screened (all sediment ~21,000 L)		967	41.107	2	0.047	0	0.000	108	8.11	7	0.206	35	0.617

Appendix Q: Trees of Costa Rica Anatomical Reference Images (Alphabetical by Family)

Base list of the most common trees obtained from Condit, R., R. Perez, and N. Daguerre 2011. *Trees of Panama and Costa Rica*. Princeton, NJ: Princeton University Press.

Reference Images obtained by Insidewood (https://insidewood.lib.ncsu.edu/) unless stated otherwise.

- Each slide showcases a single species and its anatomical characteristics (vessels, rays, parenchyma, tyloses) unless noted otherwise. Anatomical characteristics only listed if provided by Insidewood.

Text in bold are the species in the images. Text within (parenthesis) are the common names. Lists of the potential other species within that same genera present in Costa Rica today were obtained by the Búsqueda de Colecciones de Historia Natural - Museo Nacional de Costa Rica (biodiversidad.museocostarica.go.cr) and are listed after each entry in *italics*.

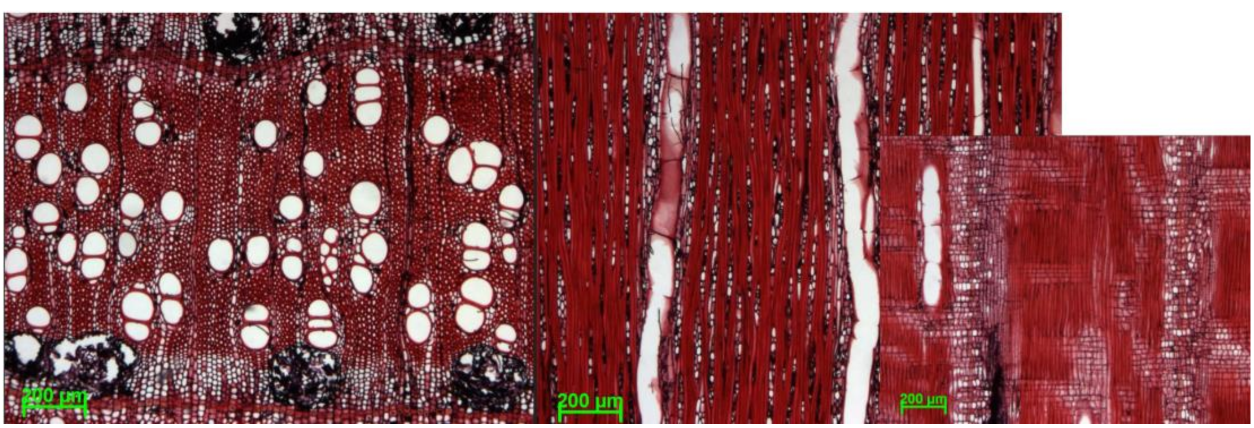
On the archaeological specimen, identification was made to the species level only if it is the only species possible within the country - or if reference images of all possible species were obtained and distinguishable. Otherwise, identifications were only made to the genus or even just the family level. If a specimen did not match sufficiently any of the obtained reference images or if preservation was too poor it was deemed unidentifiable.

ACANTHACEAE ***Aphelandra*** *A. aurantiaca, campanensis, dolichantha, gulfodulcensis, seibertii, scabra, sinclairiana, storkii, tonduzii, tridentata*
(aphelandra)

- Uniseriate rays
- Vessels in chains, clusters, solitary
- Scanty parenchyma
- No tyloses present

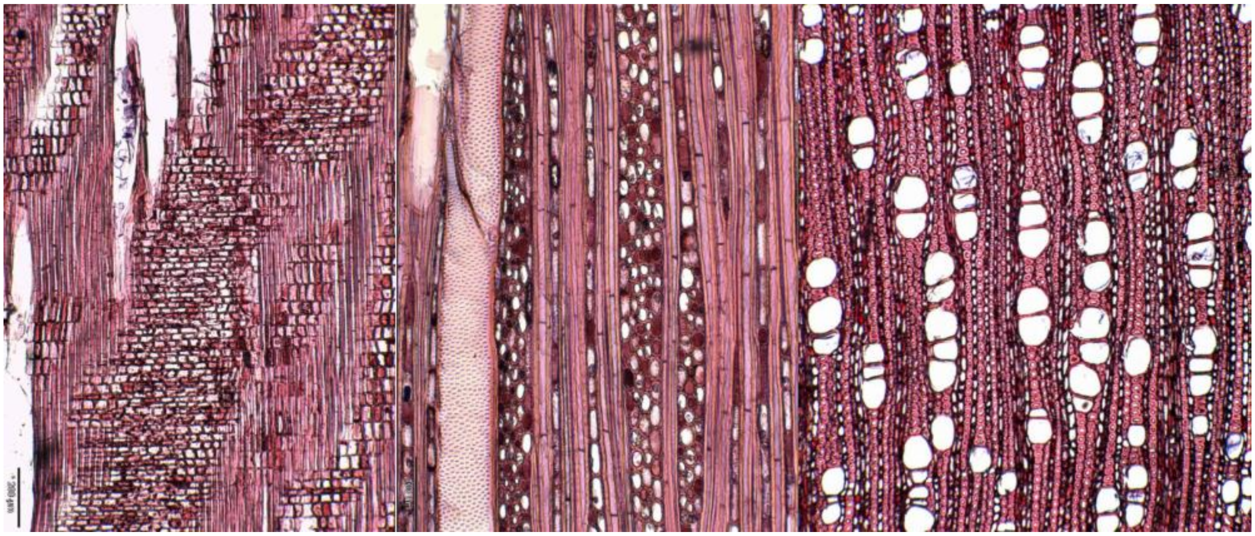
ACANTHACEAE ***Avicennia germinans****, A. bicolor, tonduzii*
(mangle salado, mangle negro, mangle prieto, black mangrove)

- Rays 1 to 3 cells, 4-12+/mm^2
- Vessels in chains, clusters, solitary, 50-100µm, 40-100 per sq. mm
- Scanty parenchyma, vasicentric, banded
- No tyloses present



ACHARIACEAE ***Lindackeria*** *laurina* (carbonero) *L. paludosa*

- Rays 4 to 10 seriate, 4-12+/mm
- Vessels in chains, 50-100 µm, 20-100 per sq. mm
- Parenchyma absent or rare
- *L. paludosa* → vessels can be <50µm or 100+/mm, rays 1 to 3, >12
- No tyloses present

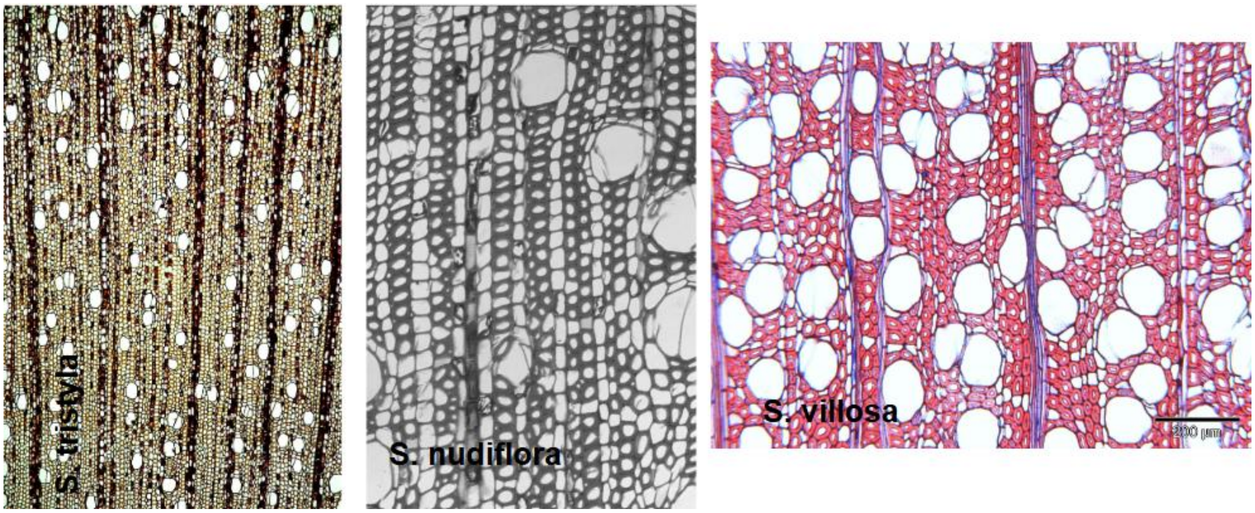


ACHARIACEAE ***Mayna odorata*** no known common name

- Rays 4 to 10 seriate, <4-12+/mm
- Vessels in chains, <50-100 µm, 20-40 /mm^2
- Parenchyma absent or rare
- Tyloses common

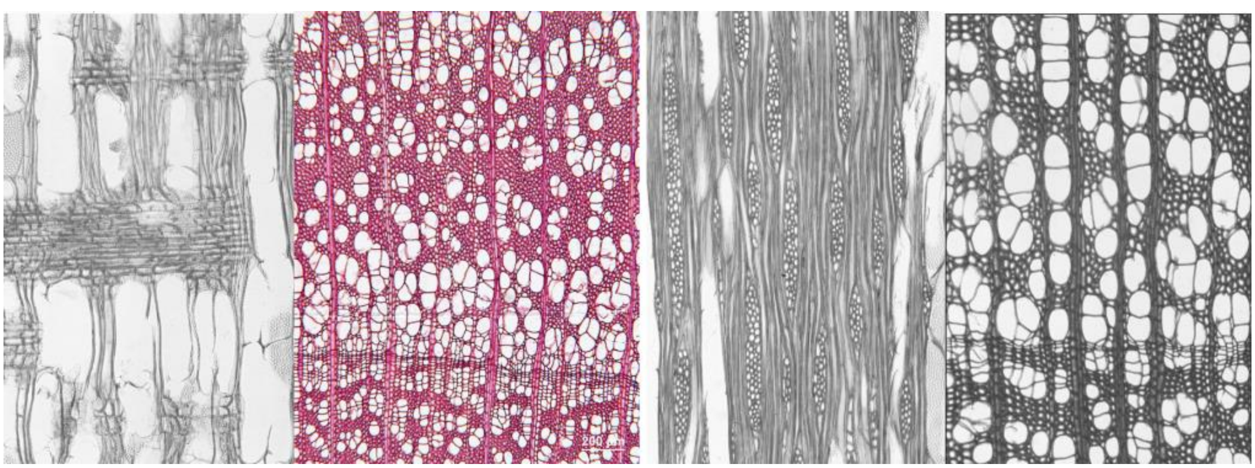
ACTINIDIACEAE *Saurauia montana* (moquillo)

- Rays of two distinct sizes, 4 to 10 seriate, 4-12/mm
- Vessels exclusively solitary, 100 - 200 µm, 5-20/mm^2
- Parenchyma diffuse, scanty paratracheal



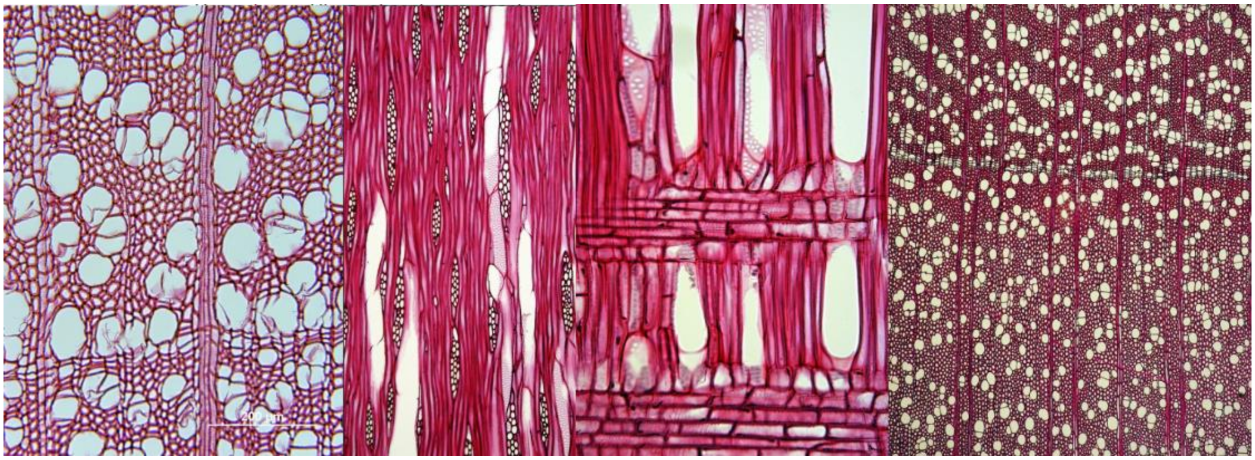
ADOXACEAE *Sambucus nigra,* *S. canadensis, caerula, mexicana, pubens, racemosa* (elderberry)

- Rays 4 to 10 seriate, 4-12/mm
- Vessels clusters common, <50-100 µm, >100 /mm^2
- Parenchyma diffuse, absent, rare, scanty, marginal bands



ADOXACEAE *Sambucus racemosa*, *canadensis, caerula, mexicana, nigra, pubens,* (elderberry)

- Rays 4 to 10 seriate, 4-12/mm
- Vessels clusters common, <50-100 µm, >100 /mm^2
- Parenchyma diffuse, absent, rare, scanty, marginal bands

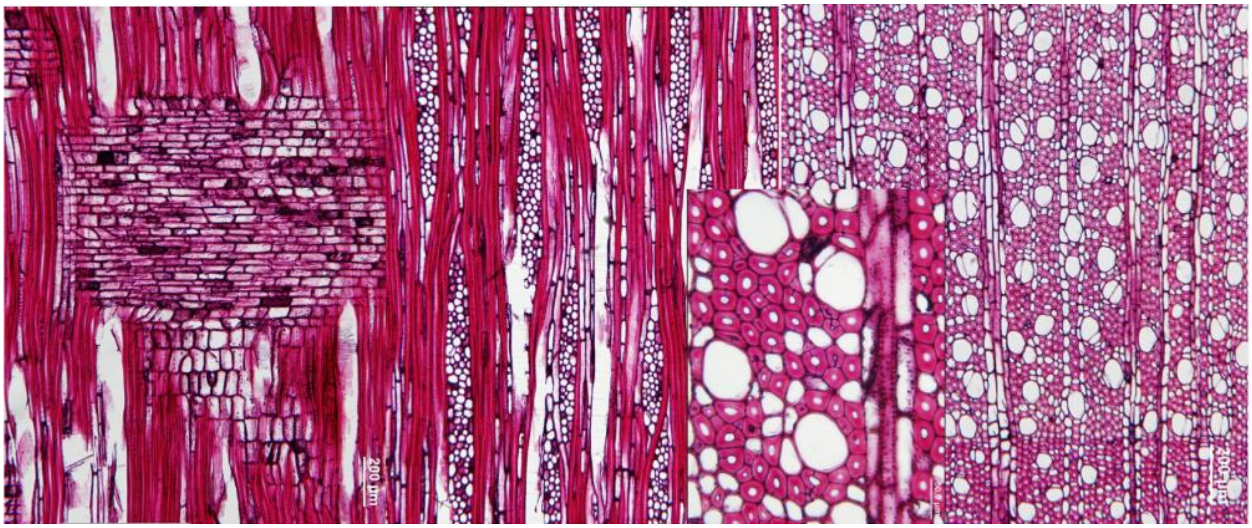


ADOXACEAE *Sambucus peruviana,* *S. mexicana, canadensis* (elderberry)

- Vessels in tangential bands, clusters common, 50-100 µm, >100/mm^2
- Rays 4-10 seriate, 4-12/mm
- Parenchyma diffuse, marginal bands

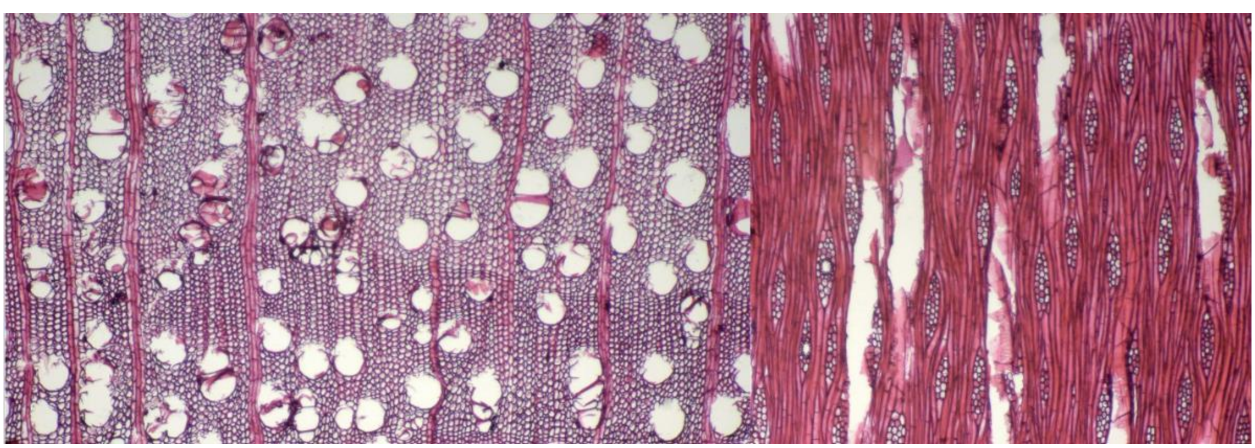
ADOXACEAE *Viburnum stellatotomentosum,* *acerifolium, costaricanum, venustum* (viburnum)

- Rays 1 to 3 cells, 4 to 10 seriate, 12+/mm
- Vessels in exclusively solitary, 50-100 µm, 20-40 /mm^2
- Parenchyma diffuse in aggregates



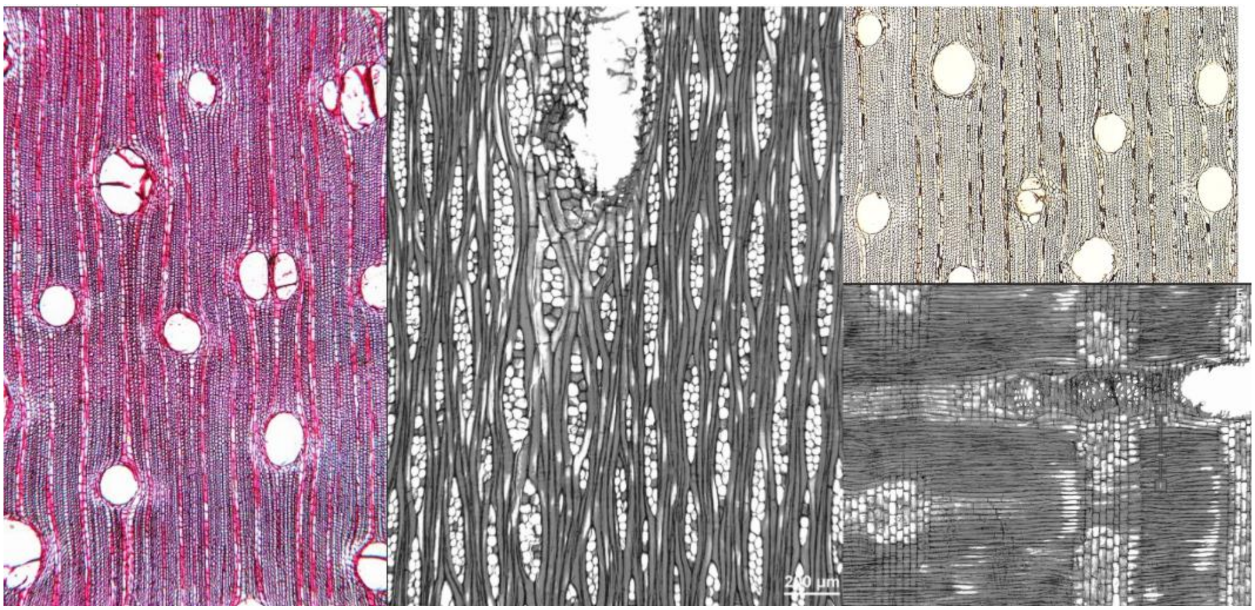
ANACARDIACEAE *Amphipterygium molle,* *simplicifoilum* (cuachalalate)

- Vessels 50-100 µm, <5-40/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Tyloses common
- Parenchyma scanty, vasicentric



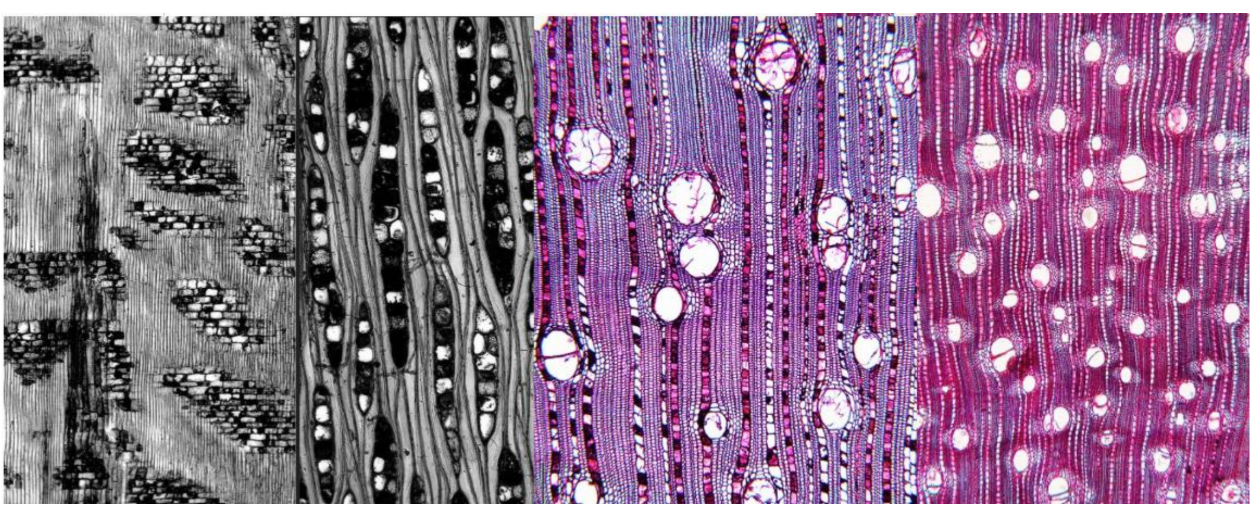
ANACARDIACEAE *Anacardium excelsum,* *occidentale* (wild cashew/espavé)

- Vessels 100-200+ µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Tyloses common
- Parenchyma vasicentric, aiform, lozenge



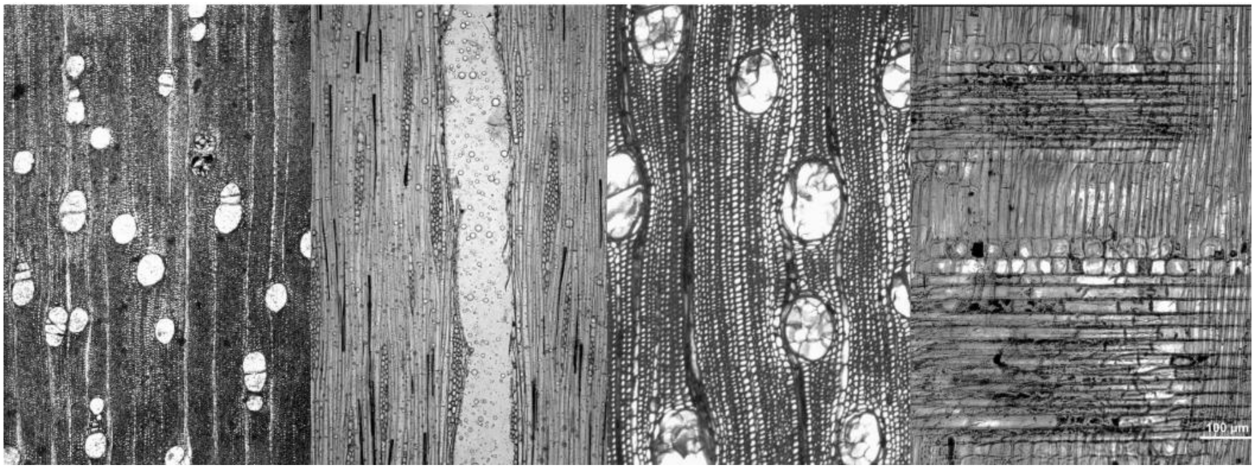
ANACARDIACEAE *Anacardium occidentale*, *excelsum (cashew, marañón)*

- Vessels 100-200+ µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Tyloses common
- Parenchyma vasicentric, aliform, lozenge, confluent



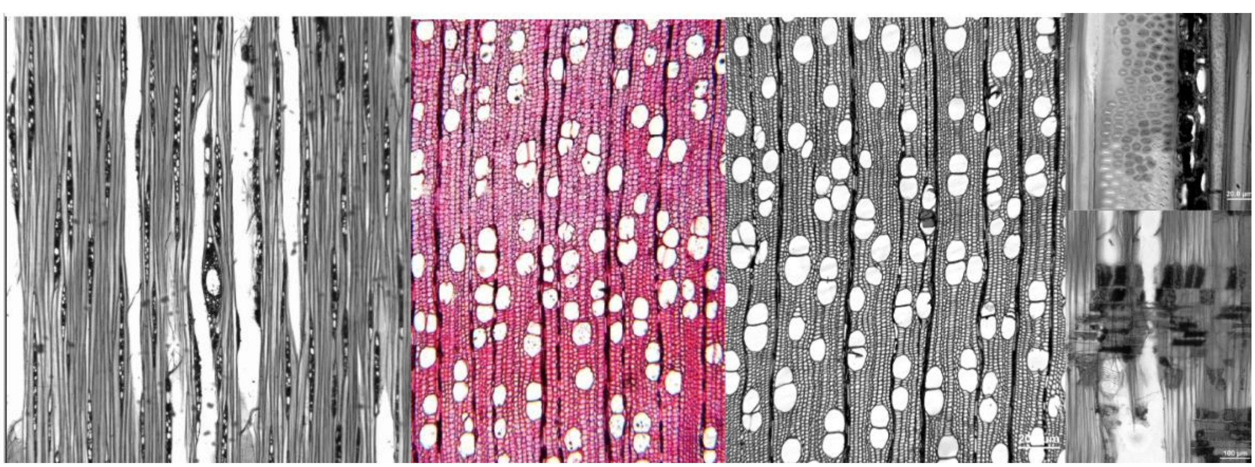
ANACARDIACEAE *Astronium graveolens* (zorro, ron-ron, tigrillo, tolerante, cucaracho)
Only species in Costa Rica within this genus

- Vessels 100-200 µm, two distinct diameter classes, <5-20/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Tyloses common
- Parenchyma vasicentric, scanty, marginal bands



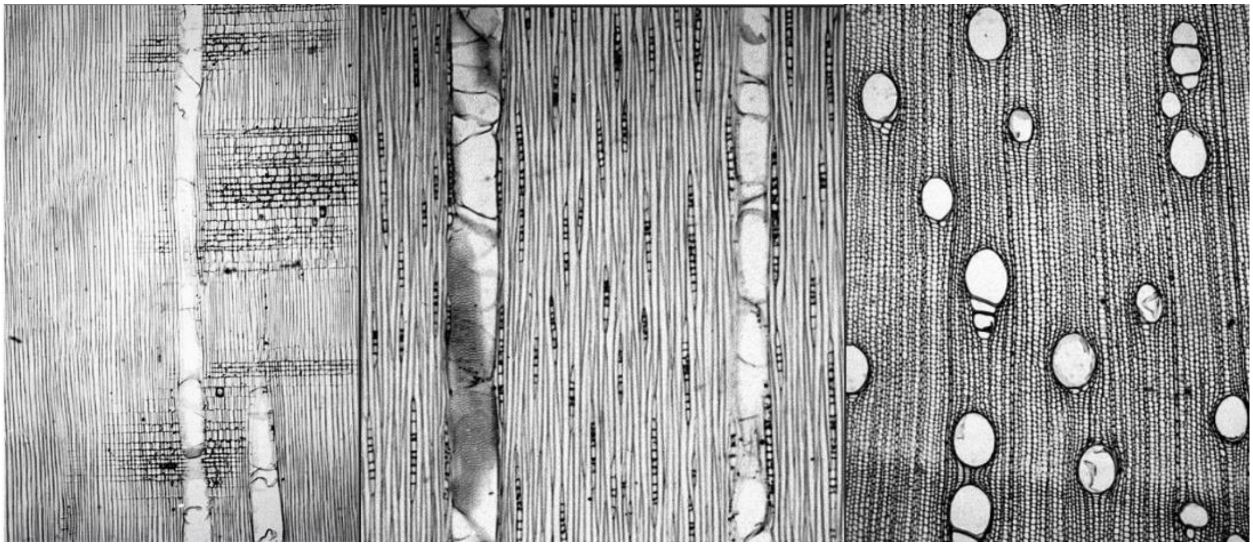
ANACARDIACEAE *Campnosperma panamense* (orey)
Only species in Costa Rica within this genus

- Vessels 50-100µm, 20-100/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent or rare



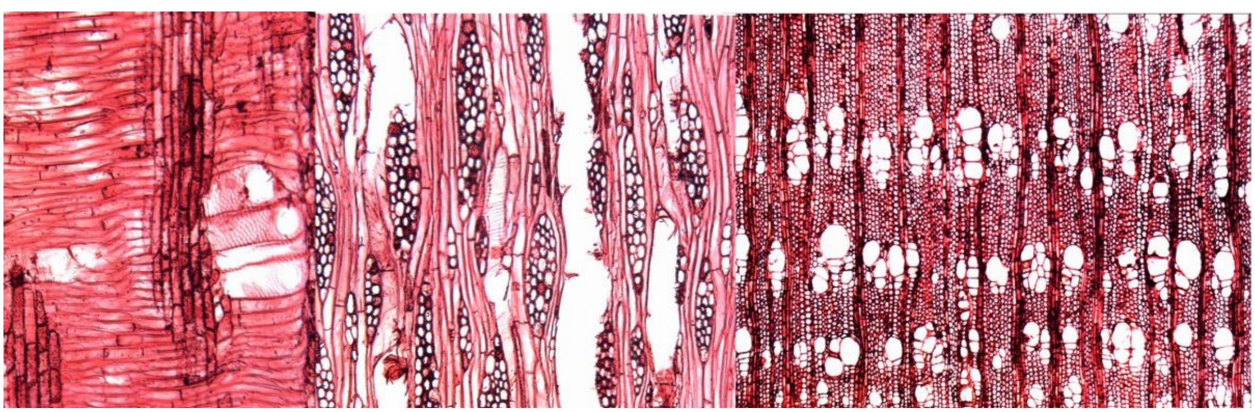
ANACARDIACEAE *Mosquitoxylum* *jamaicense (Pasak')*

- Vessels 100-200µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty



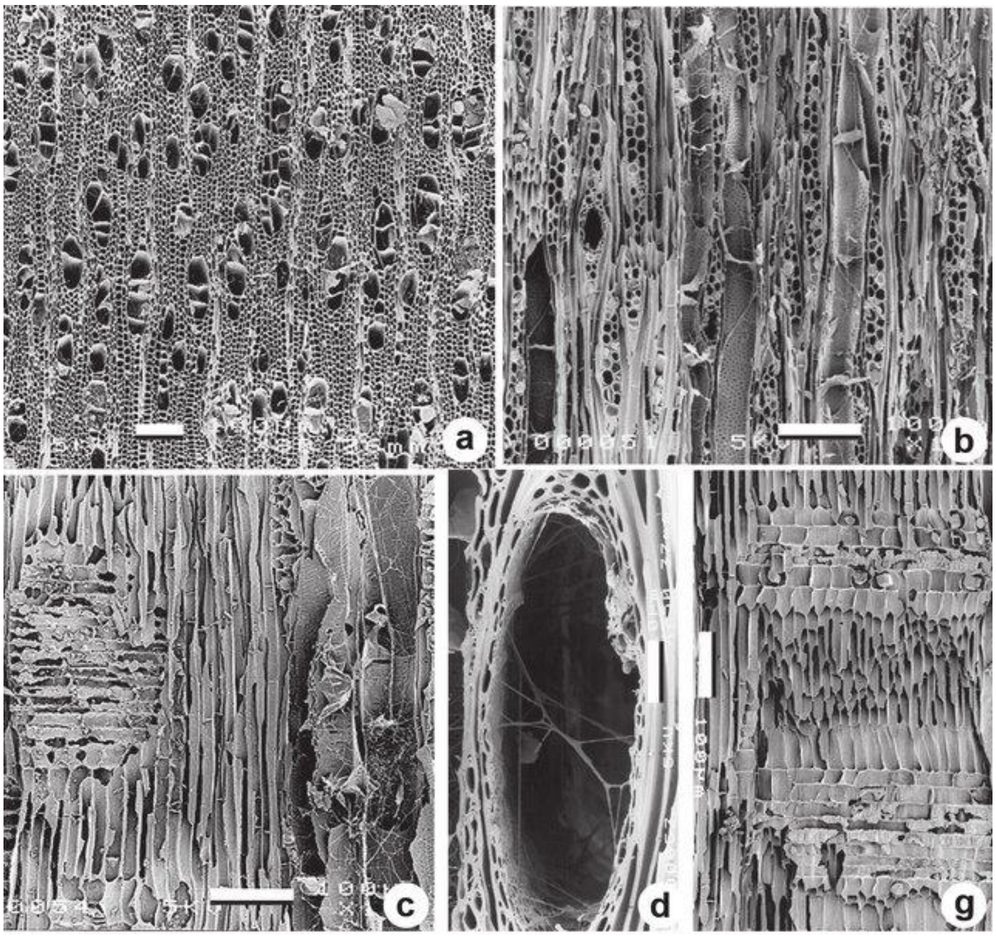
ANACARDIACEAE *Schinus molle*, *S. terebinthifolius* (pepper tree)

- Vessels <50-100µm, 40-100+/mm^2
- Tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty, absent or rare



ANACARDIACEAE *Schinus terebinthifolius,* *S. molle* (pepper tree)

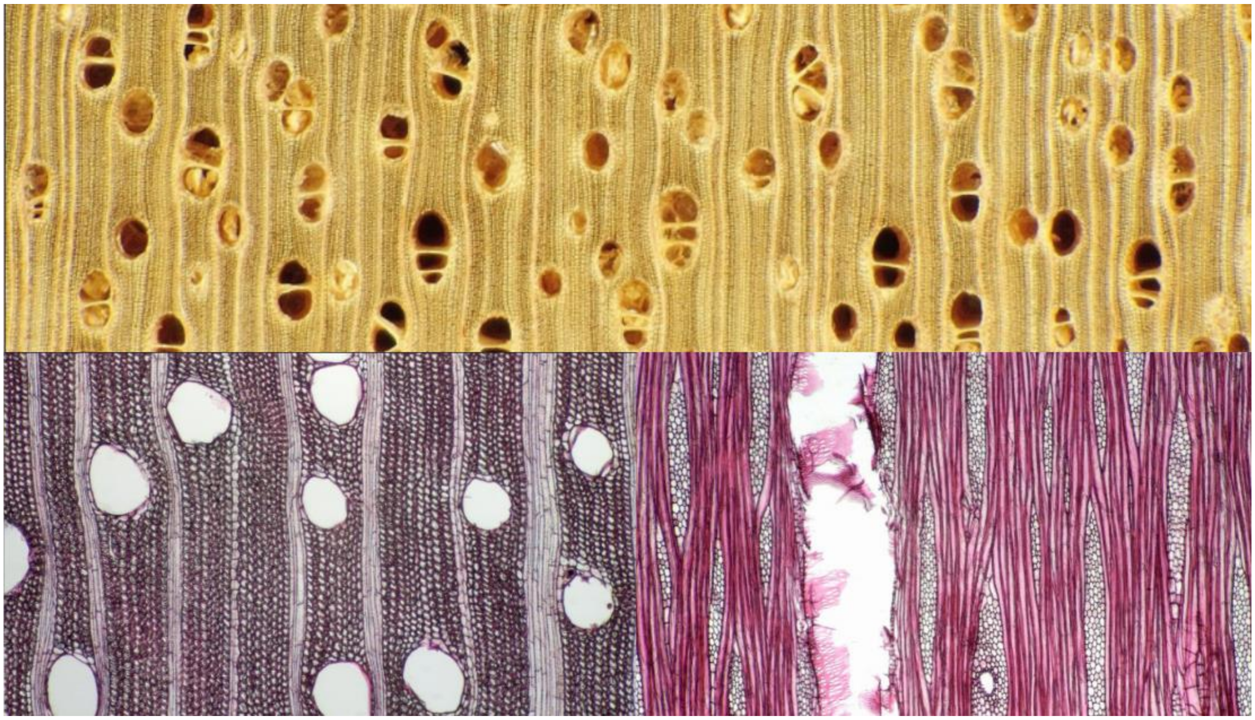
- Vessels <50-100µm, 40-100+/mm^2
- Tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty, absent or rare



Goncalves, T. and R. Scheel-Ybert. 2016. Charcoal Anatomy of Brazilian species. I. Anacardiaceae. Anais da Academia Brasileira de Ciências 88(3 Suppl.): 1711-1725.

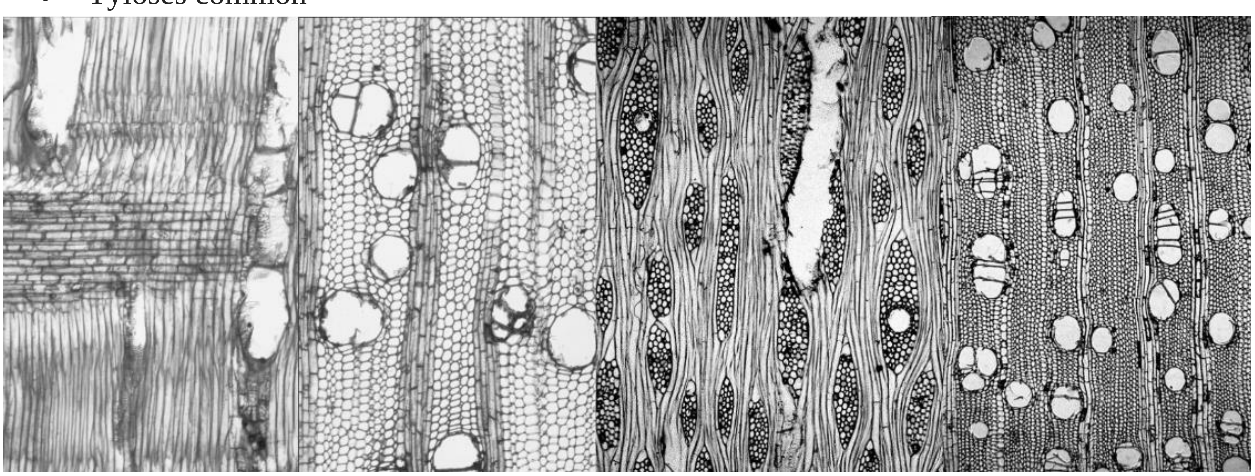
ANACARDIACEAE *Spondias mombin* *S. radlkoferi, purpurea* (jobo, mope, hogplum)

- Vessels 50-200+µm, of two distinct diameters
- Vessels <5-20/mm^2
- Rays 4 to 10 seriate, <4/mm
- Parenchyma rare, scanty
- Tyloses common



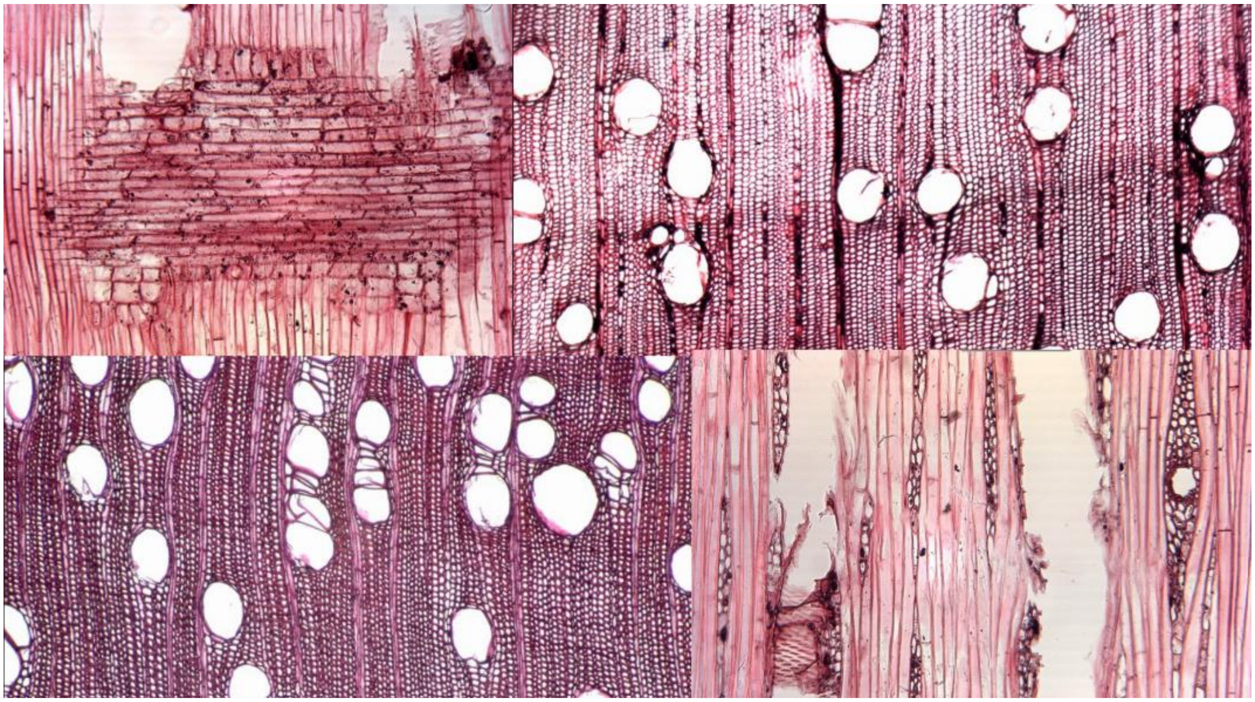
ANACARDIACEAE *Spondias* *purpurea S. radlkoferi, mombin* (jocote, jobo, hogplum)

- Vessels 100-200+µm, 5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, scanty
- Tyloses common



ANACARDIACEAE ***Tapirira guianensis*** *T. lepidota*, *mexicana* (caobilla)

- Vessels 100-200µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent, rare, scanty
- Tyloses common

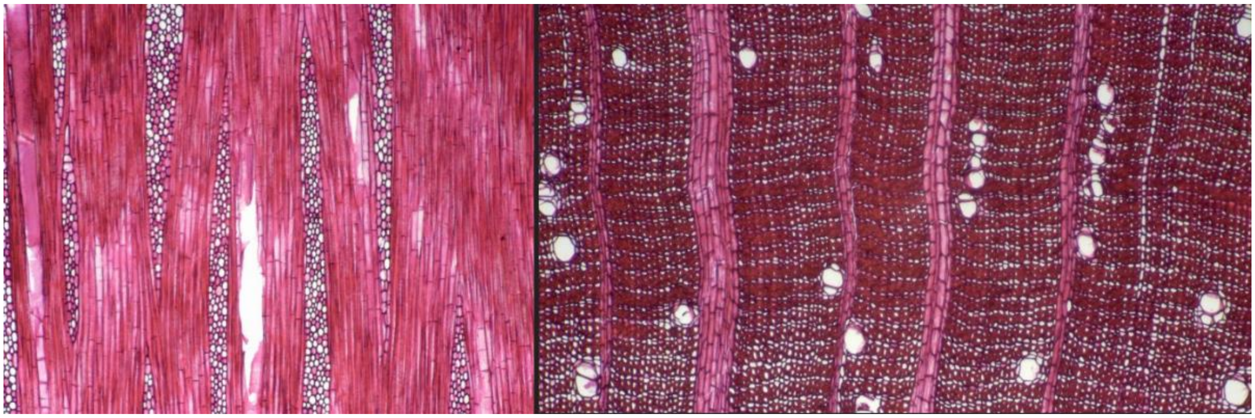


ANNONACEAE ***Anaxagorea dolichocarpa,*** *crassipetala*, *panamensis*, *phaeocarpa* (Acuanim, Envira, Socoro Jaugera)

- Vessels 50-100 µm, 5-20 /mm^2
- Parenchyma narrow bands, scalariform
- Rays <4/mm, 4 to 10 seriate

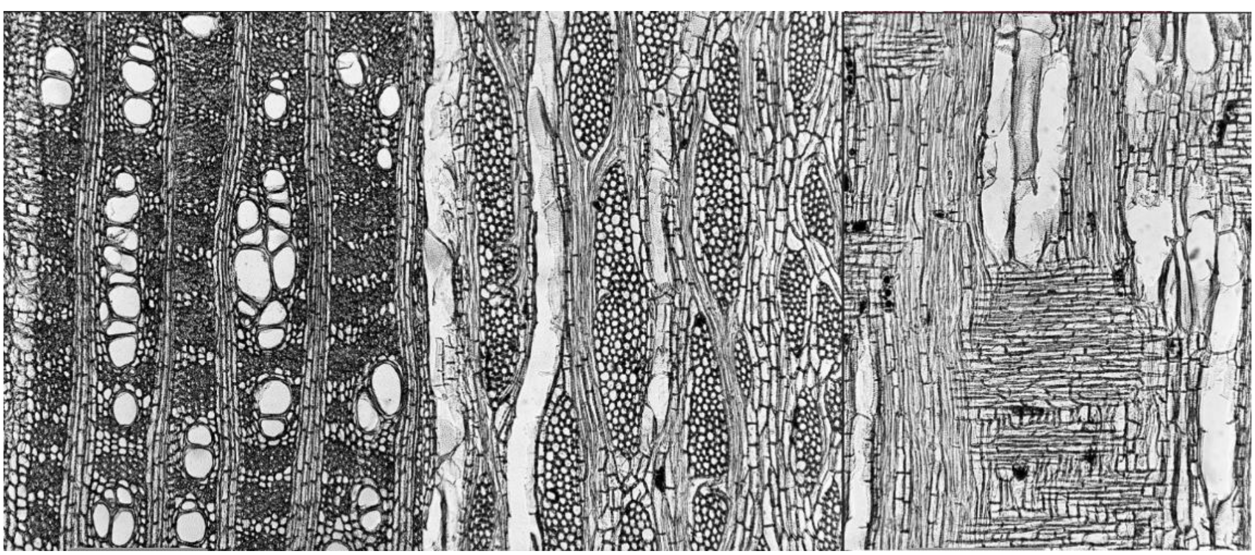
ANNONACEAE ***Anaxagorea phaeocarpa*** *crassipetala, dolichocarpa, panamensis* (Acuanim, Envira, Socoro Jaugera)

- Vessels 50-100 µm, 5-20 /mm^2
- Parenchyma narrow bands, scalariform
- Rays <4/mm, 4 to 10 seriate



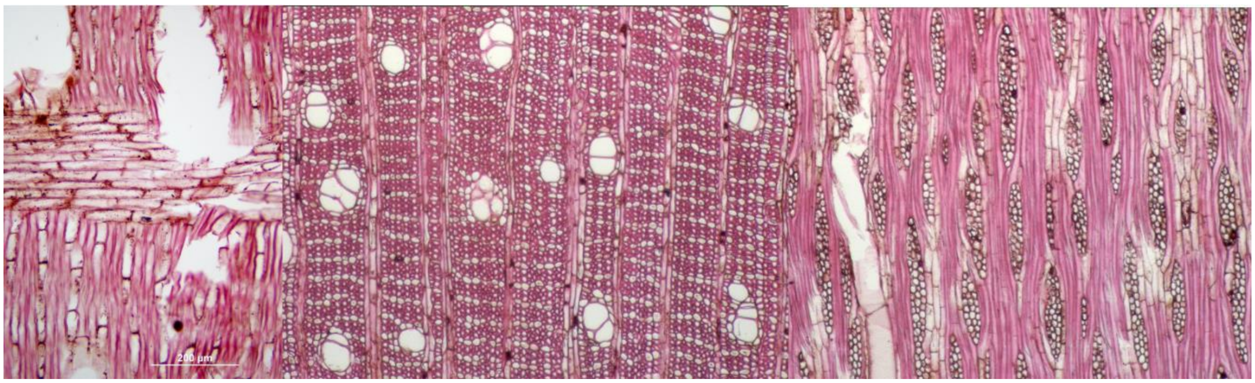
ANNONACEAE ***Annona cherimola****, amazonica, glabra, holosericea, montana, mucosa, muricata, papilionella, pittieri, pruinosa, purpurea, rensoniana, reticulata, squamosa, volubilis* (cherimoya, negrito, toreta, canelo, anon, guanabana, pond apple)

- Vessels 50-100µm, 5-20 /mm^2
- Parenchyma vasicentric, narrow bands
- Rays 4-12/mm, 4to 10 seriate



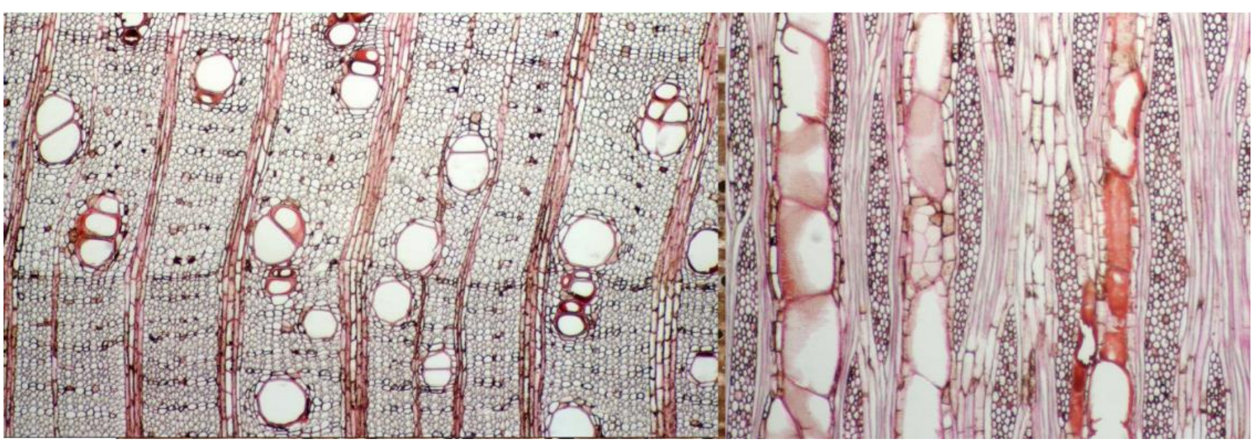
ANNONACEAE *Annona glabra* *, amazonica, cherimola, holosericea, montana, mucosa, muricata, papilionella, pittieri, pruinosa, purpurea, rensoniana, reticulata, squamosa, volubilis* (anon de pantano, guanabana de pantano)

- Vessels 100-200µm, 5-20 /mm^2
- Gums in heartwood vessels
- Parenchyma scanty, narrow bands
- Rays 4-12/mm, 4to 10 seriate



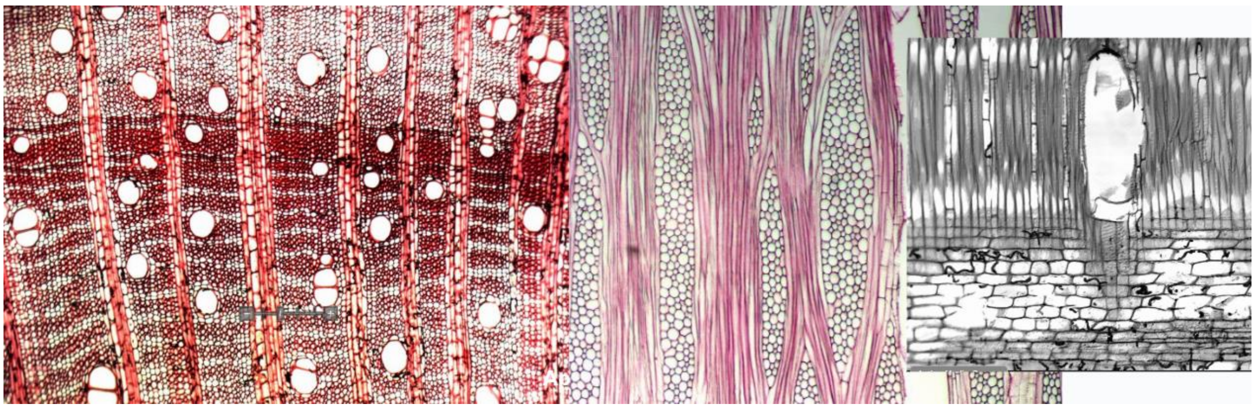
ANNONACEAE *Annona montana* *amazonica, cherimola, glabra, holosericea, mucosa, muricata, papilionella, pittieri, pruinosa, purpurea, rensoniana, reticulata, squamosa, volubilis* (cherimoya, negrito, toreta, canelo, anon, guanabana, pond apple)

- Vessels 50-200 µm, 5-20 /mm^2
- Gums in heartwood vessels
- Parenchyma vasicentric, narrow bands, scalariform
- Rays <4-12/mm, 4to 10 seriate



ANNONACEAE *Annona muricata* *amazonica, cherimola, glabra, holosericea, montana, mucosa, papilionella, pittieri, pruinosa, purpurea, rensoniana, reticulata, squamosa, volubilis* (cherimoya, negrito, toreta, canelo, anon, guanabana, pond apple)

- Vessels 100-200 µm, 5-20 /mm^2
- Gums in heartwood vessels
- Parenchyma vasicentric, narrow bands
- Rays <4-12/mm, 4to 10 seriate

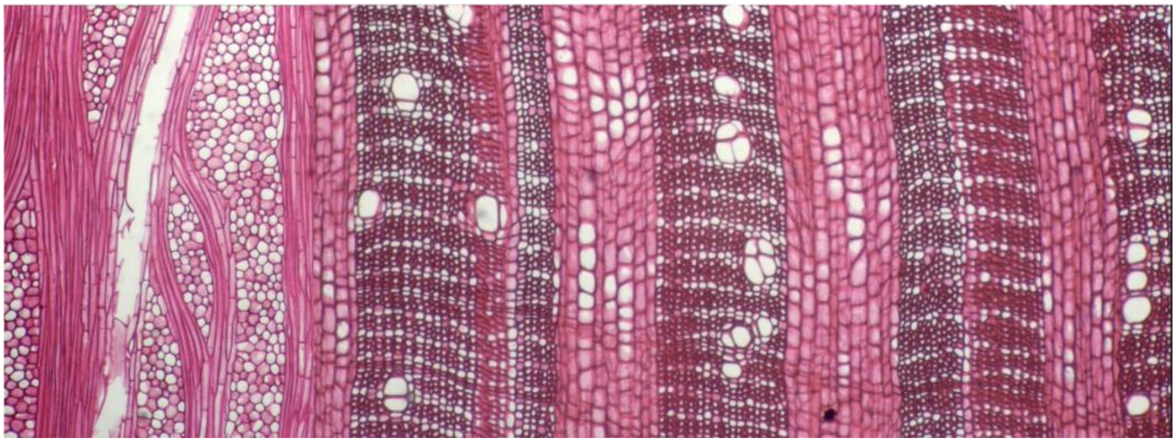


ANNONACEAE *Desmopsis bibracteata,* *confusa, heteropetala, maxonii, microcarpa, panamensis, schippii, verrucipes* (yayito)

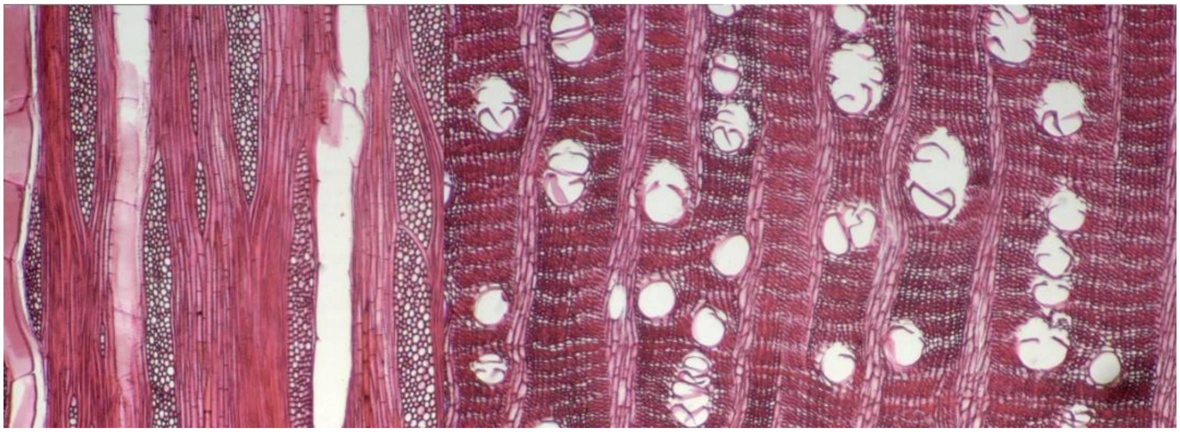
- Vessels 50-200 µm, 5-40 /mm^2
- Parenchyma, narrow bands, scalariform
- Rays <4-12/mm, 4to 10 seriate

ANNONACEAE *Desmopsis panamensis* (yayito)***, bibracteata, confusa, heteropetala, maxonii, microcarpa, schippii, verrucipes***

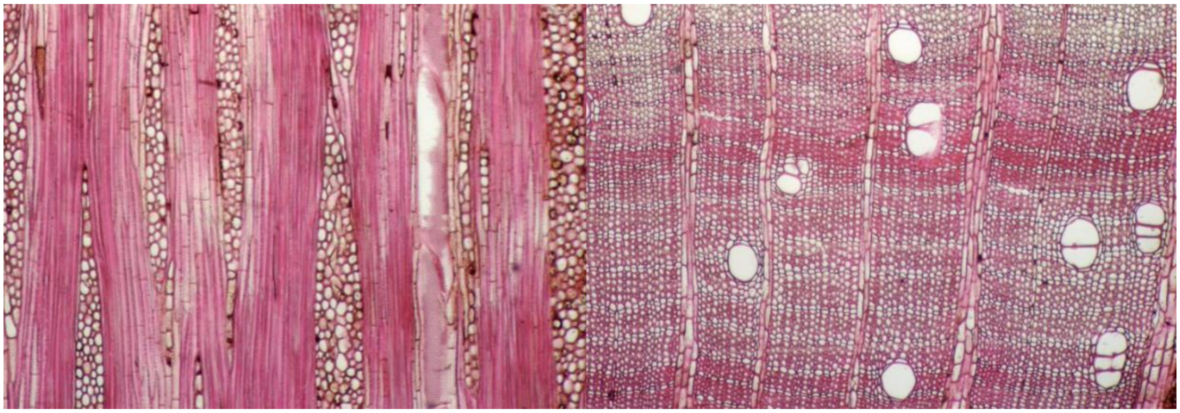
- Vessels 50-200 µm, 5-40 /mm^2
- Parenchyma, narrow bands, scalariform
- Rays <4-12/mm, 4to 10 seriate



ANNONACEAE *Duguetia stenantha,* *confusa, panamensis* (no known common name)

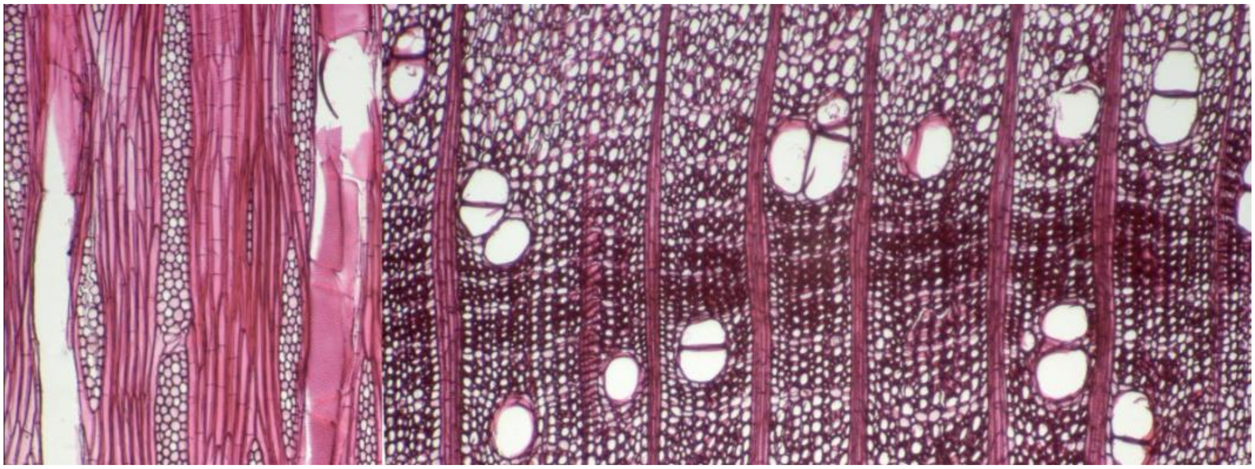


ANNONACEAE *Guatteria punctata,* (yayito, sigua negro) *amplifolia, aeruginosa, chiriquiensis, costaricensis, diospyroides, dolichopoda, lucens, oliviformis, pudica*



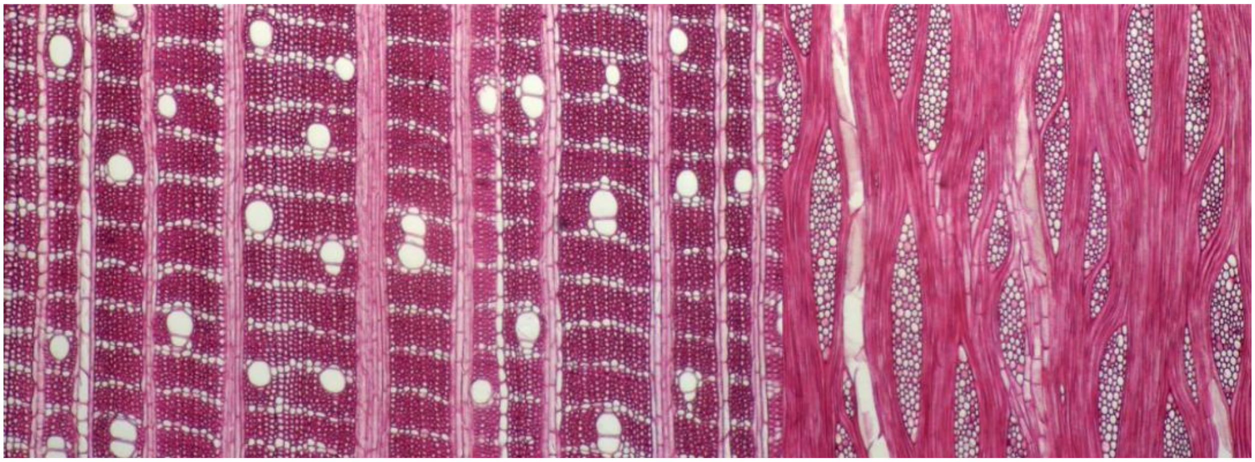
ANNONACEAE *Rollinia mucosa,* (annonillo, chirimoya) *danforthii, membranacea, pittieri*

- Vessels 100-200+µm, <=5 /mm^2
- Rays 4 to 10, <=4/mm
- Parenchyma in narrow bands scalariform, reticulate, vasicentric



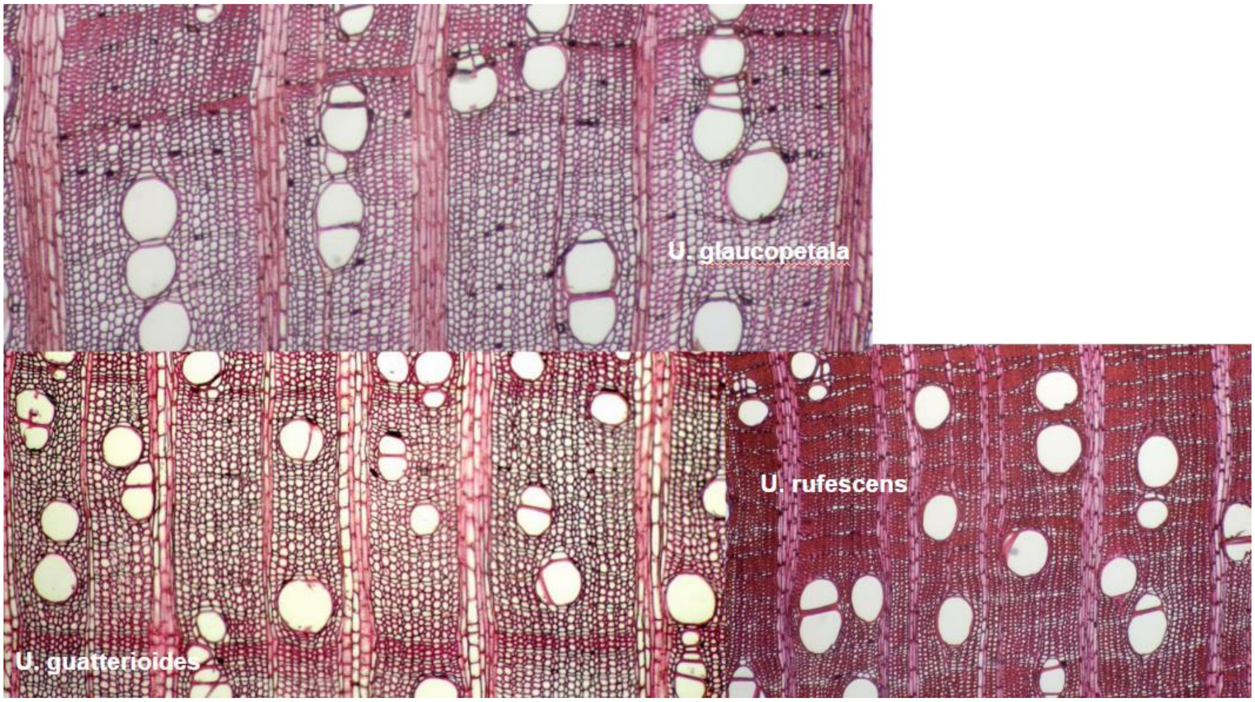
ANNONACEAE *Sapranthus palanga,* *microcarpus, viridiflorus* (El Palanco)

- Vessels 50-100 µm, 20-100 /mm^2, Gums in heartwood vessels
- Rays 4 to 10, 4-12/mm
- Parenchyma in narrow bands scalariform
- Simple alternate perforation plates



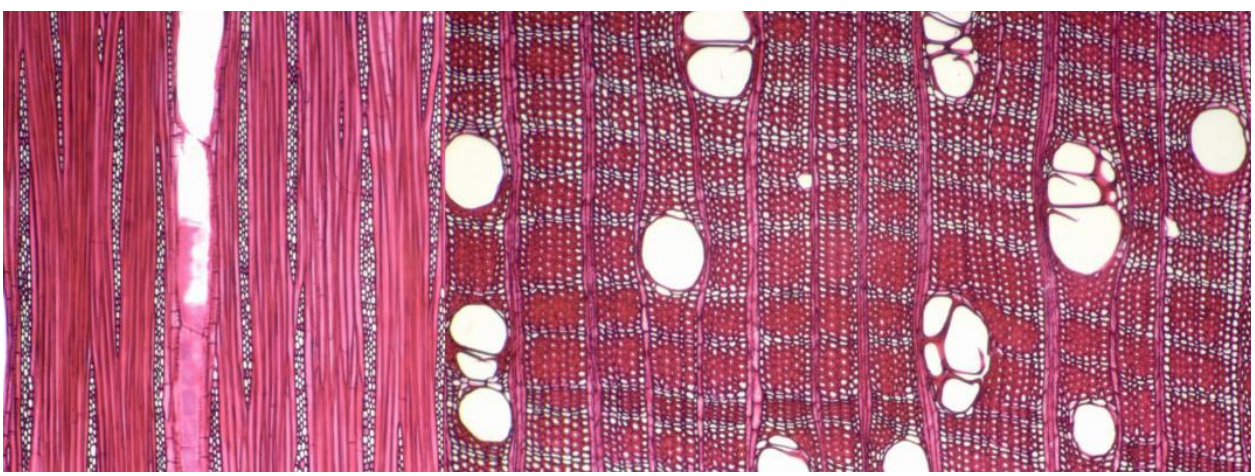
ANNONACEAE Unonopsis costaricensis, hammelii, osae, panamensis, pittieri, storkii, theobromifolia (yaya)

- Vessels 100-200µm, <5-20 /mm^2
- Rays 4 to 10, <=4/mm
- Parenchyma in narrow bands scalariform



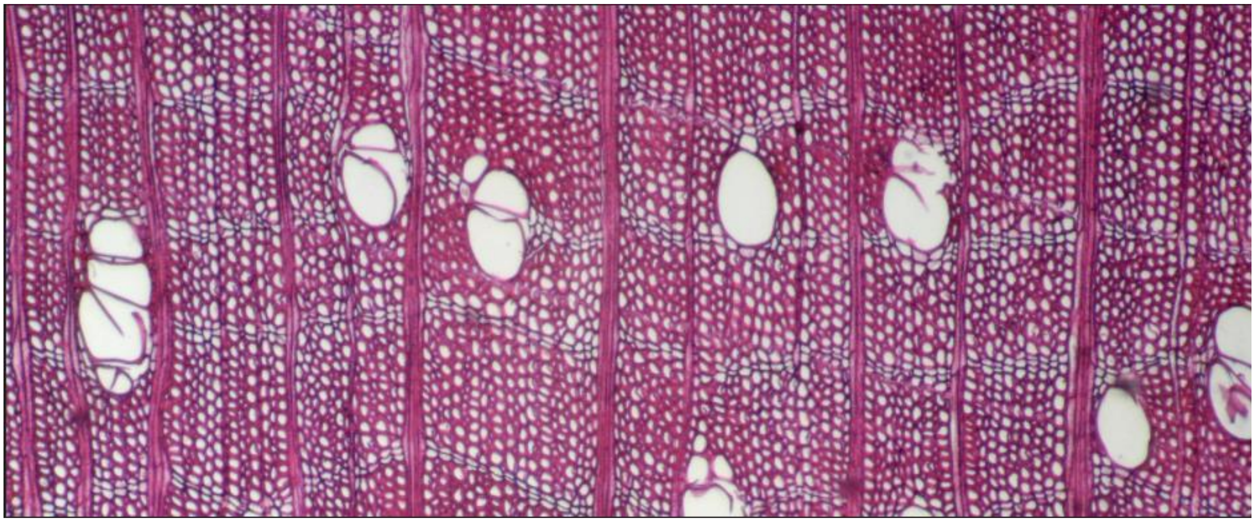
ANNONACEAE Xylopia aromatica, bocatorena, frutescens, macrantha, sericea, sericophylla, surinamensis (malagueto)

- Vessels 100-200µm, <5-20 /mm^2, gums in heartwood vessels
- Rays 4 to 10, <=4-12/mm
- Parenchyma in narrow bands scalariform, reticulate, scanty, vasicentric

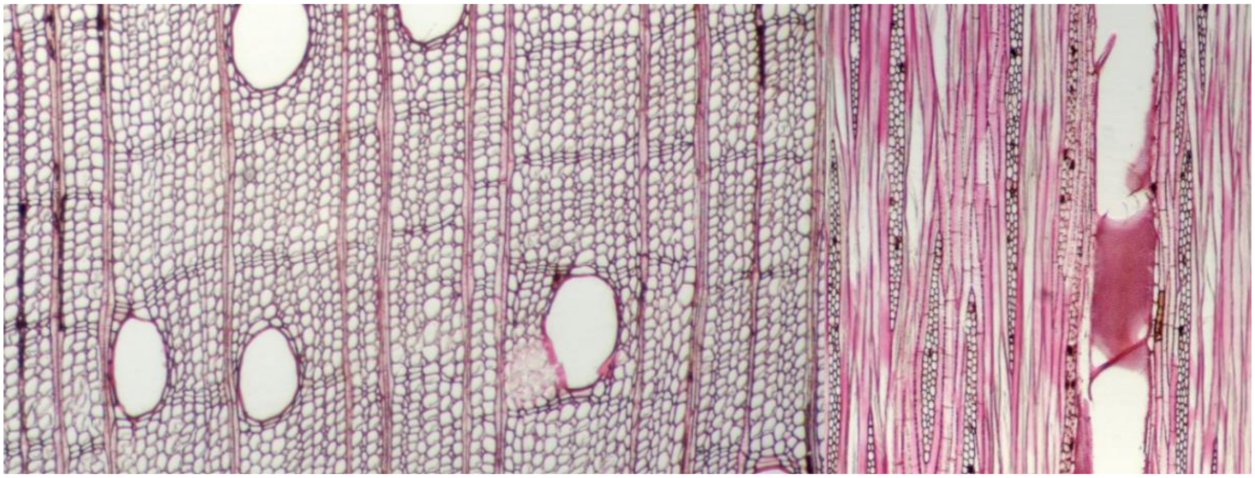


ANNONACEAE Xylopia frutescens, aromatica, bocatorena, macrantha, sericea, sericophylla, surinamensis (malagueto)

- Vessels 50-200µm, 5-40 /mm^2
- Rays 1 to 3 cells, 4 to 10, 4-12/mm
- Parenchyma in narrow bands scalariform, reticulate, scanty vasicentric

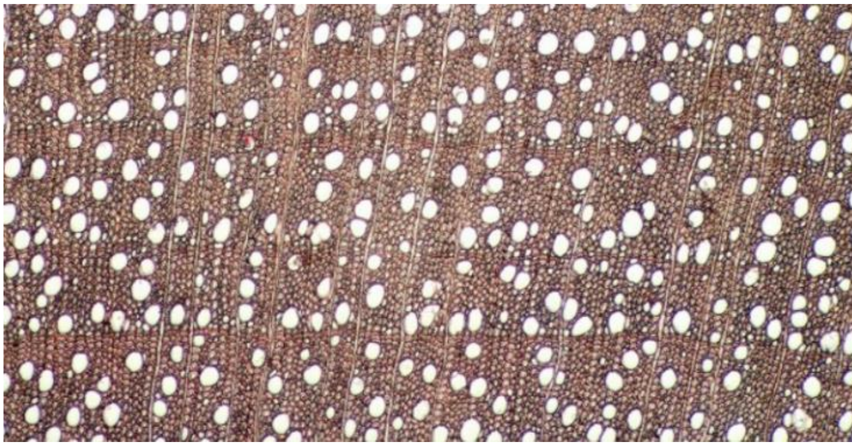
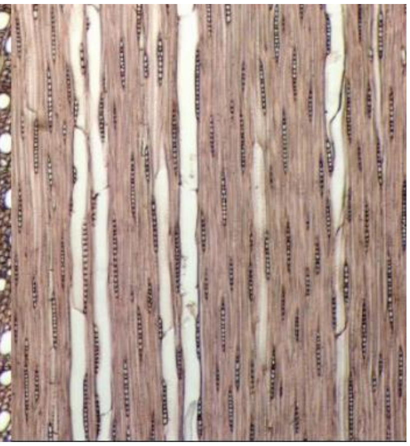


ANNONACEAE Xylopia surinamensis, aromatica, bocatorena, frutescens, macrantha, sericea, sericophylla (malagueto)



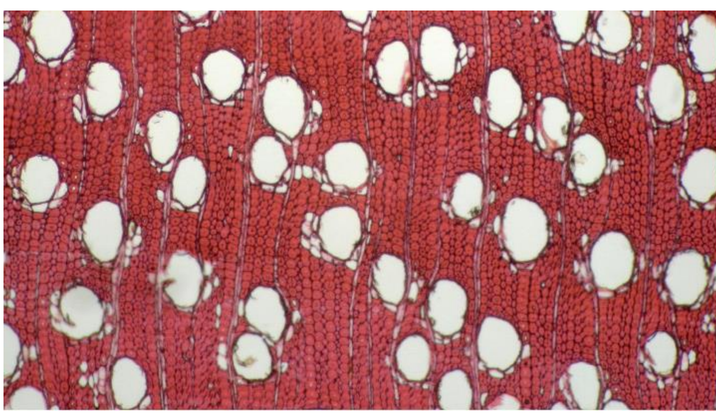
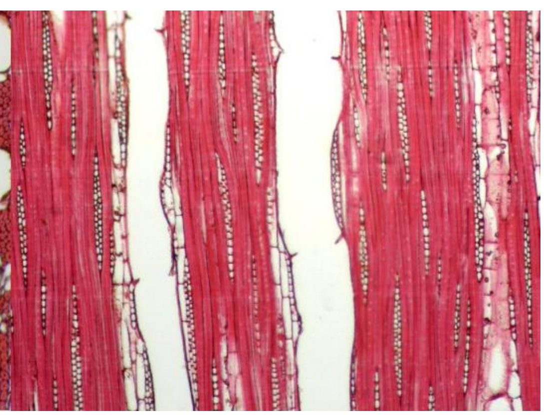
APOCYNACEAE *Aspidosperma australe* *A. album, spruceanum, australe, crypticum, excelsum, megalocarpon* (aracanga)

- Vessels exclusively solitary, <50-100µm, two diameter classes, 40-100 /mm^2
- Rays exclusively uniseriate,, 4-12/mm
- Parenchyma diffuse in aggregates, marginal bands

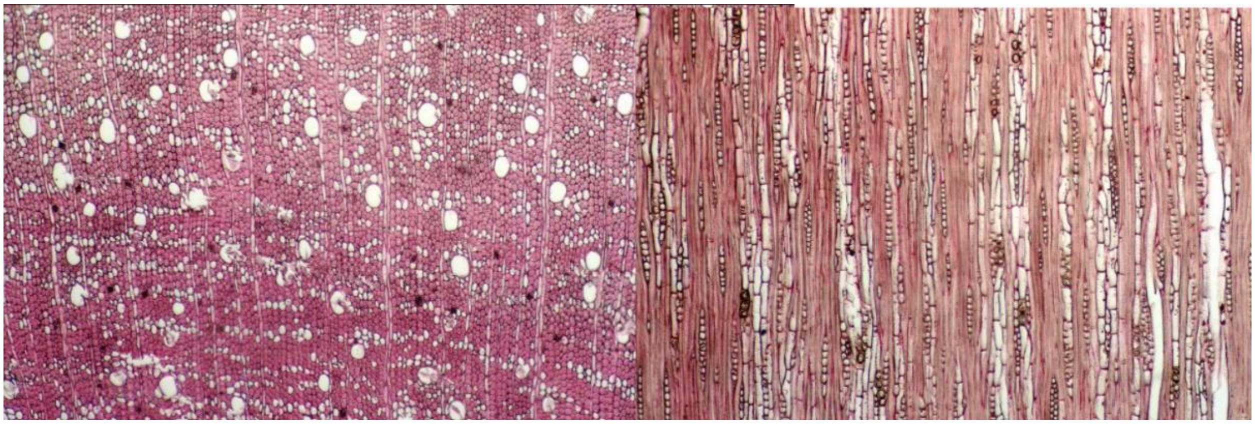
APOCYNACEAE *Aspidosperma album* *australe, spruceanum, australe, crypticum, excelsum, megalocarpon* (aracanga)

- Vessels exclusively solitary, 100-200µm, two diameter classes, 5-20 /mm^2, gums in heartwood
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, absent, scanty, unilateral

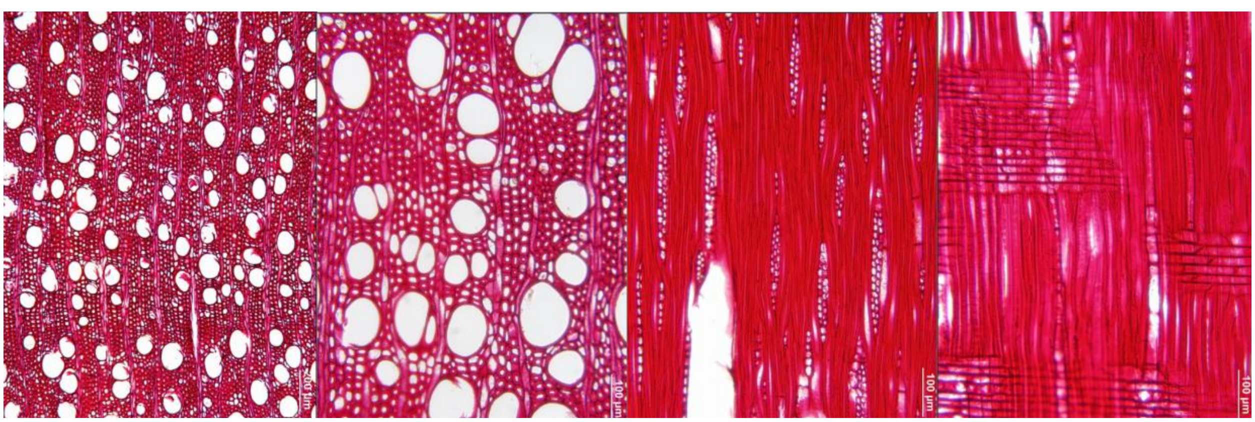
APOCYNACEAE *Aspidosperma excelsum* *A. spruceanum, australe, crypticum, desmanthum, excelsum, megalocarpon* (aracanga)

- Vessels exclusively solitary, 50-100µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates, scanty



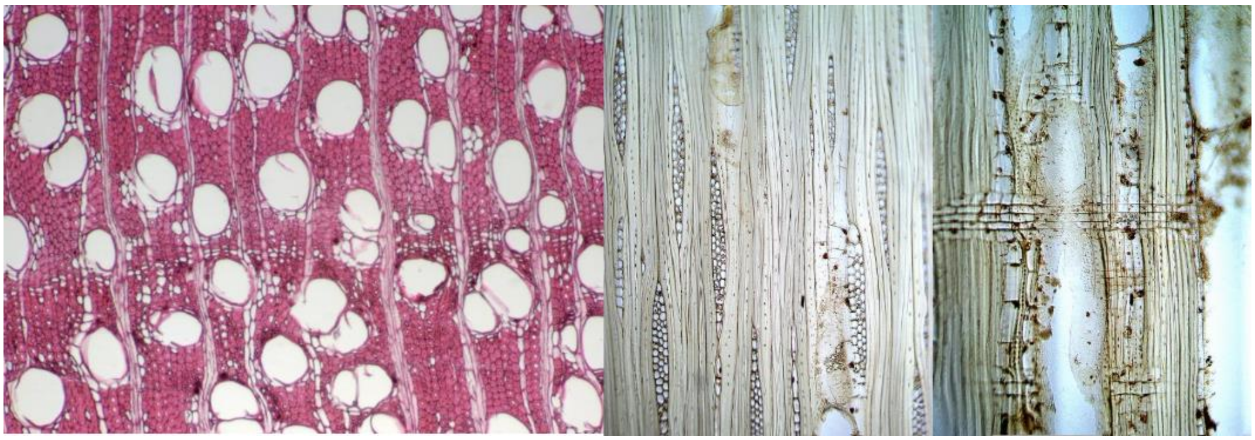
APOCYNACEAE *Aspidosperma megalocarpon* *A. spruceanum, australe, crypticum, desmanthum, excelsum, megalocarpon* (aracanga)

- Vessels exclusively solitary, 100-200µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, scanty



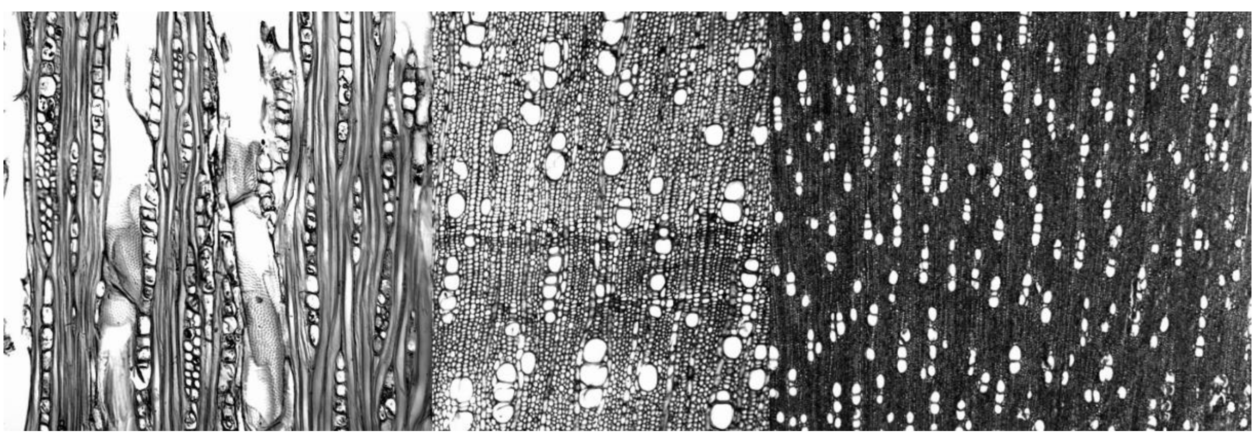
APOCYNACEAE *Aspidosperma spruceanum* *A. spruceanum, australe, crypticum, desmanthum, excelsum, megalocarpon* (alcarreto,volador)

- Vessels exclusively solitary, 100-200µm, 20-40 /mm^2
- Rays1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates, scanty



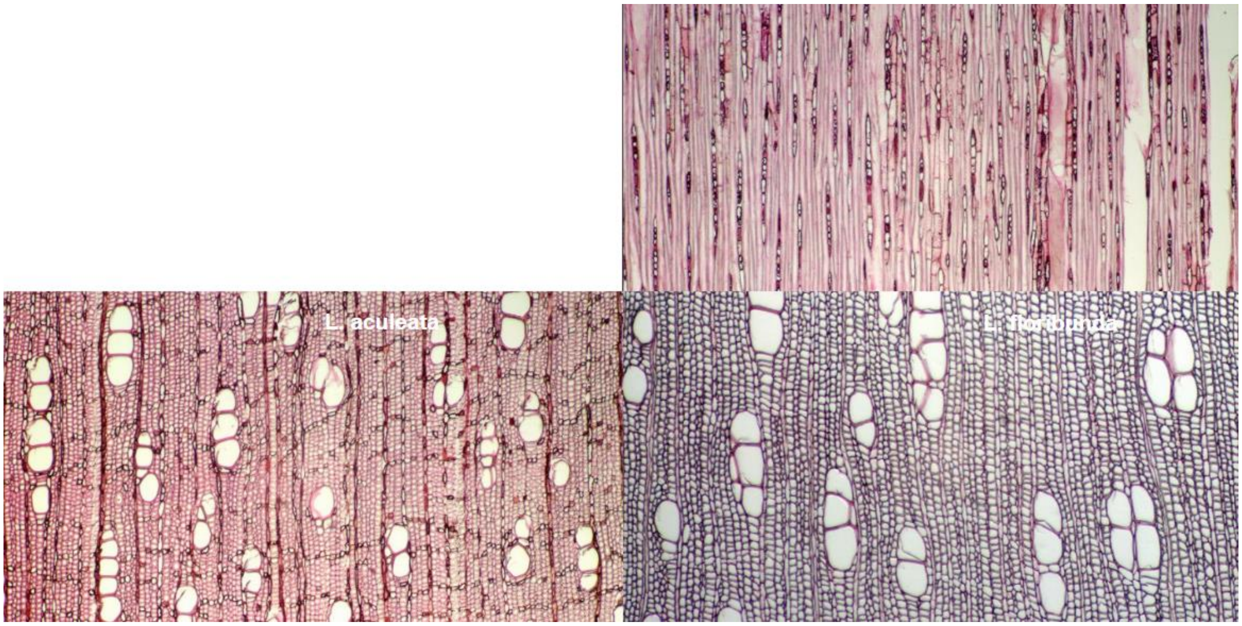
APOCYNACEAE *Thevetia peruviana,* *ahoui, ovata* (yellow oleander) *Synonym: Cascabela thevetia*

- Vessels 20-40 /mm^2, 50-100µm, in radial multiples
- Rays 4-12/mm, 1 to 3 cells
- Parenchyma diffuse in aggregates, scanty



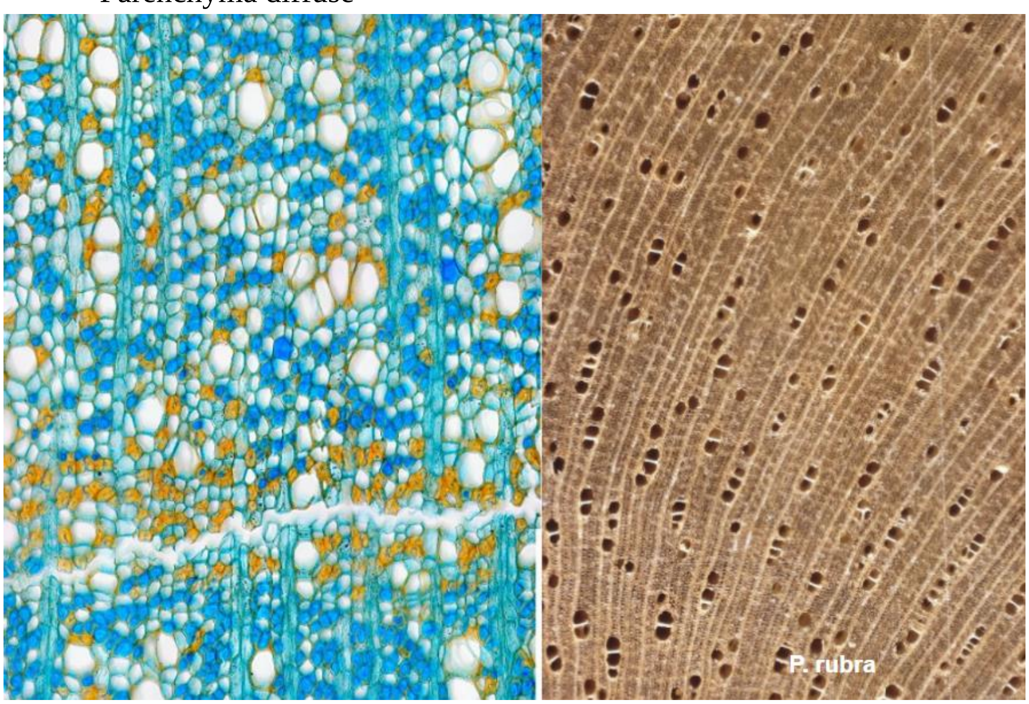
APOCYNACEAE ***Lacmellea*** *panamensis*, *speciosa*, *zamorae* (leche de vaca, lagarto negro)

- Vessels in radial multiples, 50-100µm, 20-40 /mm^2
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma diffuse in aggregates, narrow bands

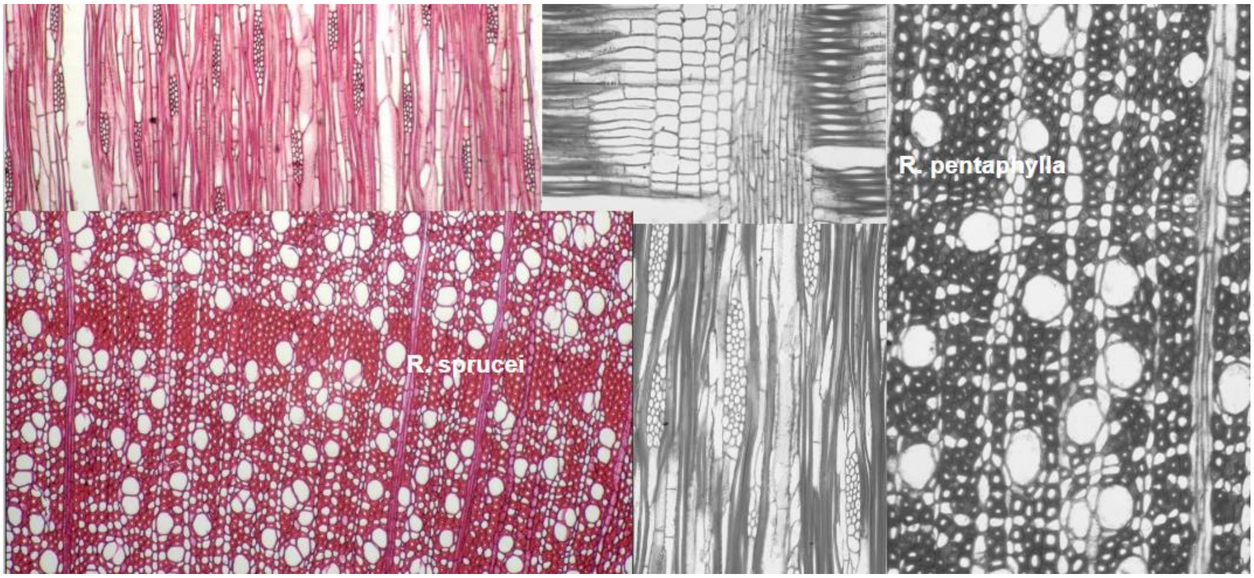


APOCYNACEAE ***Plumeria rubra*** (frangipani/ mapuche, caracucha)

- Vessels 5-20 /mm^2, 50-100 µm
- Rays 4-12/mm, uniseriate
- Parenchyma diffuse

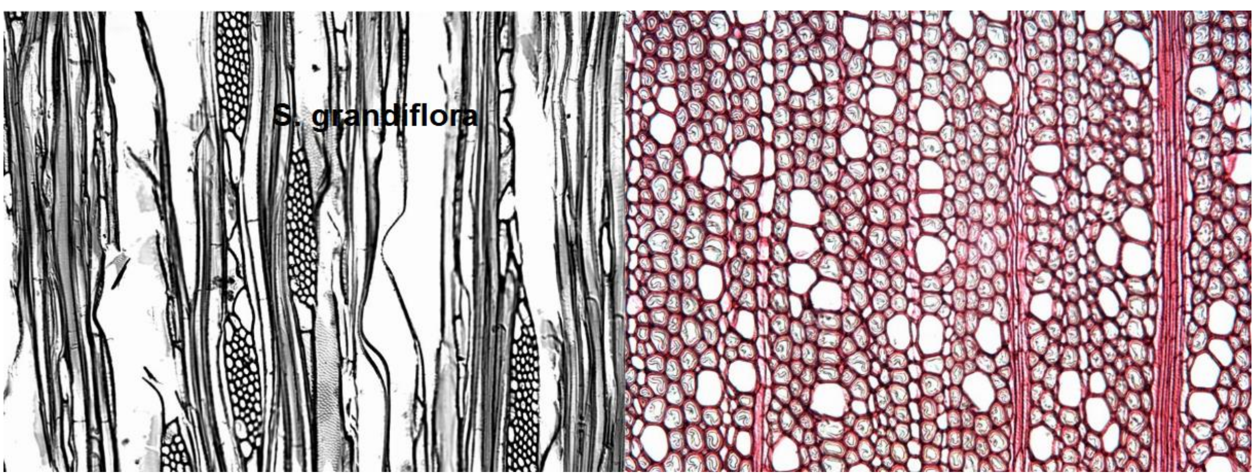


APOCYNACEAE *Rauvolfia* *aphlebia, ligustrina, littoralis, purpurascens, tetraphylla, woodsoniana* (lechosa)



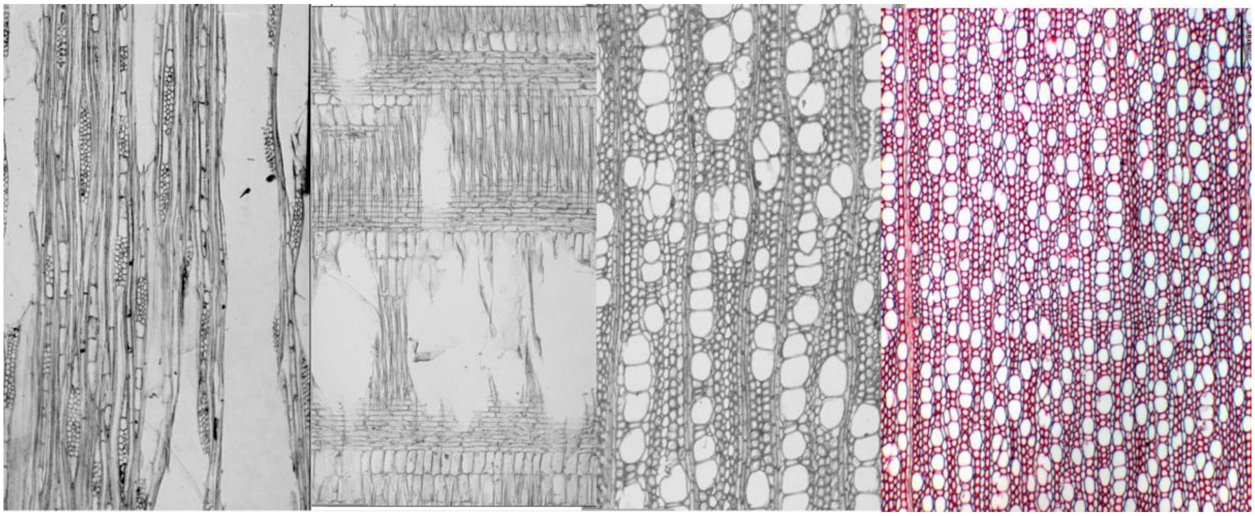
APOCYNACEAE *Stemmadenia* (huevos de gato) *alfaroi, alfari, donnell-smithii, hannae, obovata, pauli, pubescens, robinsonii*

- Vessels 20-40 /mm^2, 50-100µm
- Rays >12/mm, 4 to 10 seriate
- Parenchyma scanty

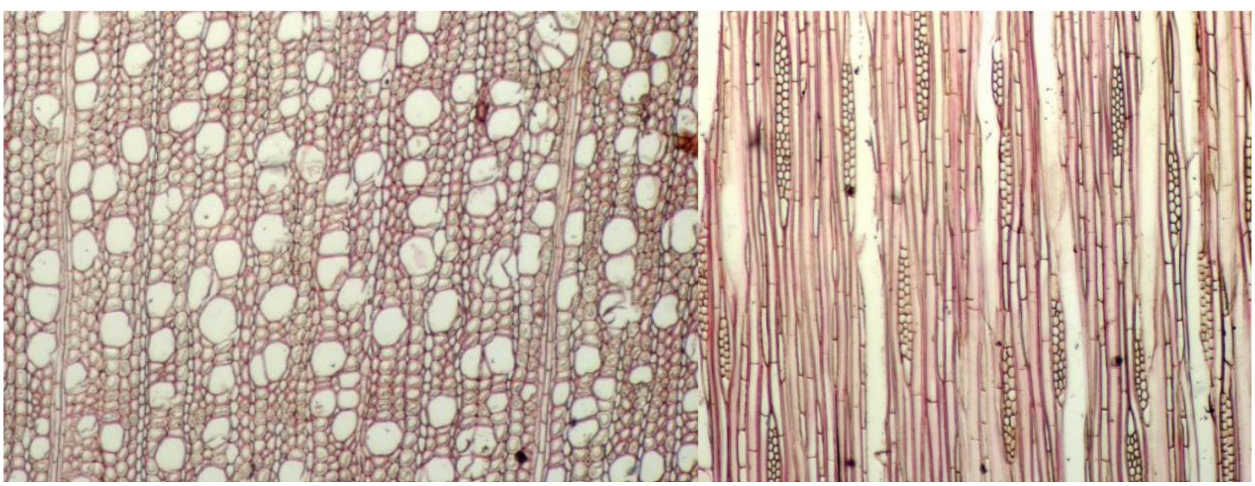


APOCYNACEAE ***Tabernaemontana*** *alba, alfaroi, amygdafolia, arborea, donnell-smithii, heterophylla, longpipes, panamensis, pauli, robinsonii, undulata* (milkwood, huevos de gato)

- Vessels 40-100 /mm^2, <50-100μm
- Vessel outline angular
- Rays 1 to 3 cells, >12/mm
- Parenchyma absent or rare

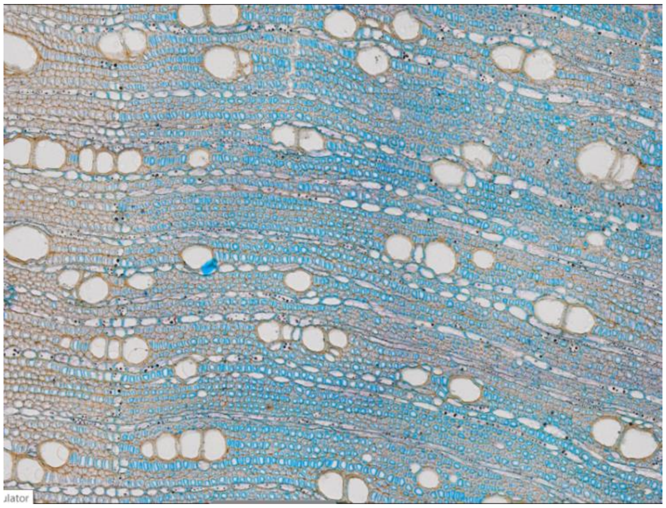


APOCYNACEAE ***Tabernaemontana undulata,*** *alba, alfaroi, amygdafolia, arborea, donnell-smithii, heterophylla, longpipes, pauli, robinsonii,* (milkwood)



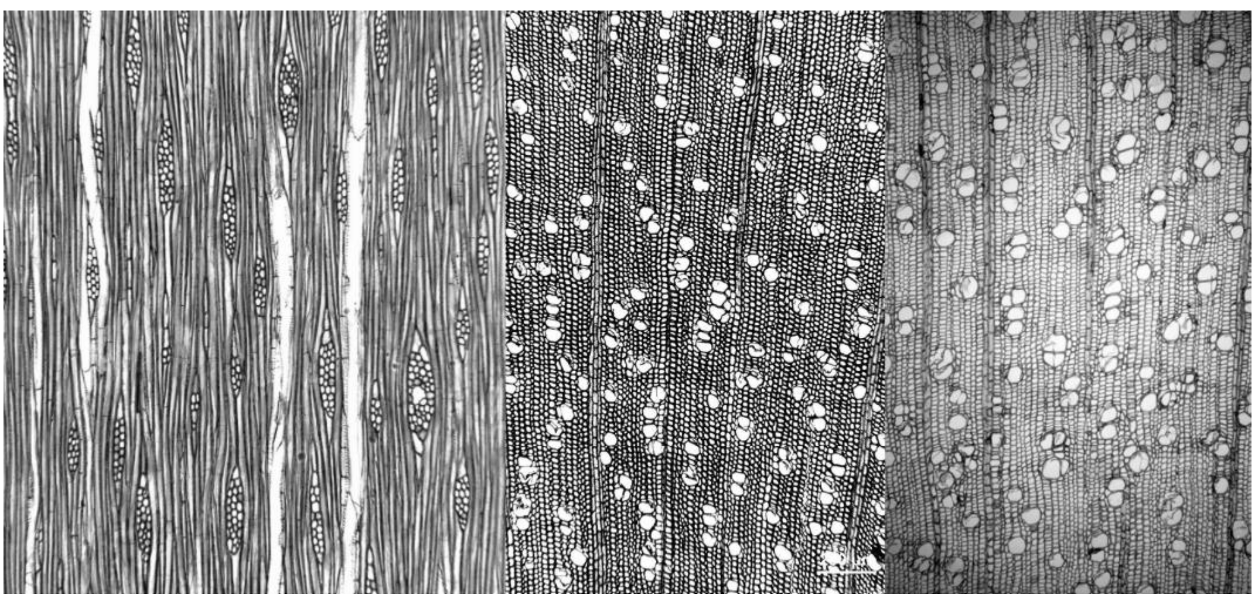
APOCYNACEAE *Thevetia ovata,* *ahouai, gaumeri, peruviana* (huevos de gato)

- Vessels 20-40 /mm^2, 50-100µm, in radial multiples
- Rays 4-12/mm, 1 to 3 cells
- Parenchyma diffuse in aggregates, scanty



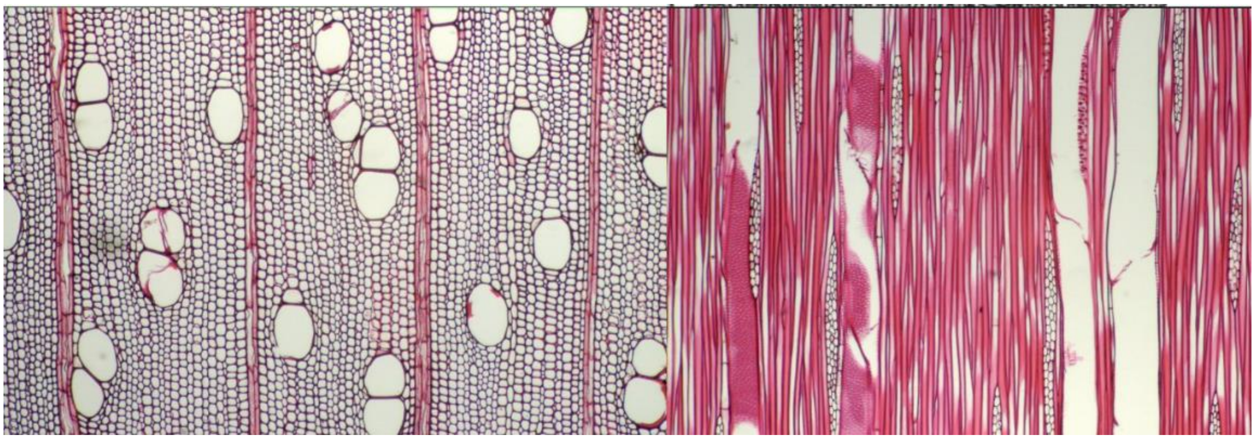
ARALIACEAE *Dendropanax arboreus* (vaquero), *capillaries, caucanus, colombianus, globosus, gonatopodus, praestans, querceti, sessiliflorus, stenodontus*

- Vessels 5-20 /mm^2, 50-200µm
- Rays <4/mm, 4 to 10 cells
- Parenchyma absent, rare, scanty



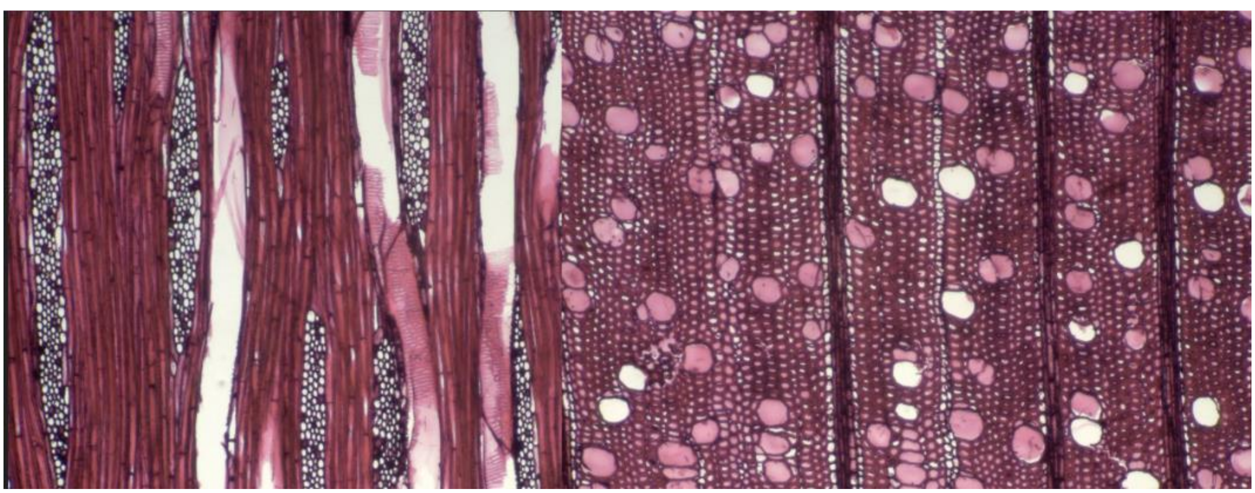
ARALIACEAE *Schefflera morototoni,* *brenesii, cartagoensis, robusta, rodriguesiana, seibertii, systyla (mangabé)*

- Vessels 5-20 /mm^2, 50-200µm, in radial multiples
- Rays <4/mm, 4 to 10 seriate
- Parenchyma diffuse in absent or rare



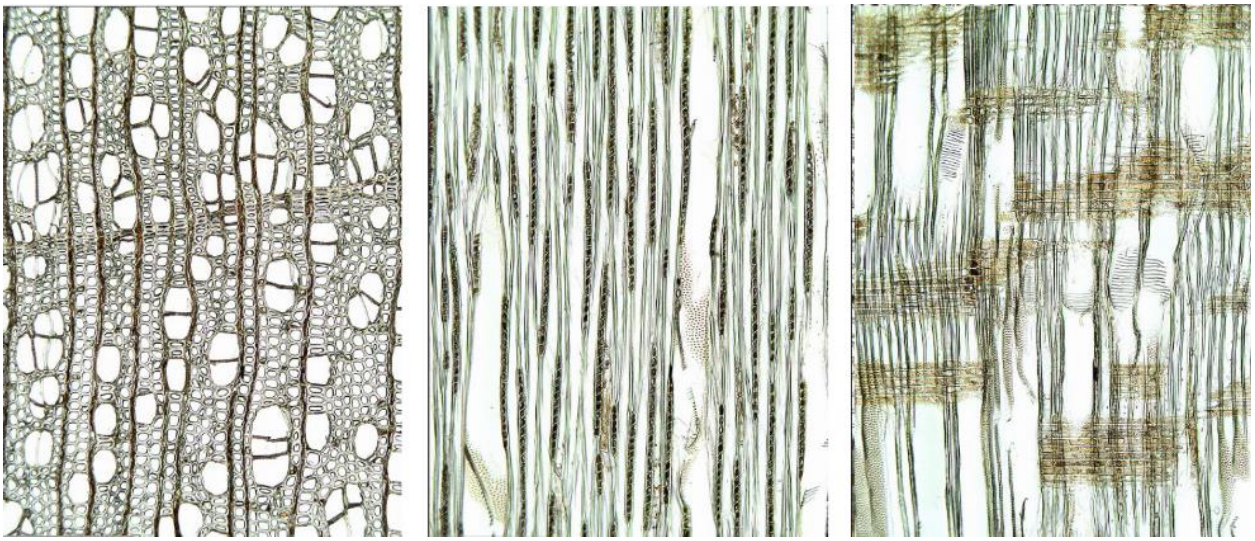
ARALIACEAE *Schefflera robusta,* *brenesii, cartagoensis, morototoni, rodriguesiana, seibertii, systyla (mangabé)*

- Vessels 5-20 /mm^2, 50-200µm, in radial multiples
- Rays <4/mm, 4 to 10 seriate
- Parenchyma diffuse in absent or rare



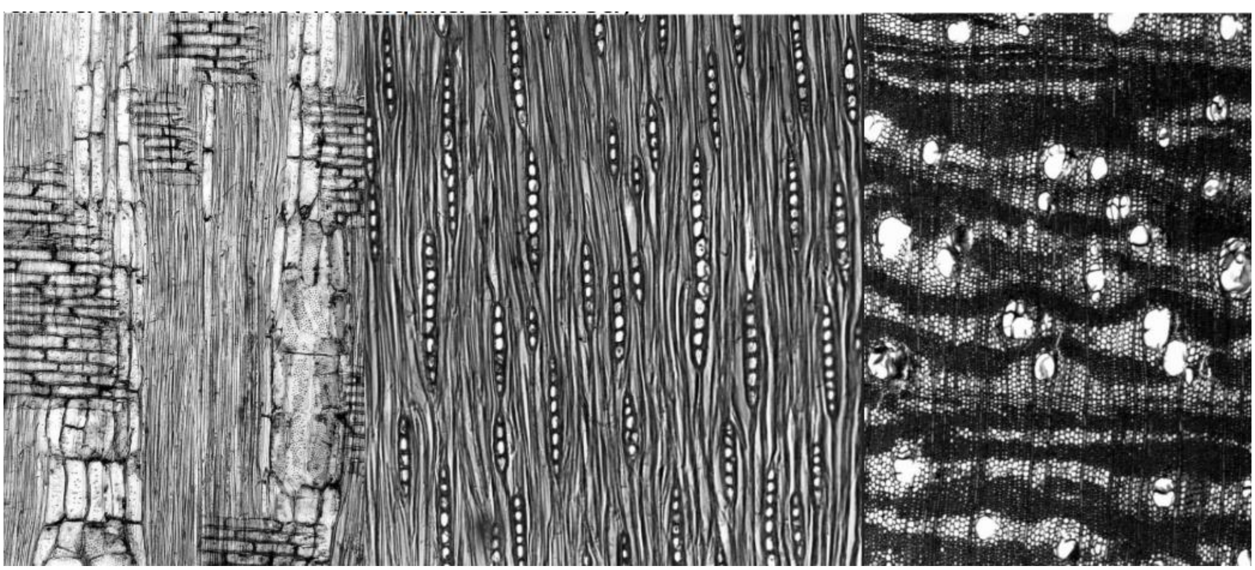
BETULACEAE *Alnus incana,* *acuminata aliso, jaúl, serrulata*

- Vessels 40-100 /mm^2, 50-100µm, in radial multiples
- Rays 4-12+/mm, exclusively uniseriate
- Parenchyma diffuse



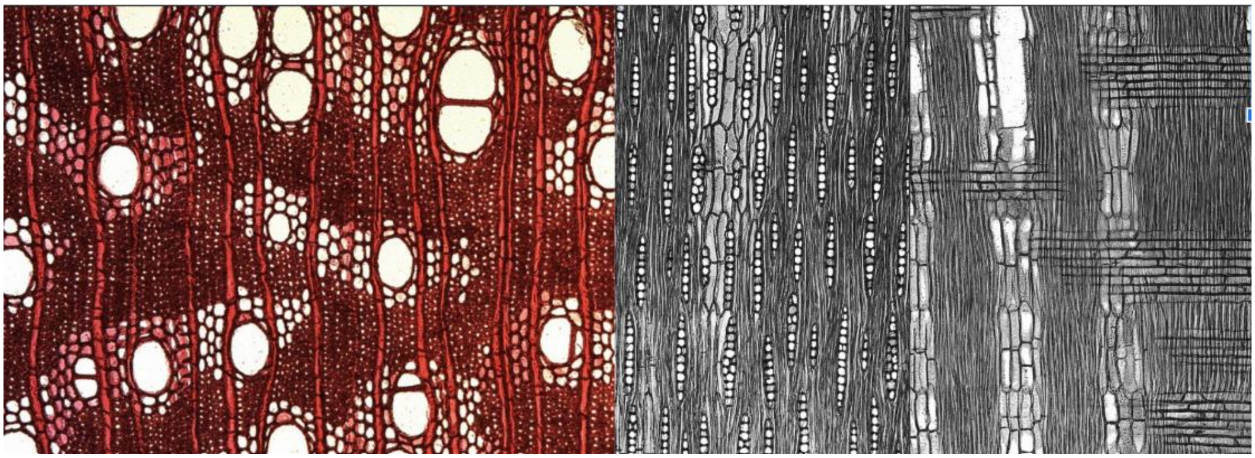
BIGNONIACEAE *Amphitecna latifolia,* *gentryi, isthmica, kennedyi, sessifolia*
(calabacito, totumillo, maraquita de marea)

- Vessels 50-100µm, 5-20/mm^2
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma aliform, vasicentric, confluent



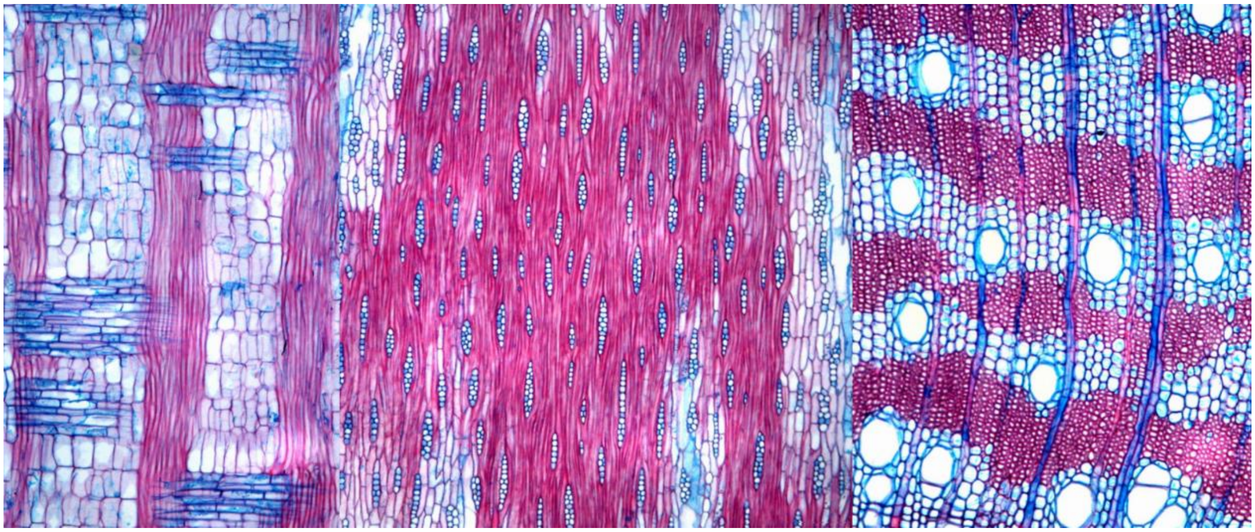
BIGNONIACEAE *Crescentia alata* (calabash, jicaro)

- Vessels 50-100µm, 20-40/mm^2
- Rays exclusively uniseriate, >12/mm, storied
- Parenchyma aliform, lozenge, confluent



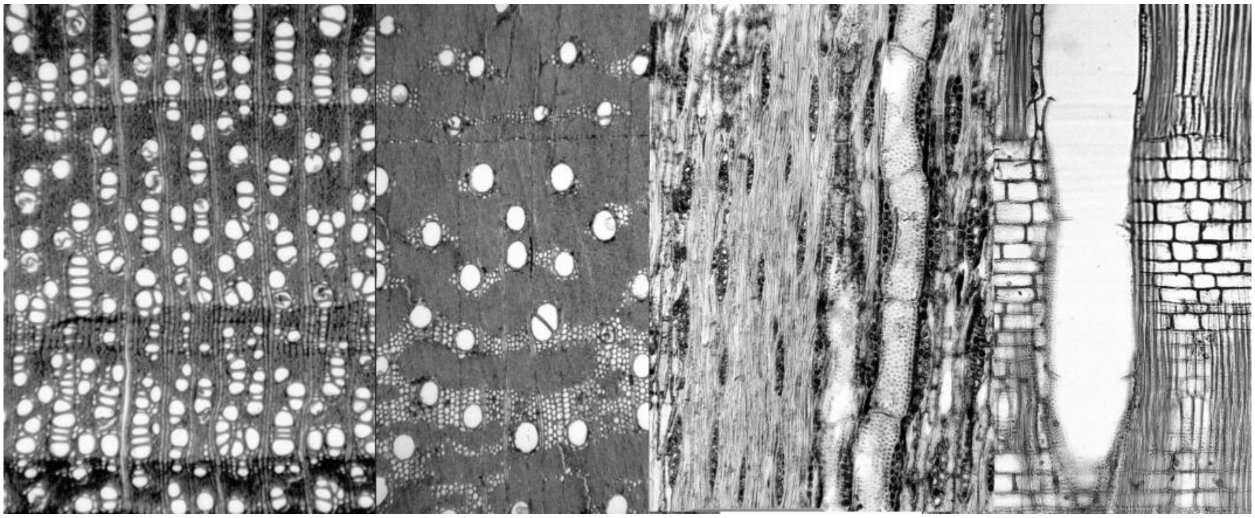
BIGNONIACEAE *Crescentia cujete* (calabazo, totumo)

- Vessels 50-100µm, 5-20/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma aliform, lozenge, winged, confluent, bands more than 3 cells wide



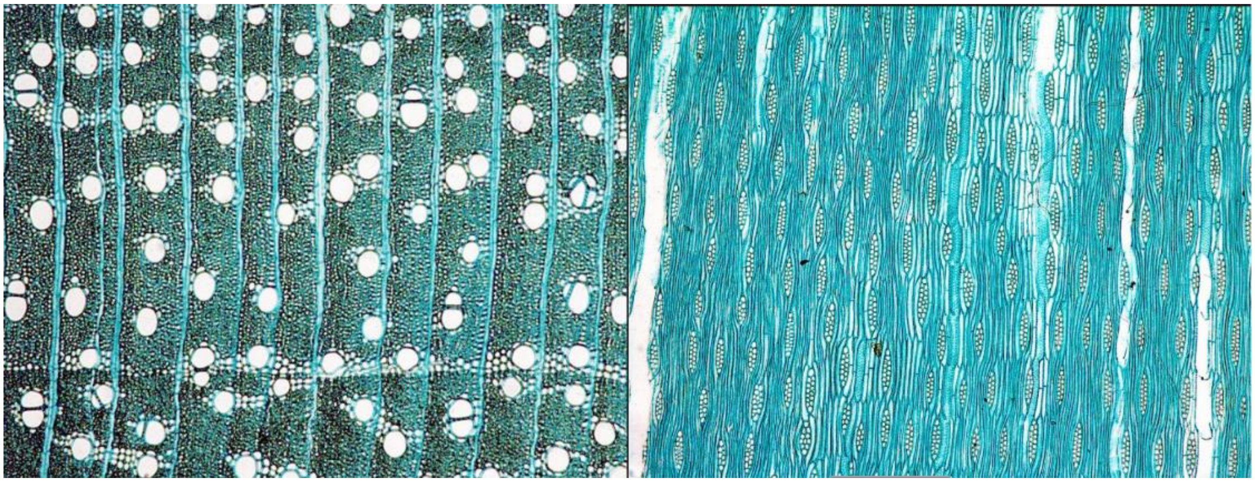
BIGNONIACEAE *Handroanthus chrysanthus* (poui, pau d'arco, or ipê)
Tabebuia impetiginosa, palustris, ochracea, rosea, spectabilis

- Vessels 50-100µm, 20-40/mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands

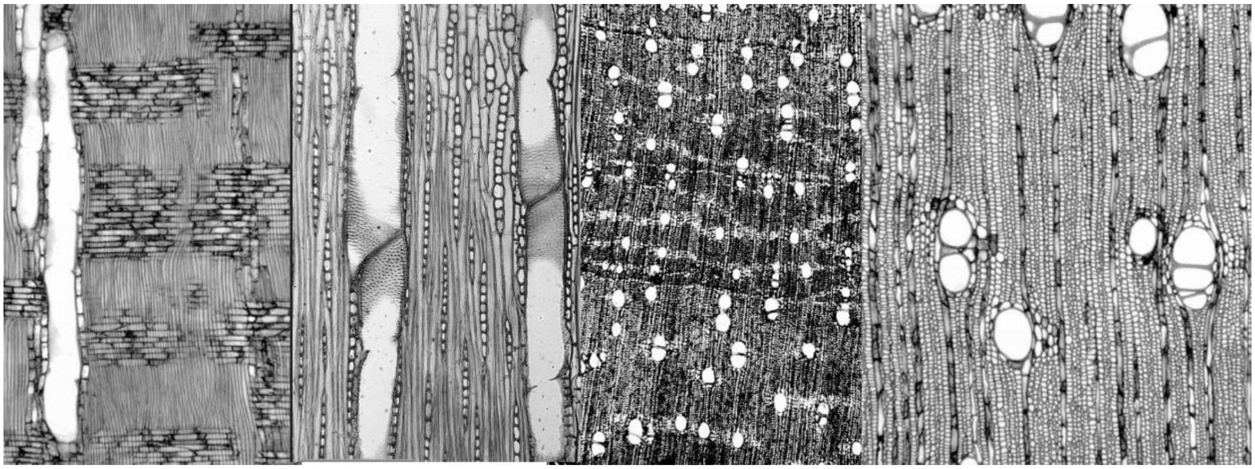


BIGNONIACEAE *Handroanthus impetiginosus,* (poui, pau d'arco, or ipê)
Tabebuia chrysanthus, palustris, ochracea, rosea

- Vessels 50-100µm, 20-40/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands

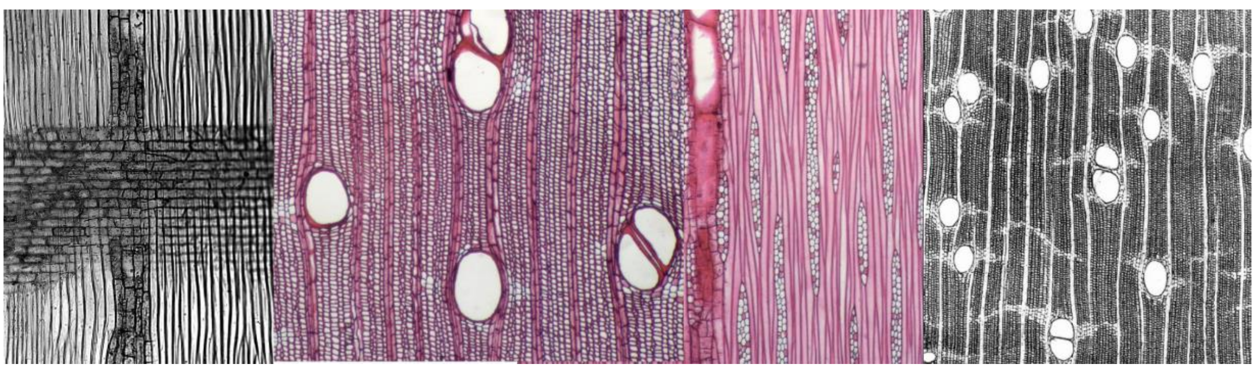


BIGNONIACEAE *Jacaranda caucana* *J. caucana, copaia, hondurensis, mimosifolia* (blue flamboyant)



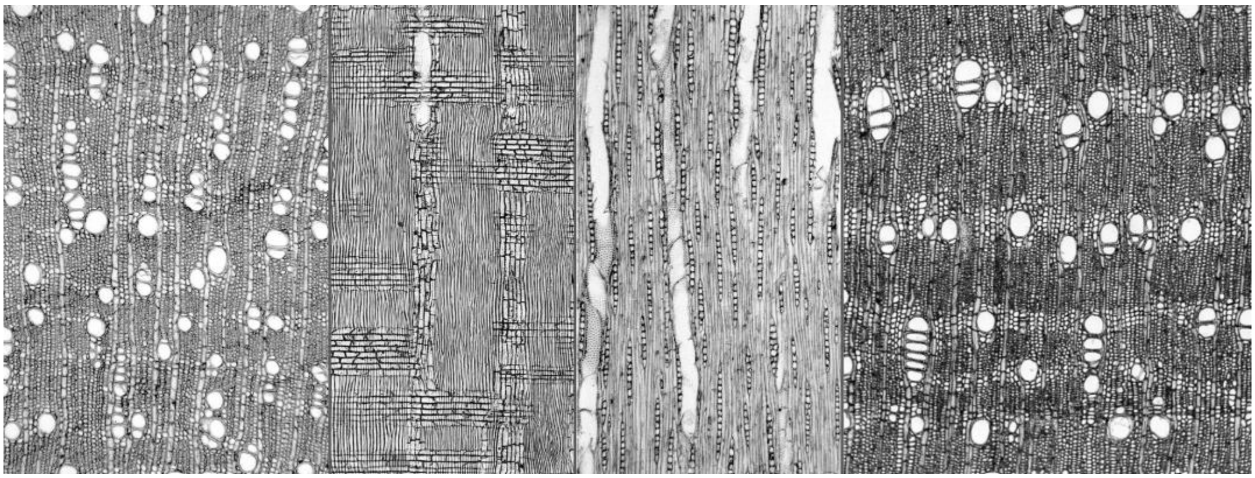
BIGNONIACEAE *Jacaranda copaia* *J. caucana, copaia, hondurensis, mimosifolia* (jacaranda, nazareno, guabanday, chingala, gobaja, para-para)

- Vessels 100-200+µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma winged-aliform, confluent, marginal bands

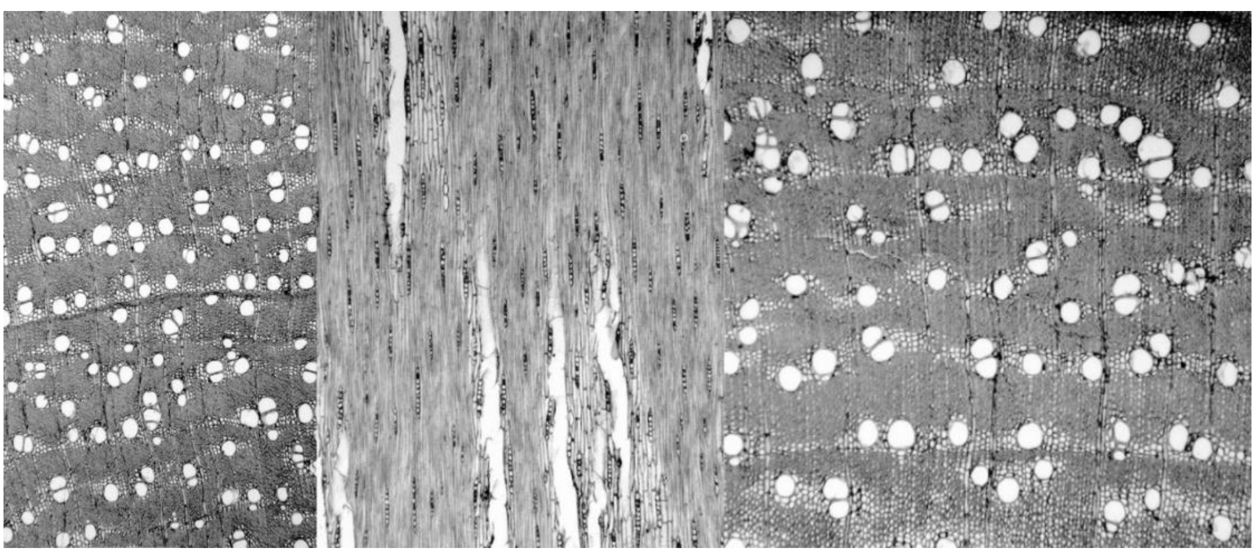


BIGNONIACEAE *Jacaranda mimosifolia* (jacaranda, tarco)
J. caucana, copaia, hondurensis, mimosifolia

- Vessels 50-100µm, 20-40/mm^2
- Rays uniseriate cells, 4-12+/mm
- Parenchyma winged-aliform, confluent, narrow bands

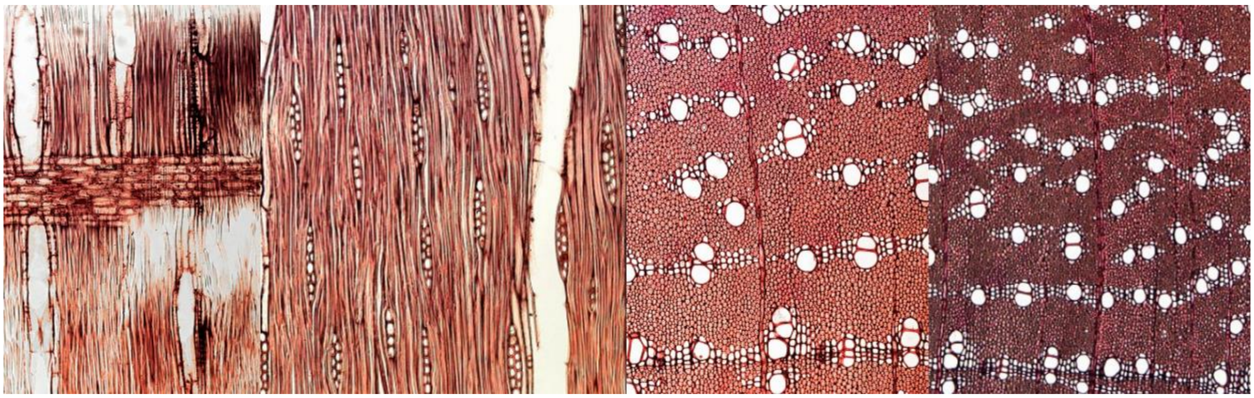


BIGNONIACEAE *Parmentiera cereifera* *dressleri, macrophylla, valeroi, valerii (arbol de vela)*



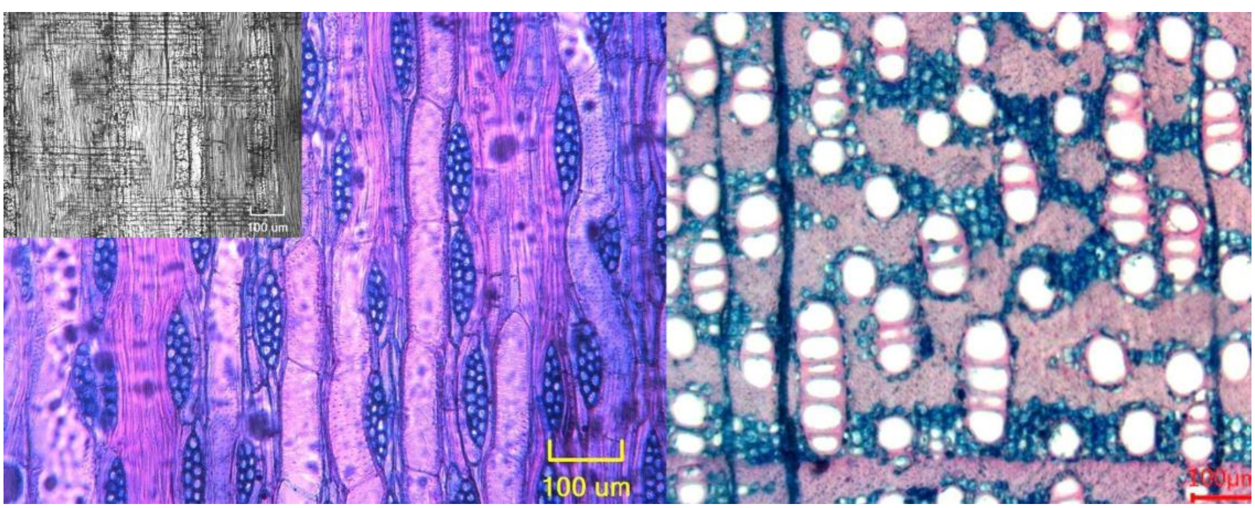
BIGNONIACEAE *Parmentiera macrophylla* *cereifera, dressleri, valeroi, valerii (arbol de vela)*

- Vessels <50-100µm, 40-100/mm^2
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma diffuse, aliform, confluent, marginal bands



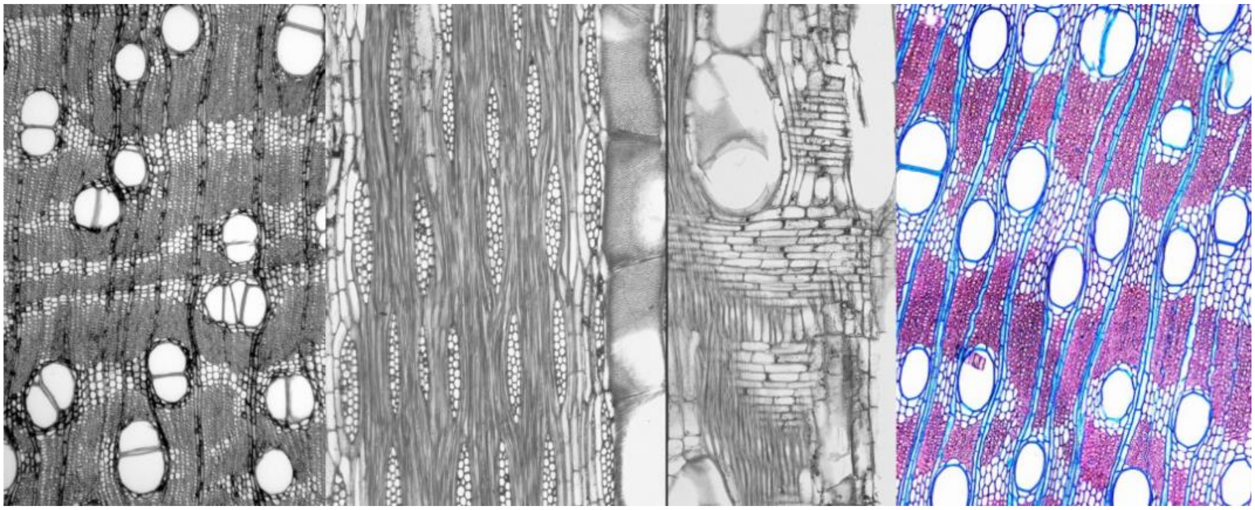
BIGNONIACEAE *Tabebuia chrysantha,* *guayacan, impetiginosa, palustris, ochracea, rosea* (roble de sabana (CR), apamate, rosy trumpet tree, guayacan)

- Vessels 50-100µm, 20-40/mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm, storied
- Parenchyma vasicentric, aliform, confluent, marginal bands



BIGNONIACEAE ***Tabebuia rosea,*** *chrysantha, guayacan, impetiginosa, palustris, ochracea* (roble de sabana (CR), apamate, rosy trumpet tree, guayacan)

- Vessels 100-200µm, 20-40/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands

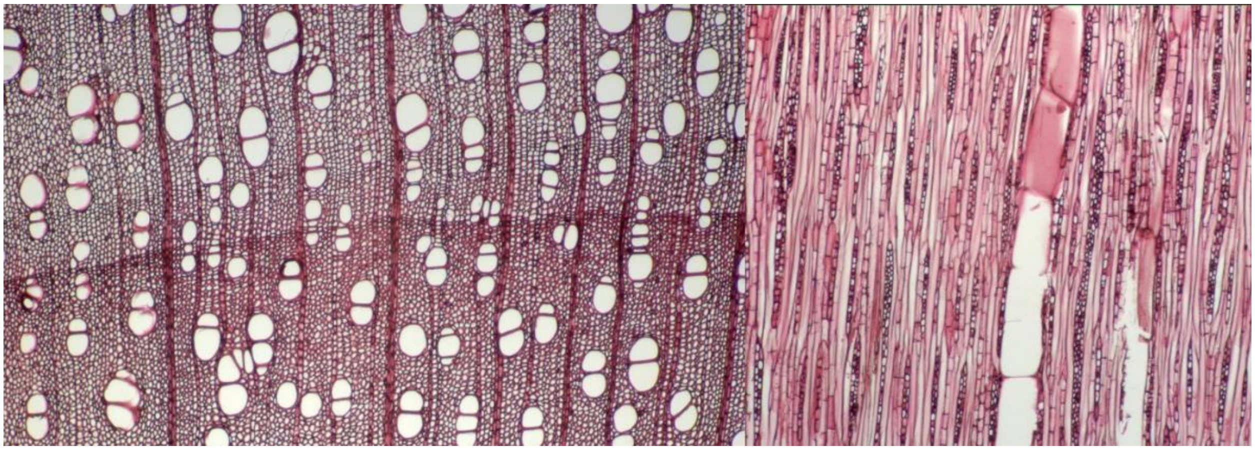


BIGNONIACEAE ***Tecoma stans*** (Yellow Elder of El Vainillo) Only species in Costa Rica within this genus

- Vessels 50-100 µm, 20-40 /mm^2
- Rays 1 to 3 cells, 4-12/mm, storied
- Parenchyma vasicentric, aliform, confluent

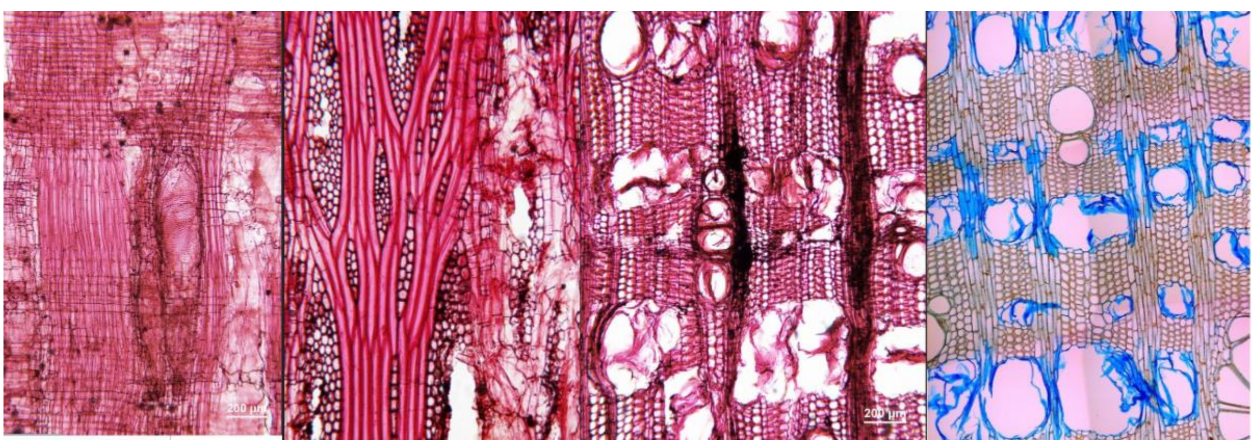
BIXACEAE *Bixa orellana,* *urucurana (annatto, achiote)*

- Vessels 50-200µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm, storied
- Parenchyma diffuse



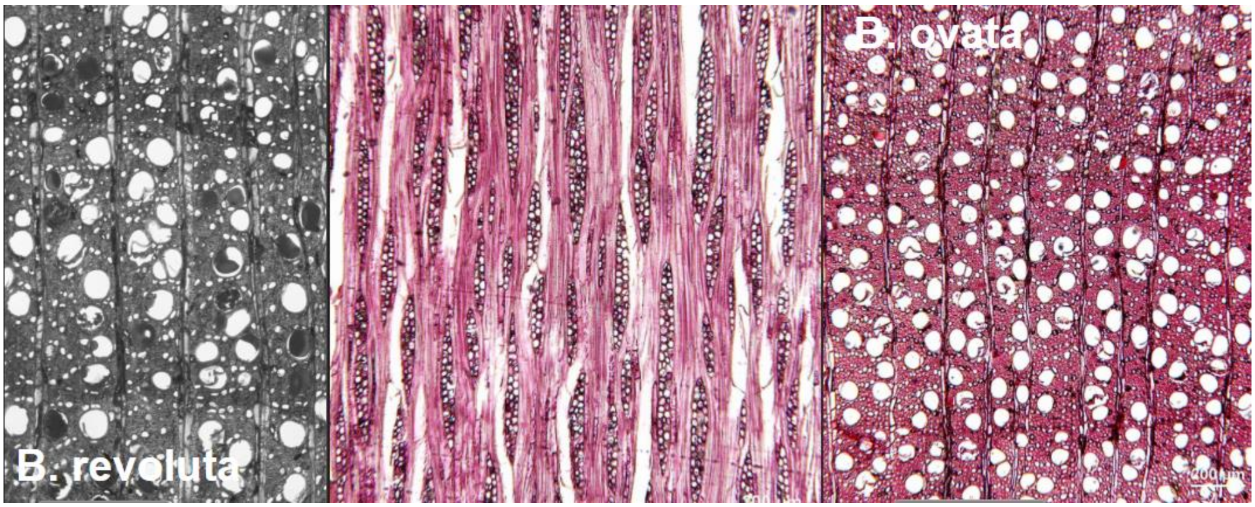
BIXACEAE Cochlospermum vitifolium, *orinocense, tetroporum* (poro-poro)

- Vessels 100-200+ µm, <=5-20/mm^2
- Tyloses common
- Rays 4 to 10 seriate, <=4-12/mm
- Parenchyma vasicentric, banded



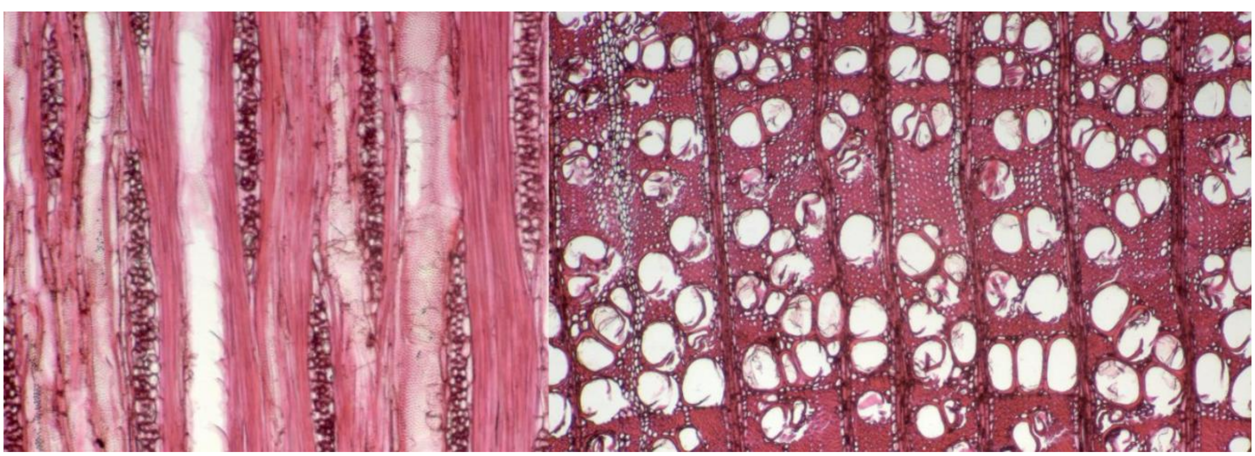
BORAGINACEAE *Bourreria* *andrieuxii, costaricensis, grandicalyx, grayumii, huanita, litoralis, oxyphylla, pulchra, quirosii, rinconensis* (canalú)

- Vessels 50-100 µm, 40-100 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, scanty



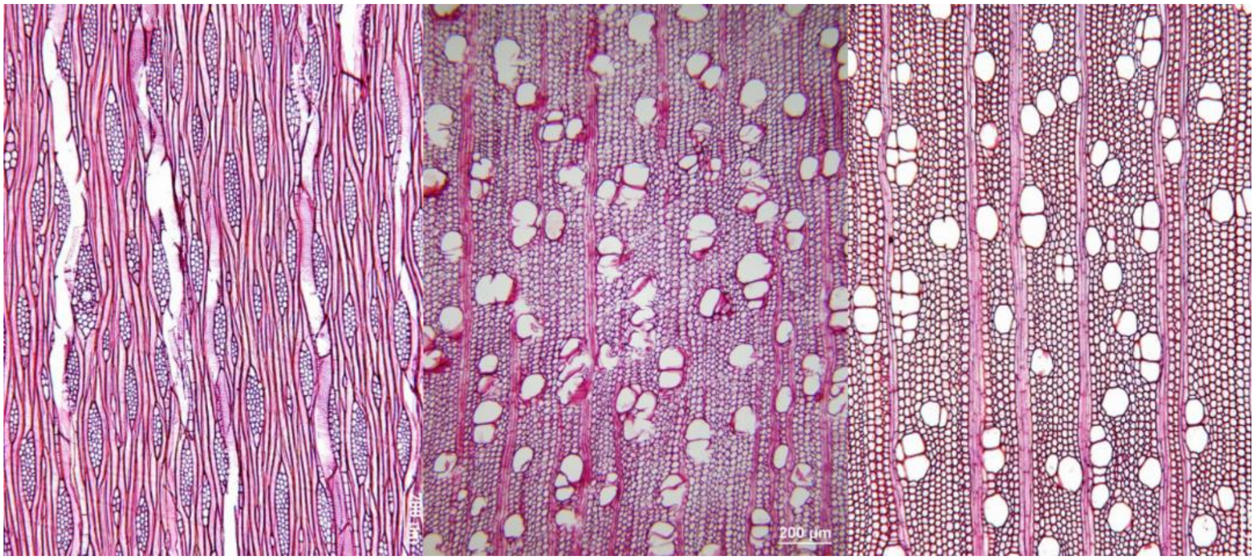
BORAGINACEAE *Cordia alliodora,* *(laurel, muñeco, biyuyo, paico) bicolor, collococca, croatia, curassavica, cymosa, dentata, diversifolia, dwyeri, eriostigma, gerascanthus, guanacastensis, liesneri, linnaei, lucidula, megalantha, panamensis, porcata*

- Vessels 100-200µm, 5-20 /mm^2
- Rays 4 to 10 cells, <4-12/mm
- Parenchyma diffuse, vasicentric, aliform, confluent, marginal bands



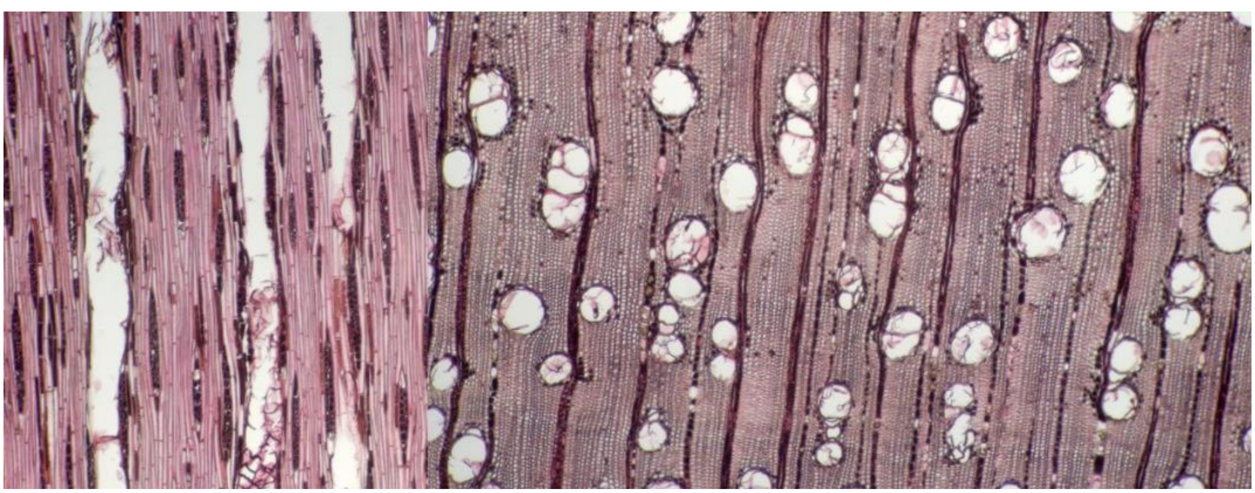
BURSERACEAE *Bursera simaruba,* (gumbo limbo, almacigo) *aptera, bipinnata, glabra, graveolens, grandiflora, howelii, morelensis, sessiflora, standleyana, tomentosa, trimera*

- Vessels 100-200µm, 5-20 /mm^2
- Rays 4 to 10 cells, <4-12/mm
- Parenchyma scanty paratracheal



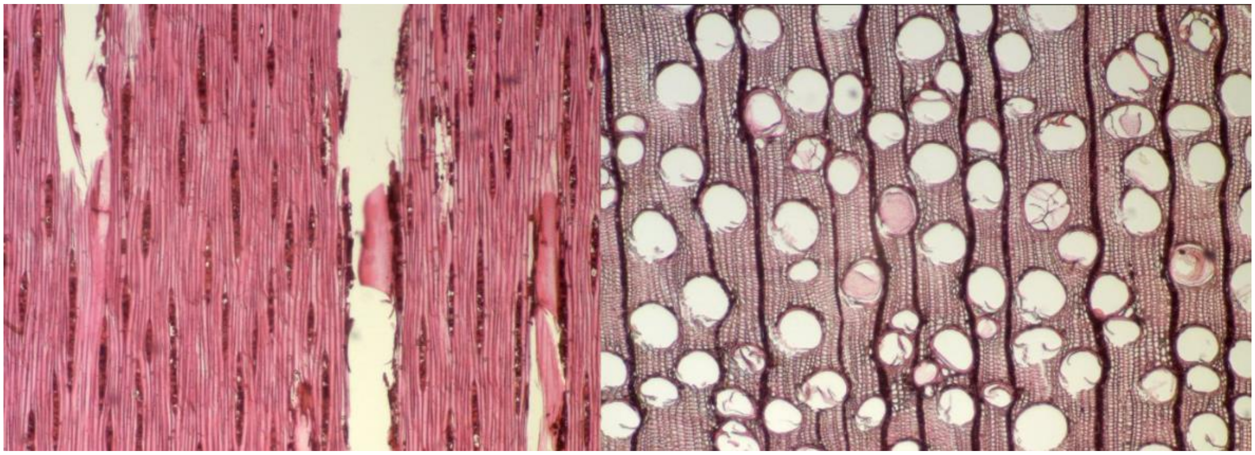
BURSERACEAE *Protium heptaphyllum,* *aracouchini, costaricense, confusum, glabrum, hostmannii, neglectum, panamense, pecuniosum, pittieri, ravenii, tenuifolium* (copal, chutra, alconfor, kerosín)

- Vessels 50-200µm, 5-40 /mm^2
- Rays 1 to 3 cells, <4-12/mm
- Parenchyma scanty paratracheal, vasicentric



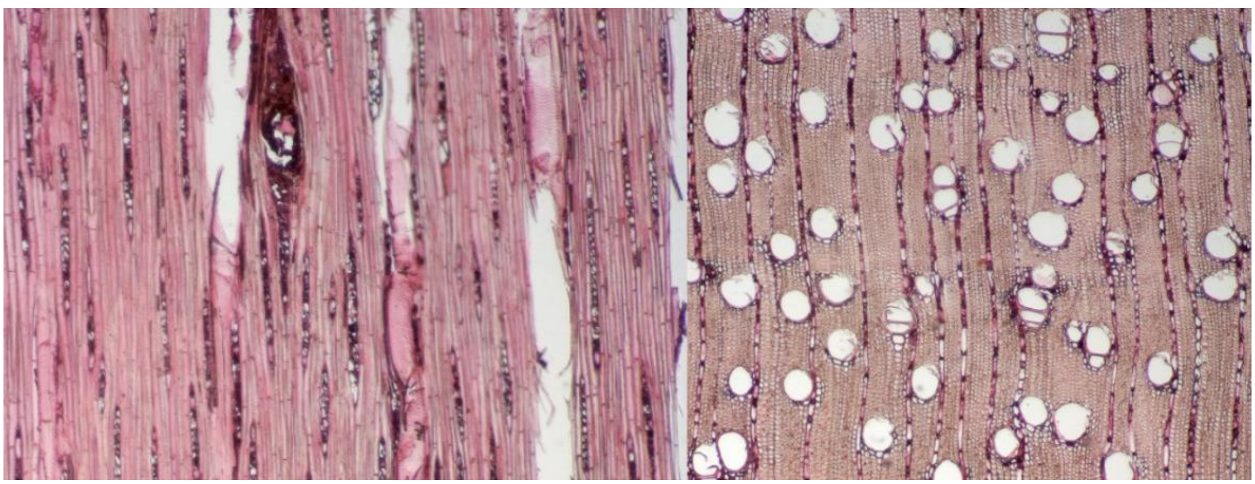
BURSERACEAE *Protium tenuifolium,* *aracouchini, costaricense, confusum, glabrum, heptaphyllum, hostmannii, neglectum, panamense, pecuniosum, pittieri, ravenii* (copal, chutra, alconfor, kerosín)

- Vessels 100-200µm, 5-20 /mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty paratracheal, absent/rare



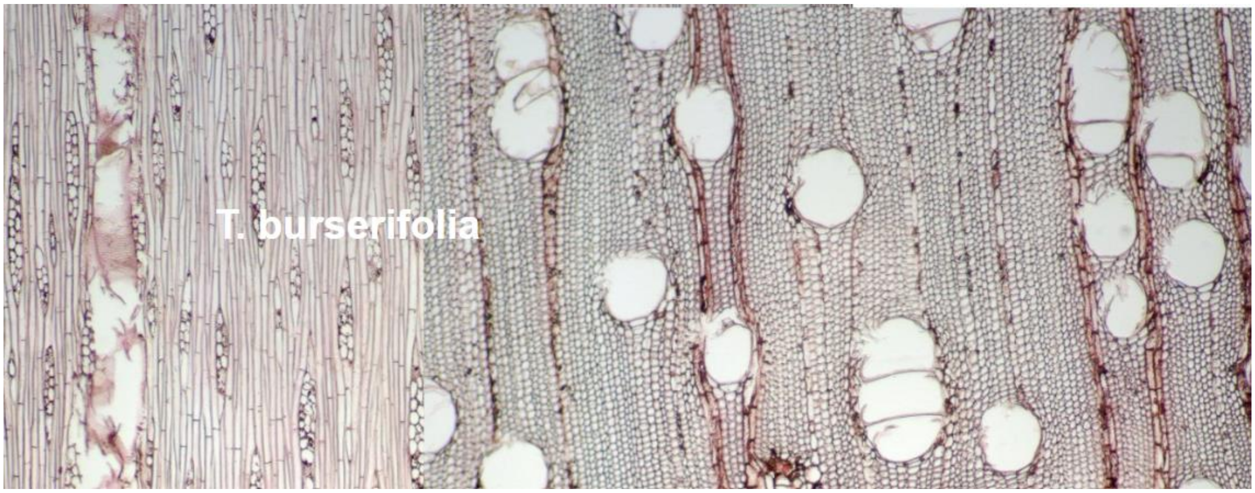
BURSERACEAE *Tetragastris panamensis* *(anime, cuatro estomagos, chutra, kerosin)*

- Vessels 50-200µm, 5-20 /mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty paratracheal, vasicentric



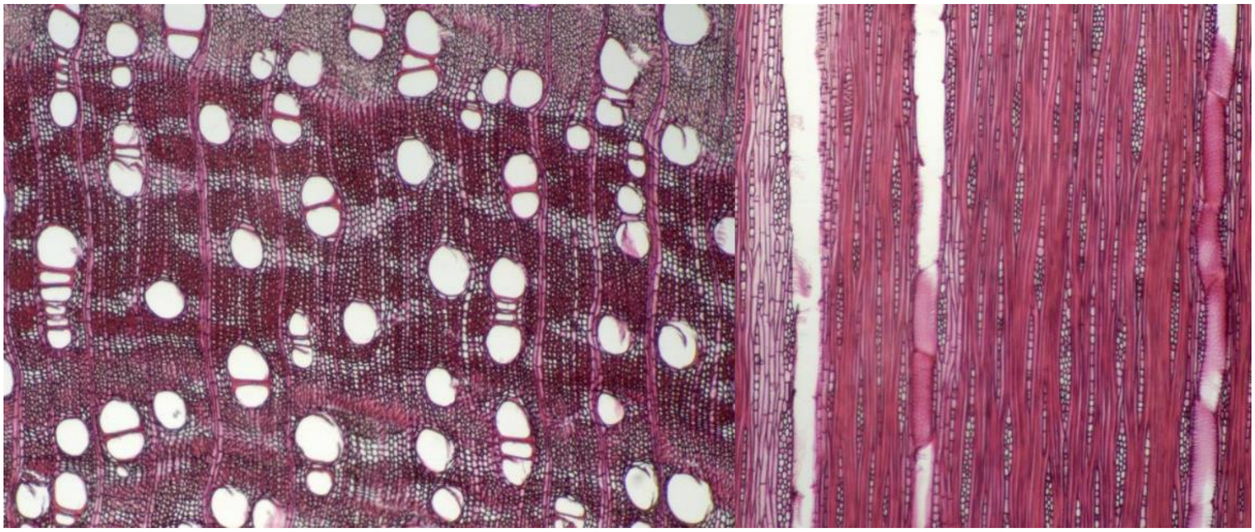
BURSERACEAE ***Trattinnickia*** *aspera* (caraño) (Only species in Costa Rica within this genus)

- Vessels 100-200µm, <5-20 /mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent/rare



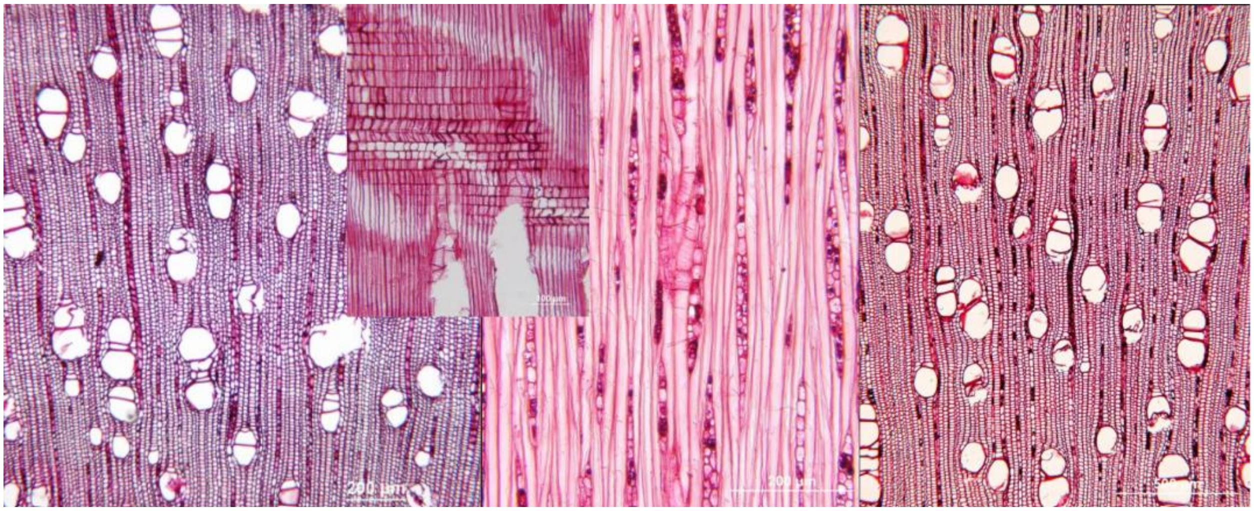
CANNABACEAE ***Celtis iguanaea*** *C. caudata, iguanaea, schippi* (hackberry)

- Vessels 100-200µm, 5-20/mm^2
- Rays larger 4 to 10 seriate, 4-12/mm
- Parenchyma winged-aliform, confluent, bands

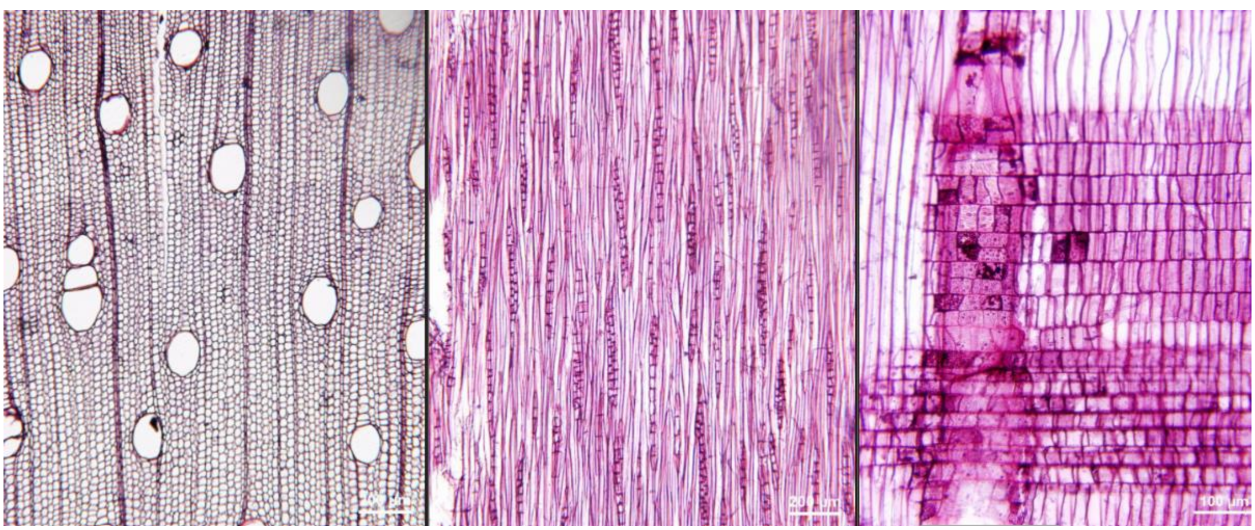


CANNABACEAE *Trema micrantha,* *domingensis, integerrima (both rare)*
(jordancillo, capulin)

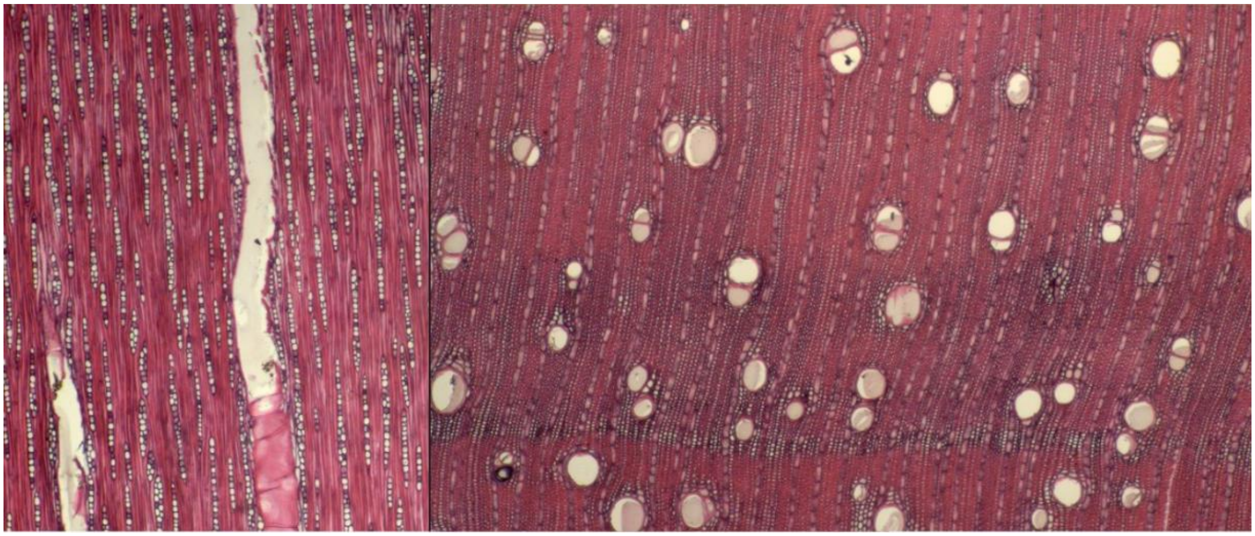
- Vessels 50-200µm, 5-20/mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty paratracheal



CANNABACEAE *Trema integerrima (rare)* *micrantha, domingensis (rare)*
(jordancillo, capulin)

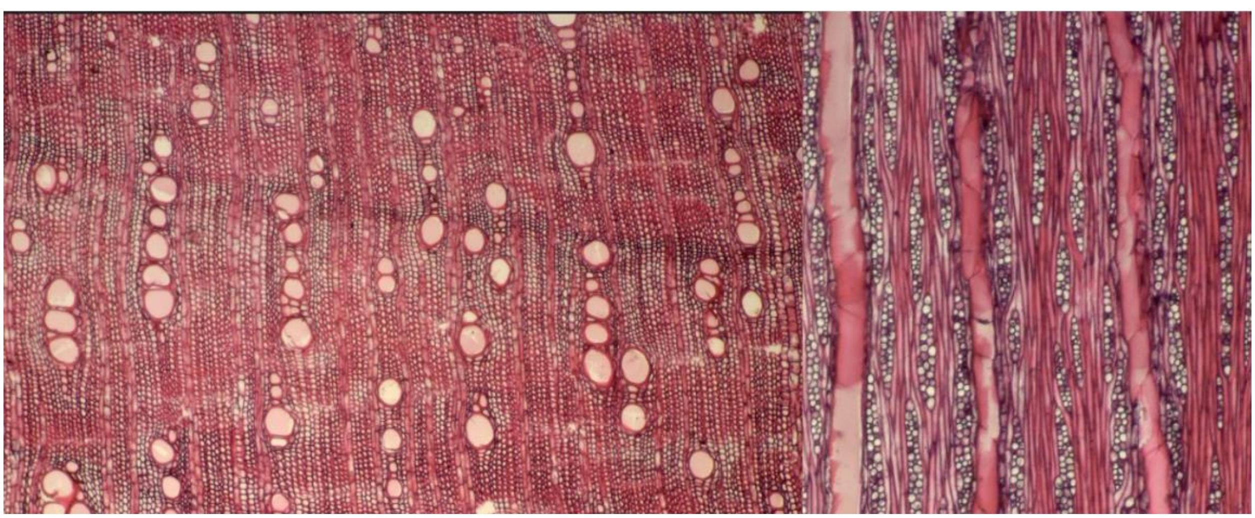


CAPPARACEAE *Capparis cynophallophora,* *amplissima, brenesii, discolor, filipes, flexuosa, frondosa, heydeana, incana, indica, odoratissima, pittieri, pringlei, quiriguensis, uniflora, verrucosa* (caper bush, carne de venado, garrotillo)

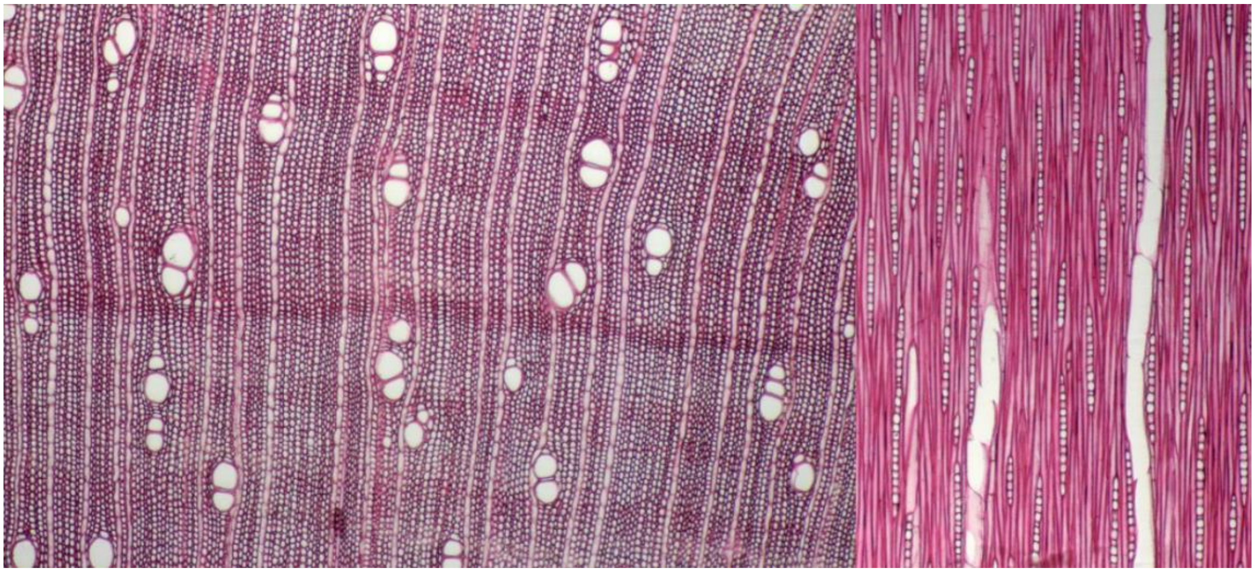


CAPPARACEAE *Capparis flexuosa,* *amplissima, brenesii, cynophallophora, discolor, filipes, frondosa, heydeana, incana, indica, odoratissima, pittieri, pringlei, quiriguensis, uniflora, verrucosa* (caper bush)

- Vessels 50-100µm, 20-40/mm^2, vessels of two distinct sizes
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty paratracheal

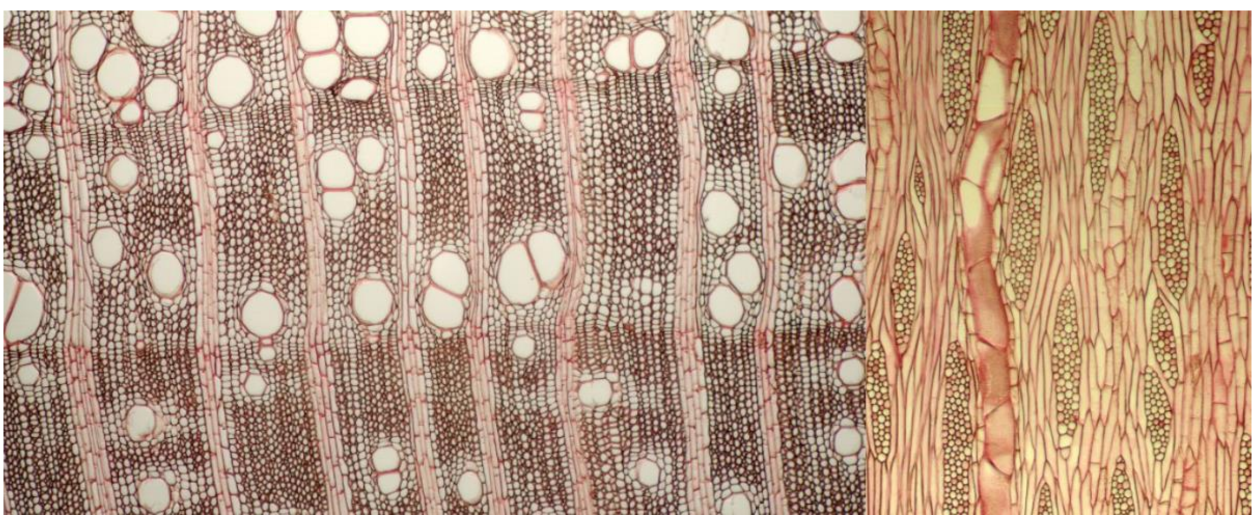


CAPPARACEAE *Capparis frondosa,* *amplissima, brenesii, cynophallophora, discolor, filipes, flexuosa, heydeana, incana, indica, odoratissima, pittieri, pringlei, quiriguensis, uniflora, verrucosa* (garrotillo, caper bush)

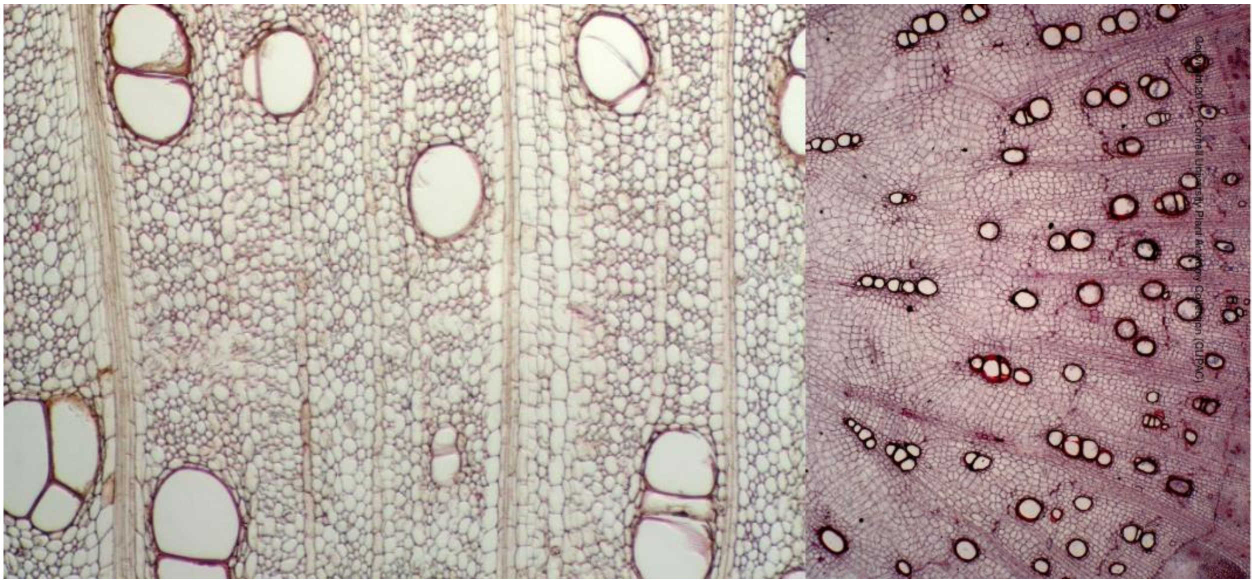


CAPPARACEAE *Crateva tapia,* *C. palmeri (*guaco, palo de guaco, perguetano, mongo)

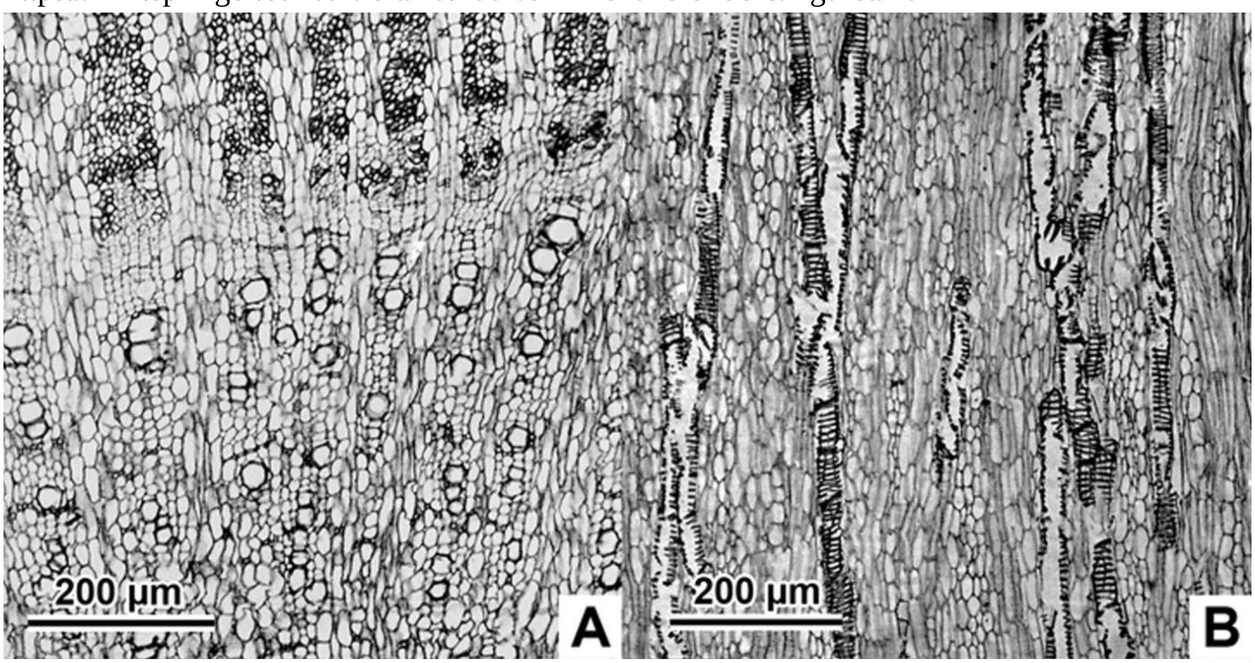
- Vessels 50-200µm, 5-20/mm^2,
- Rays 4 to 10 cells, <4/mm
- Parenchyma vasicentric, marginal bands



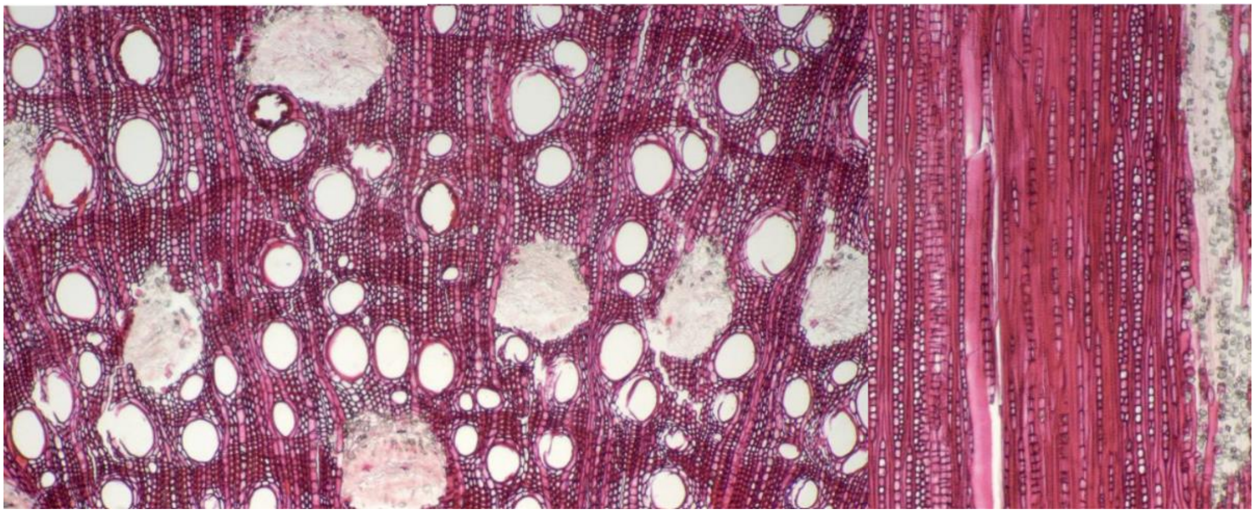
CARICACEAE *Carica papaya,* (papaya) *cauliflora, pubescens*



CARICACEAE *Jacaratia* *dolichaula, spinosa* (papayito) *(img of Jacaratia hassleriana)*
https://link.springer.com/article/10.1007/s12229-018-9198-5/figures/10

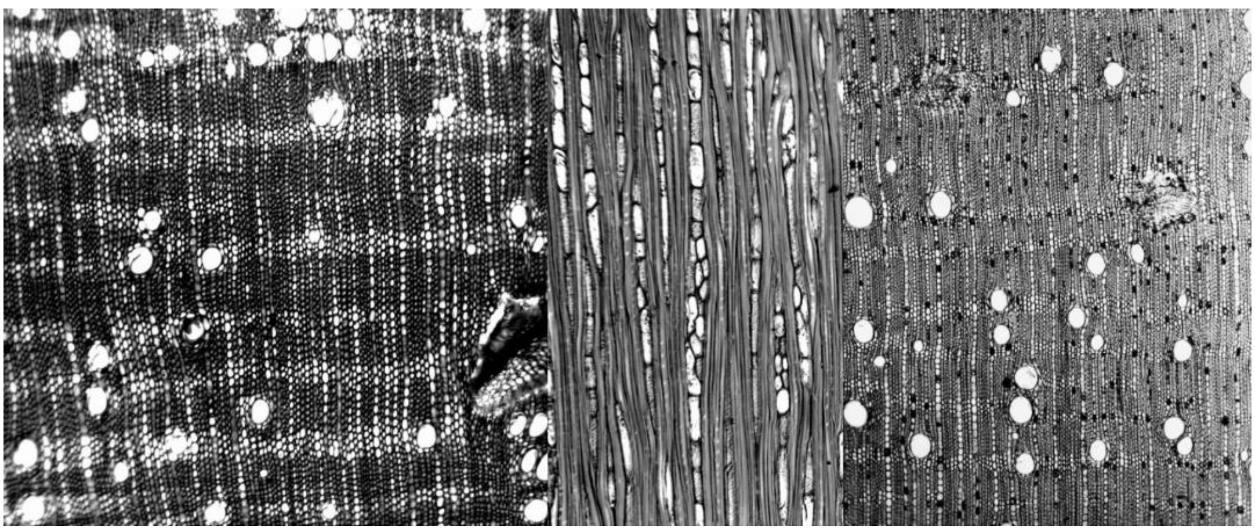


CELASTRACEAE *Cheiloclinium belizense,* *cognatum* (fruta de mono, cocora)



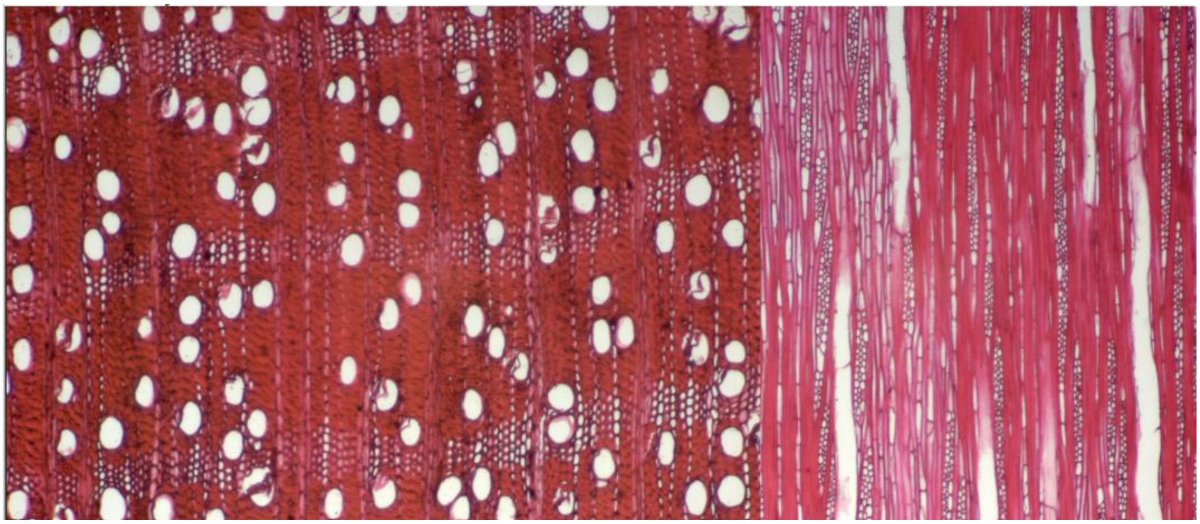
CELASTRACEAE *Cheiloclinium cognatum,* *belizense* (fruta de mono, cocora)

- Vessels exclusively solitary, 50-100µm, 5-20/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma scanty



CELASTRACEAE *Maytenus guyanensis,* (mayten) *purpusii, recondita, segoviarum, woodsonii*

- Vessels exclusively solitary, <50-100µm, 40-100+/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, >12/mm
- Parenchyma banded

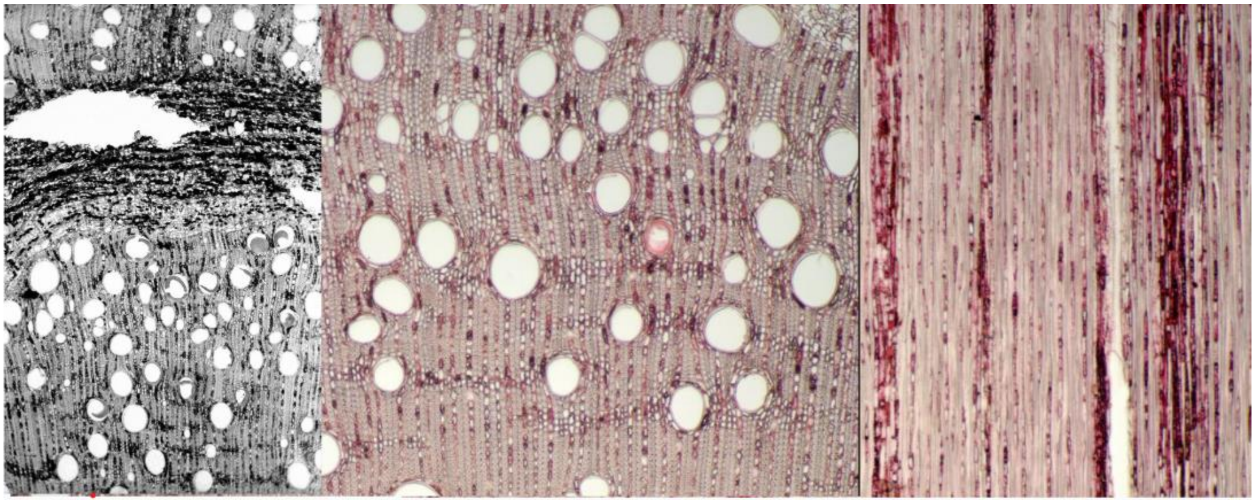


CELASTRACEAE *Salacia elliptica*, *impressifolia, mutiflora, petenensis* (salacia)

- Vessels exclusively solitary, 100-200µm, two distinct classes, 5-20/mm^2
- Rays exclusively uniseriate, >12/mm
- Parenchyma vasicentric
- vine/liana

CELASTRACEAE *Salacia impressifolia,* *elliptica, mutiflora, petenensis* (salacia)

- Vessels exclusively solitary, 100-200µm, two distinct classes, 5-20/mm^2
- Rays exclusively uniseriate, >12/mm
- Parenchyma vasicentric
- vine/liana

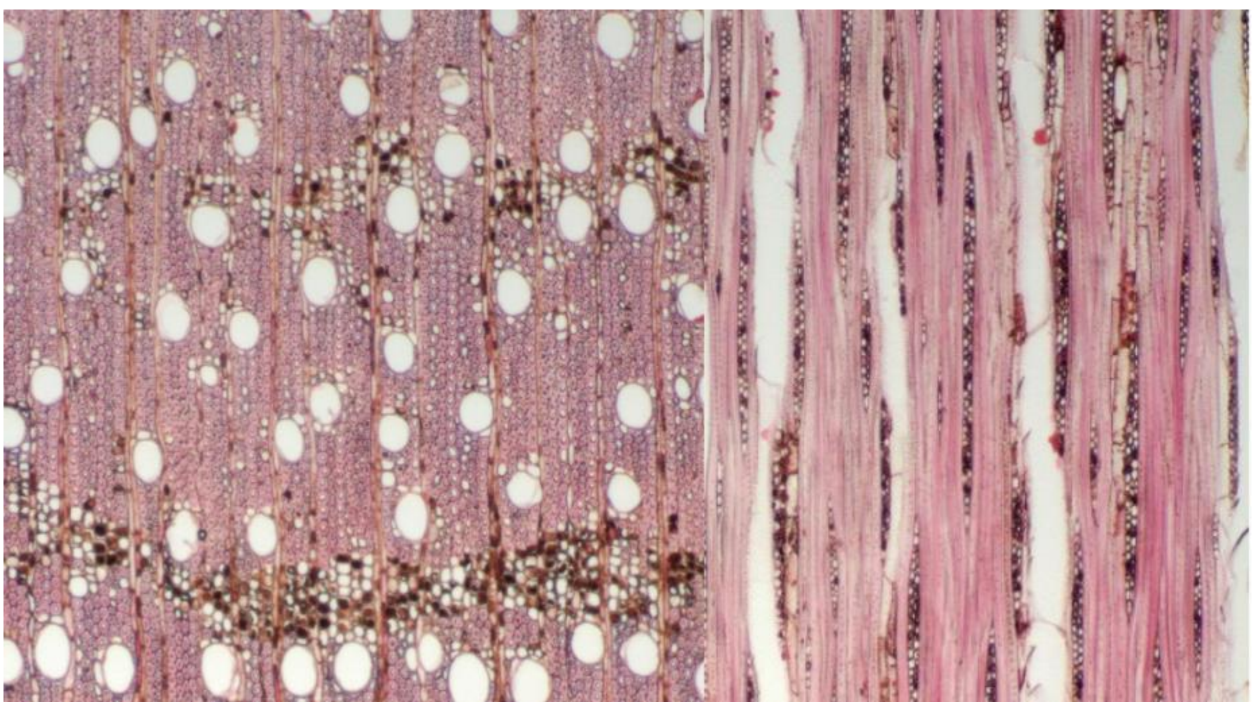


CELASTRACEAE *Salacia mutiflora,* *impressifolia, elliptica, petenensis* (salacia)

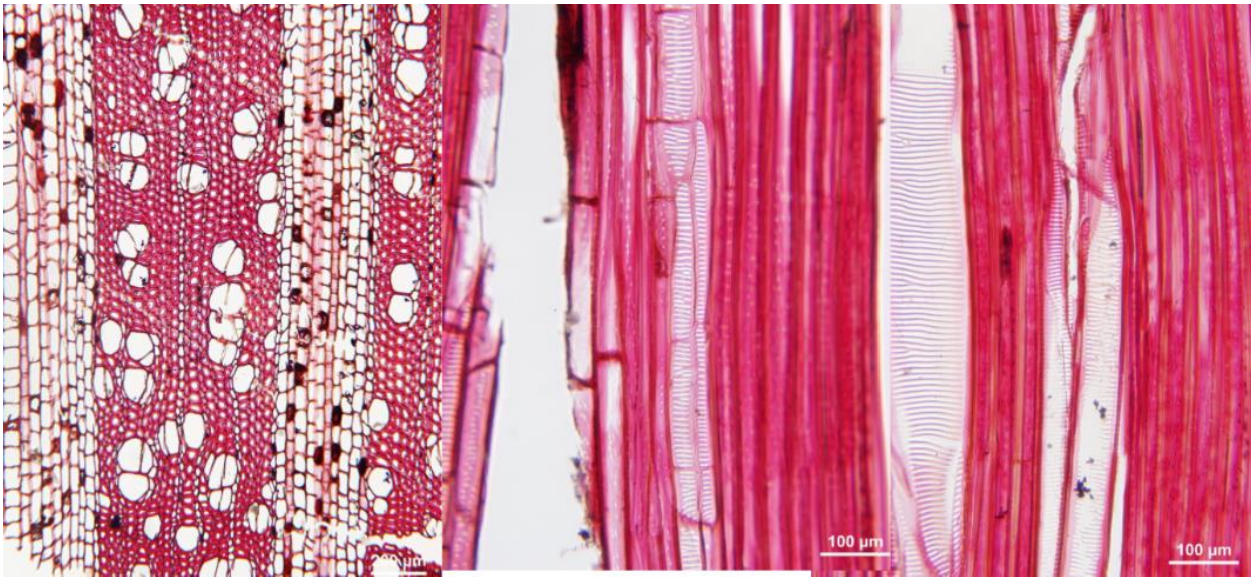
- Vessels exclusively solitary, 100-200µm, two distinct classes, 5-20/mm^2
- Rays exclusively uniseriate, >12/mm
- Parenchyma vasicentric
- vine/liana

CELASTRACEAE *Wimmeria bartlettii,* *acuminata, excoriata, sternii*
(no common name)

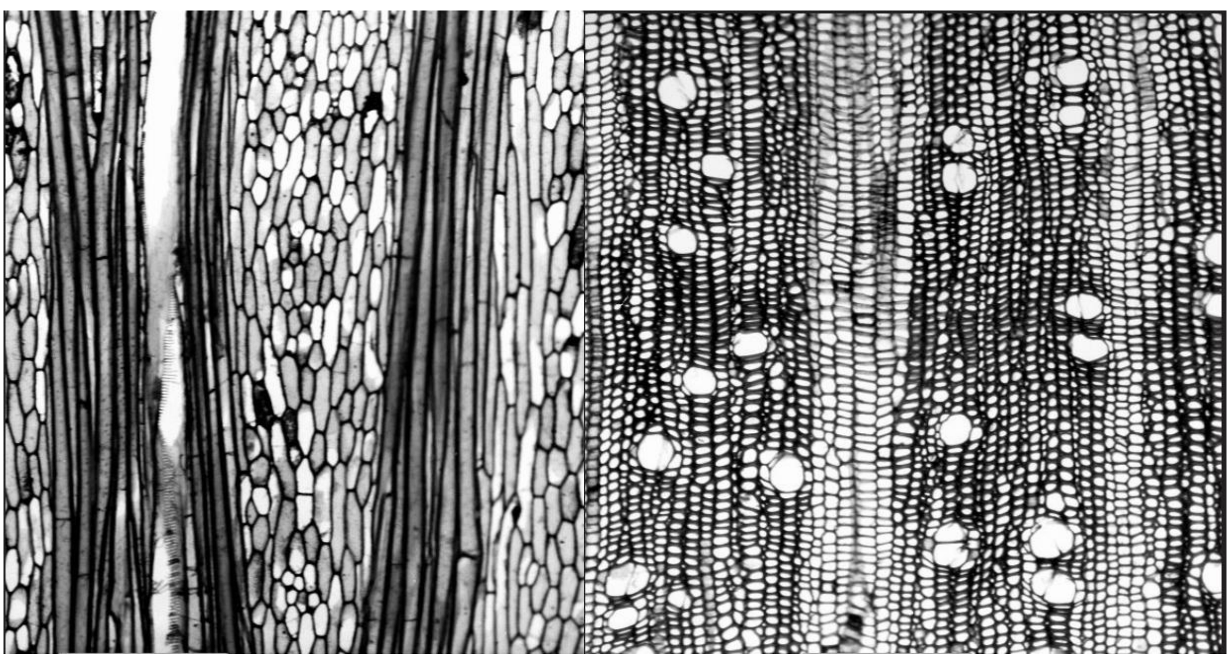
CELASTRACEAE *Wimmeria sternii,* *bartlettii, acuminata, excoriata,* (no common name)



CHLORANTHACEAE *Hedyosmum bonplandianum, (sauquillo, limoncillo)*
brenesii, costaricense, goudotianum, mexicanum, scaberrimum

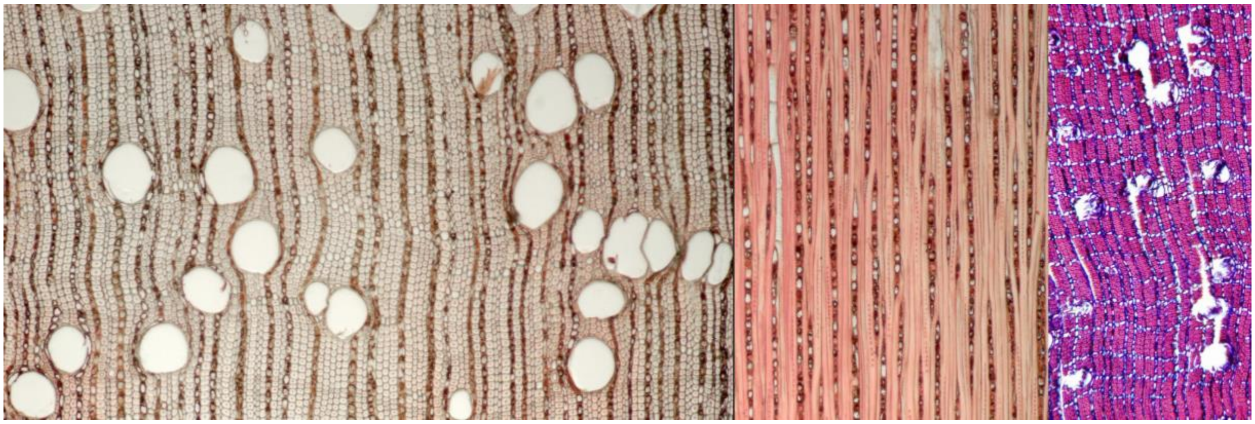


CHLORANTHACEAE *Hedyosmum scaberrimum,* (sauquillo)
bonplandianum, brenesii, costaricense, goudotianum, mexicanum



CHRYSOBALANACEAE *Hirtella racemosa,* (camaron, garrapato, conejo) *americana, davisii, latifolia, lemsii, media, triandra, trichotoma, tubiflora*

- Vessels exclusively solitary, 100-200µm, 5-20/mm^2
- Rays exclusively uniseriate, >=12/mm
- Parenchyma in narrow bands, reticulate

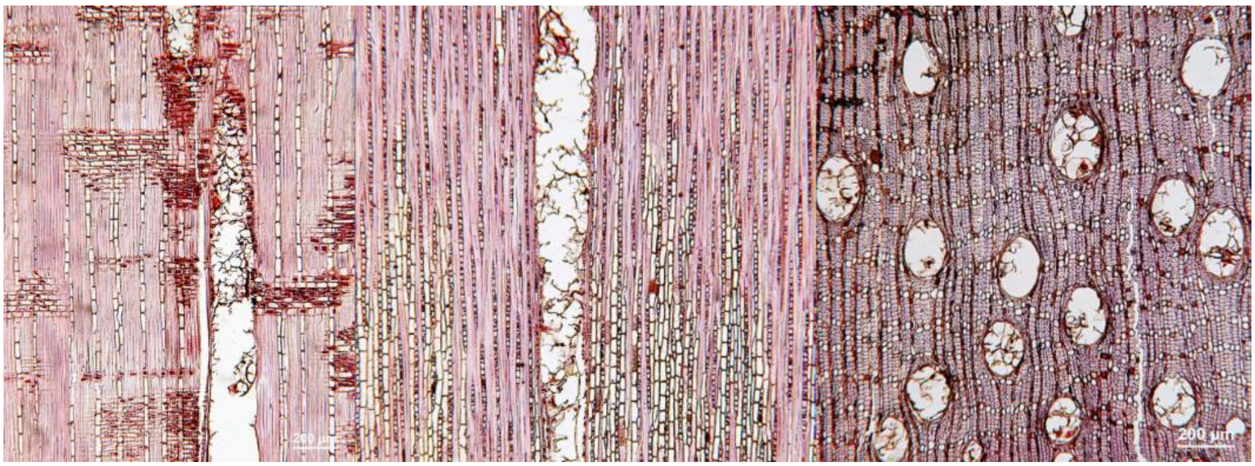


CHRYSOBALANACEAE *Licania arborea,* (corocillo, garrapato, raspa, rasca, rascador, sapote, sangre) *affinis, belloi, costaricensis, glabriflora, hypoleuca, kallunkiae, operculipetala, platypus, riverae, sparsipilis, stevensii*

- Vessels exclusively solitary, 100-200+µm, <=5-20/mm^2
- Tyloses common
- Rays exclusively uniseriate, >=12/mm
- Parenchyma in diffuse in aggregates, reticulate, narrow bands

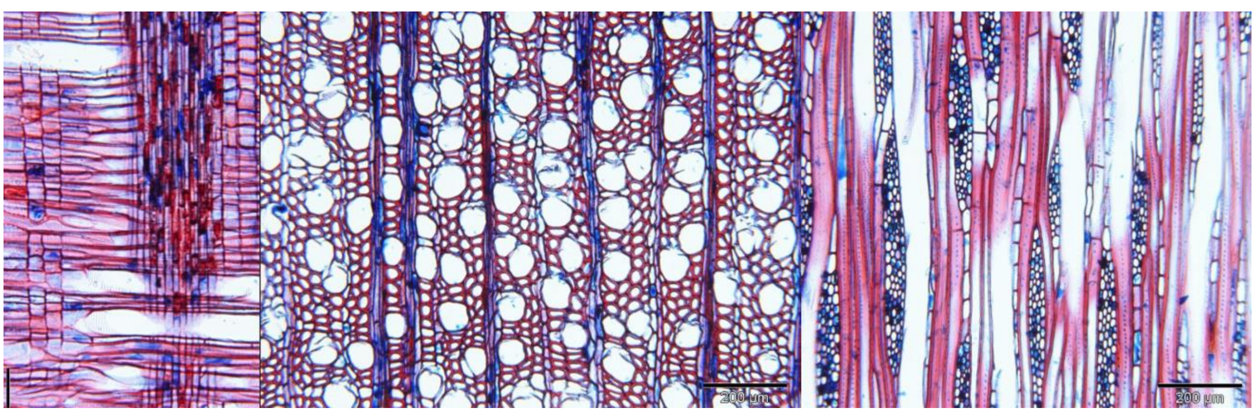
CHRYSOBALANACEAE *Licania hypoleuca,* (corocillo, garrapato, raspa, rasca, rascador, sapote, sangre) *arborea*, *affinis, belloi*, *costaricensis, glabriflora, kallunkiae*, *operculipetala*, *platypus*, *riverae*, *sparsipilis*, *stevensii*

- Vessels exclusively solitary, 100-200µm, 5-20/mm^2
- Tyloses common
- Rays exclusively uniseriate, >=12/mm
- Parenchyma reticulate, narrow bands



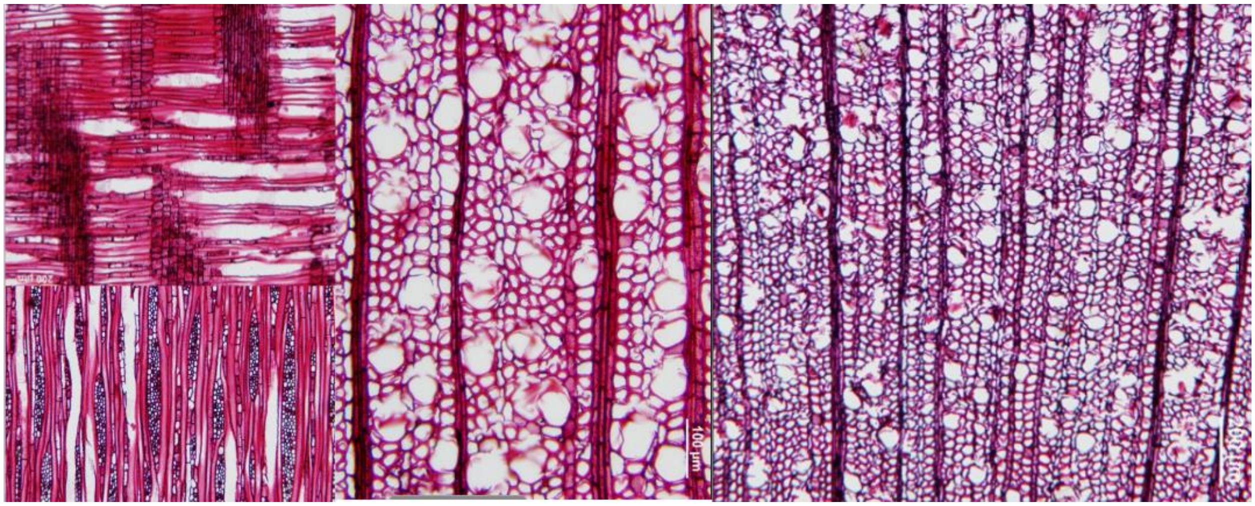
CLETHRACEAE *Clethra lanata* *alcoceri*, *costaricensis*, *formosa*, *gelida*, *hondurensis*, *mexicana, pyrogena* (nancito, nancillo, nance macho, memeicillo, pepperbush)

- Vessels exclusively solitary, <=50-100µm, 40-100/mm^2
- Rays 4 to 10 seriate, >=12/mm
- Parenchyma scanty, diffuse



CLETHRACEAE *Clethra mexicana* *alcoceri, costaricensis, formosa, gelida, hondurensis, lanata, pyrogena* (nancito, nancillo, nance macho, memeicillo, pepperbush)

- Vessels exclusively solitary, 50-100µm, 20-40/mm^2
- Rays 4 to 10 seriate, >=12/mm
- Parenchyma scanty, diffuse in aggregates

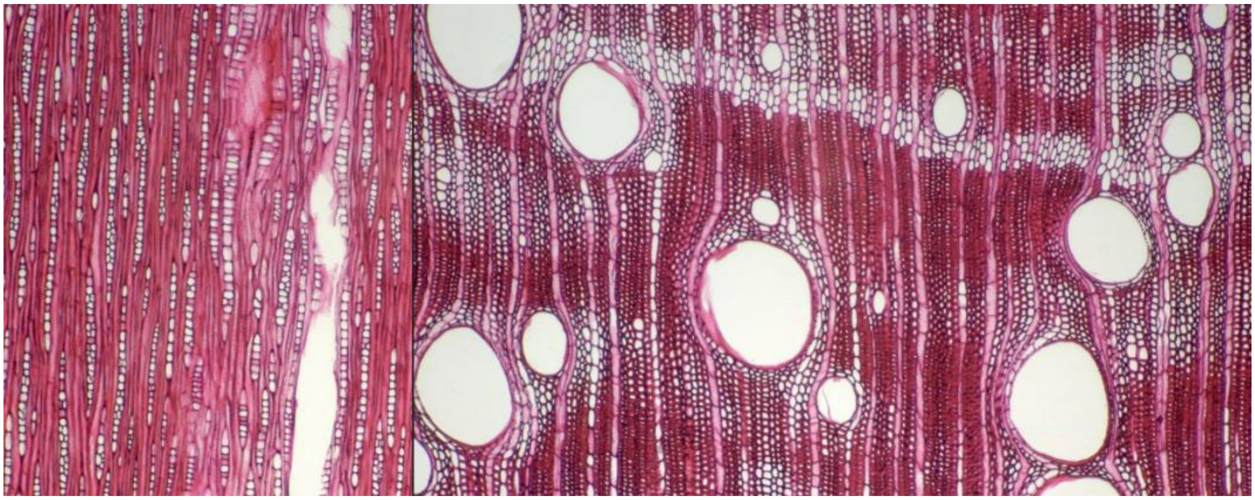


CLUSIACEAE *Calophyllum brasiliense,* *calaba, inophyllum, longifolium, lucidum, mesoamericanum*
(maria enano, calaba)

- Vessels exclusively solitary, 100-200µm, 5-20/mm^2, tyloses common
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma bands, reticulate, marginal bands

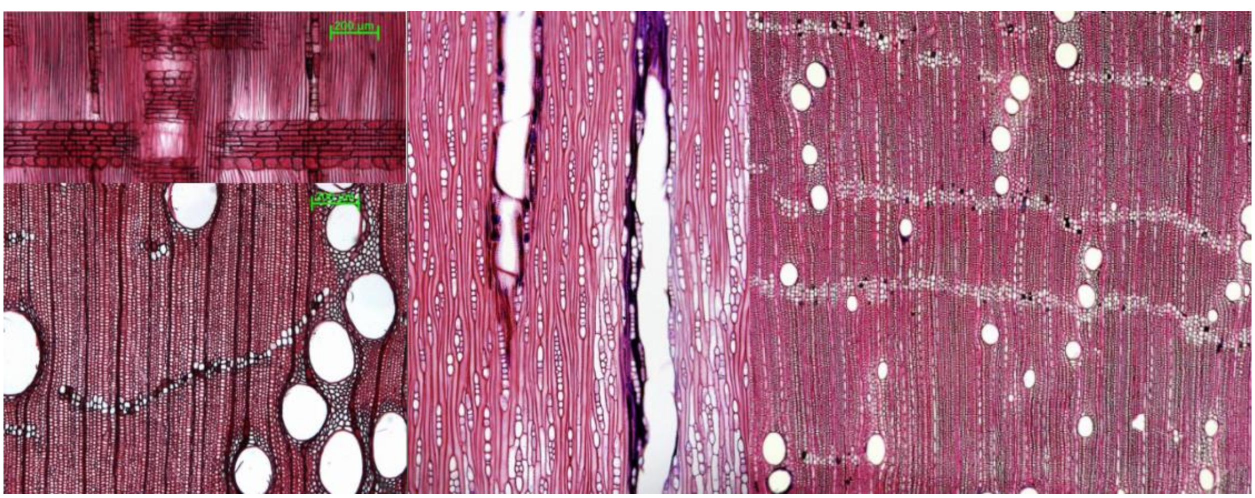
CLUSIACEAE *Calophyllum calaba,* (maria enano, calaba)
brasiliense, inophyllum, longifolium, lucidum, mesoamericanum

- Vessels exclusively solitary, 100-200+µm, <=5-20/mm^2
- Rays exclusively uniseriate, 1 to 3 cells, 4-12/mm
- Parenchyma banded



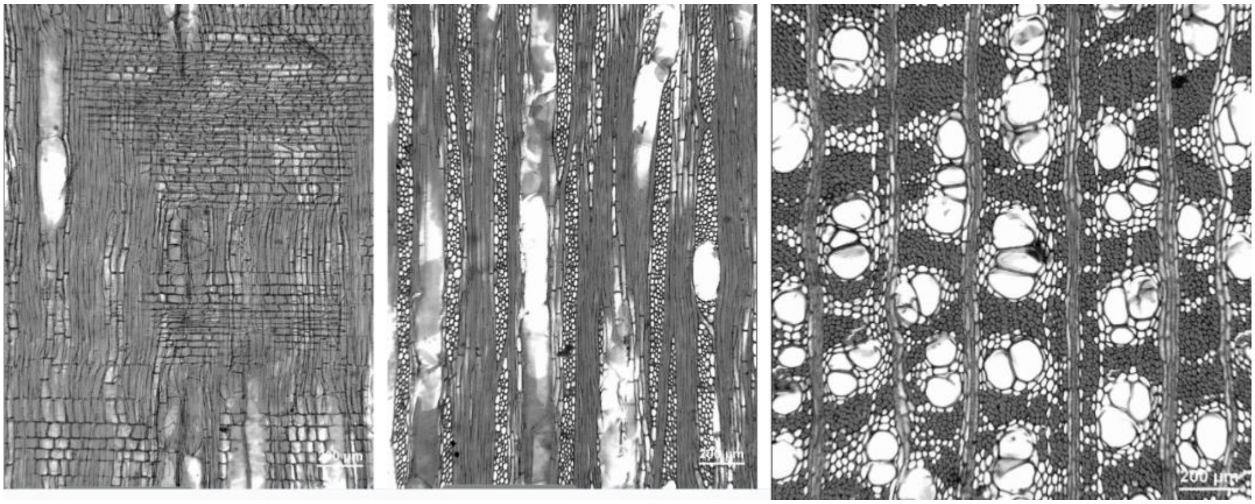
CLUSIACEAE *Calophyllum inophyllum,* *brasiliense, calaba, longifolium, lucidum, mesoamericanum* (maria enano, calaba)

- Vessels exclusively solitary, 100-200+µm, <=5-20/mm^2
- Rays exclusively uniseriate, 1 to 3 cells, 4-12/mm
- Parenchyma banded



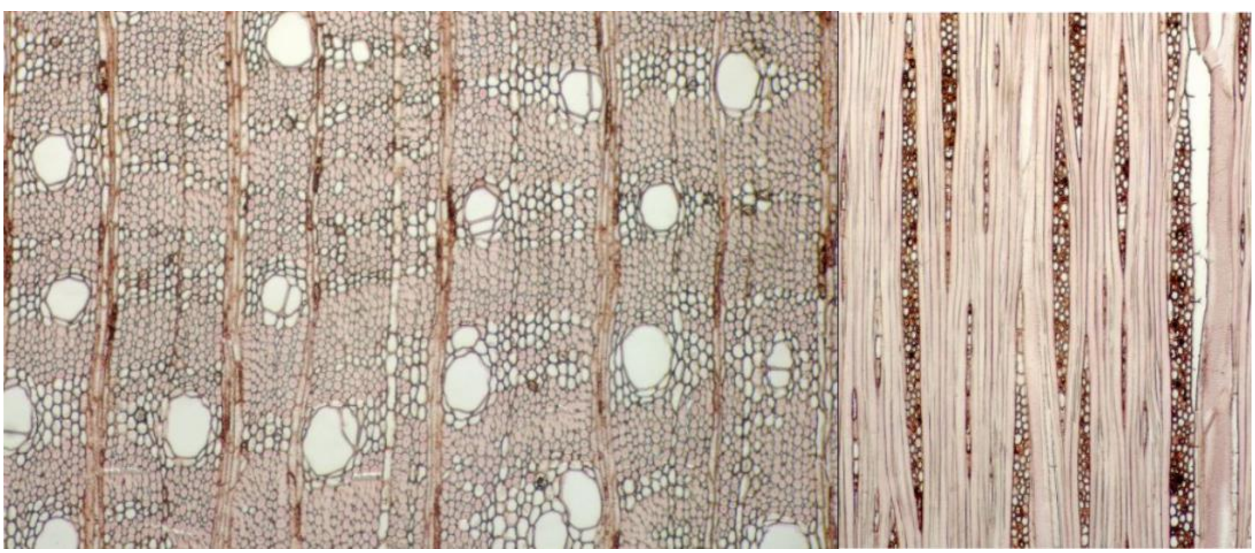
CLUSIACEAE *Garcinia intermedia,* *madruno, macrophylla, magnifolia, mangostana* (madroño, chaparrón, sastra, sastro)

- Vessels 100-200µm, 5-40/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma aliform confluent, winged, lozenge



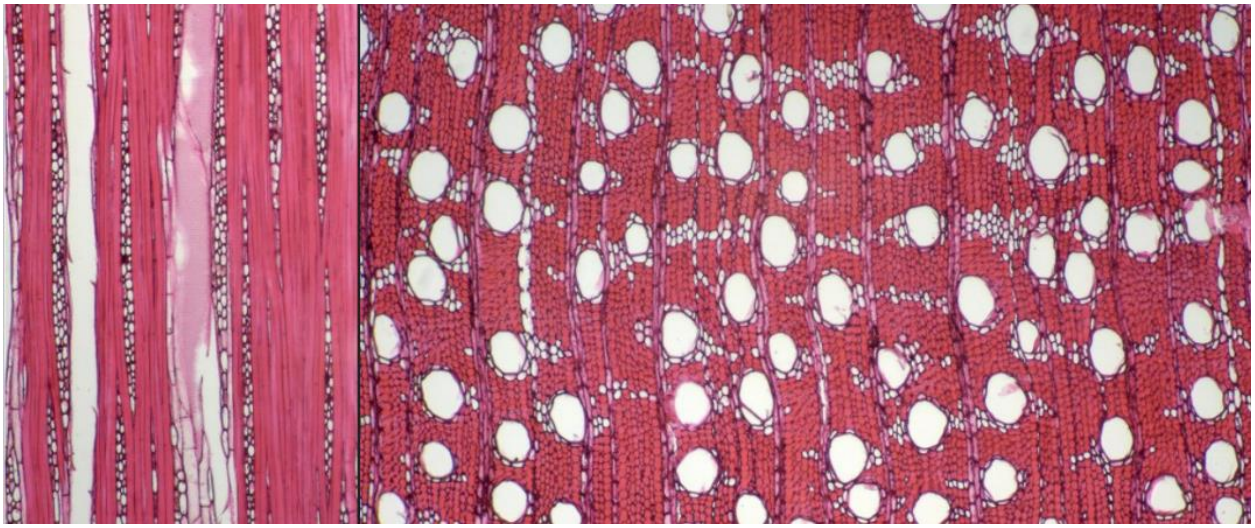
CLUSIACEAE *Garcinia macrophylla,* *intermedia, madruno, magnifolia, mangostana* (madroño, chaparrón, sastra, sastro)

- Vessels 100-200µm, 5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, confluent, winged



CLUSIACEAE *Garcinia madruno,* *intermedia*, *macrophylla*, *magnifolia*, *mangostana* (madroño, chaparrón, sastra, sastro)

- Vessels 50-200µm, 5-40/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform confluent, winged



CLUSIACEAE *Symphonia globulifera* (cerillo, cero, barillo) Only species in Costa Rica within this genus

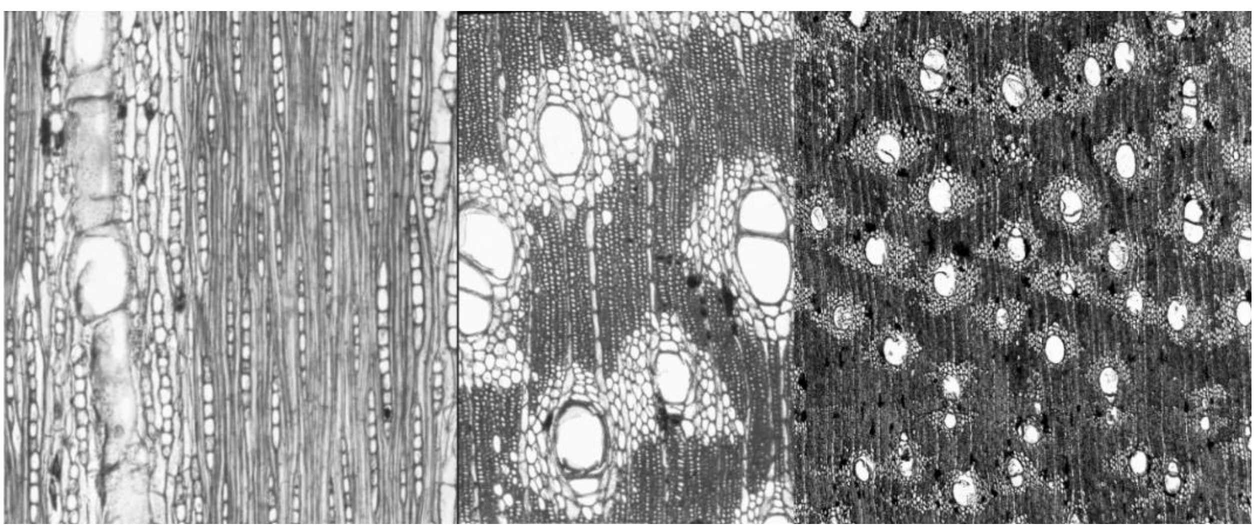
- Vessels exclusively solitary, 100-200+µm, <=5-20/mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, confluent, bands

CLUSIACEAE *Tovomita longifolia* *choisyana, croatia, laurina, stylosa, weddelliana*
(no known common name)

- Vessels 50-200µm, 5-40/mm^2, tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, winged

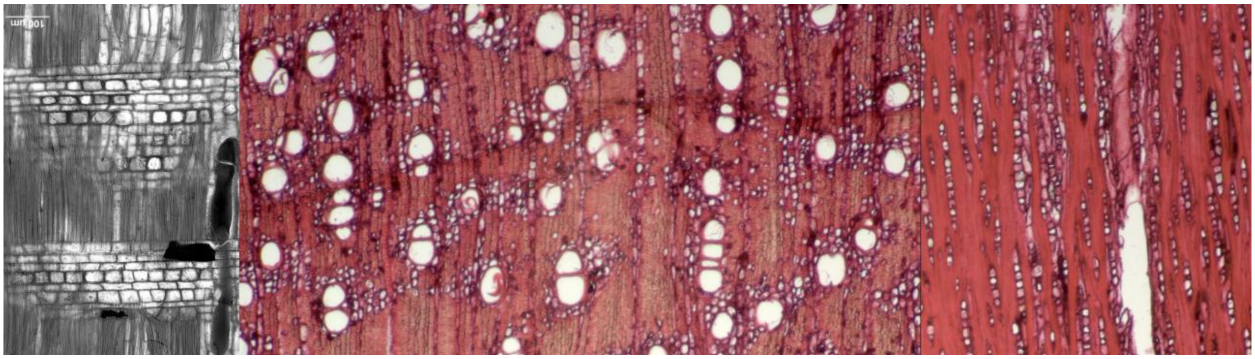
COMBRETACEAE *Buchenavia tetraphylla,* *costaricensis* (amarillo, amarillo de pepita)

- Vessels 50-200 µm, 5-20/mm^2
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma vasicentric, diffuse, aliform, confluent



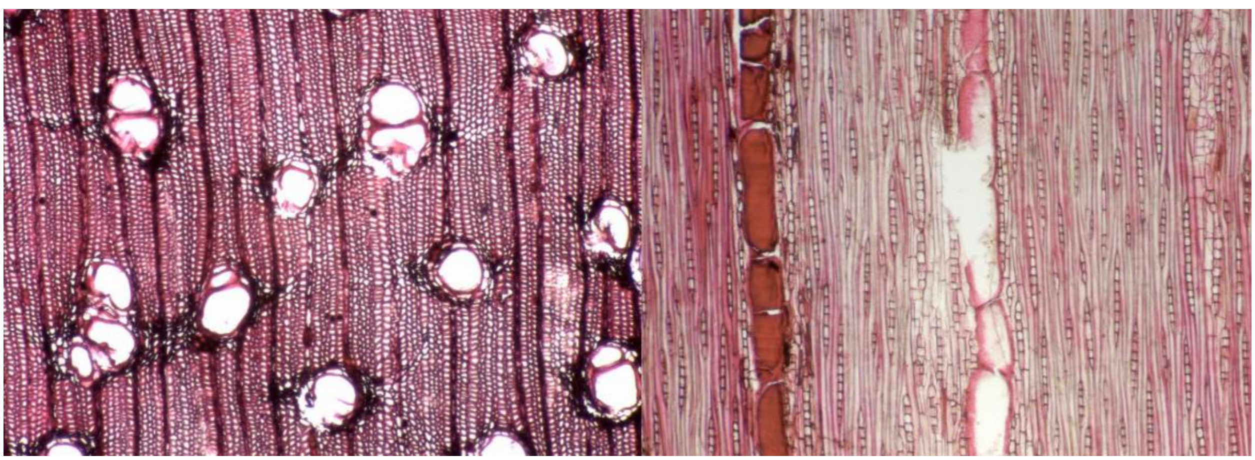
COMBRETACEAE *Conocarpus erectus* *Only species in Costa Rica within this genus*
(mangle botón, mangle botoncillo, button mangrove)

- Vessels 50-100 µm, 5-40/mm^2
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma vasicentric, diffuse, aliform, confluent, marginal bands



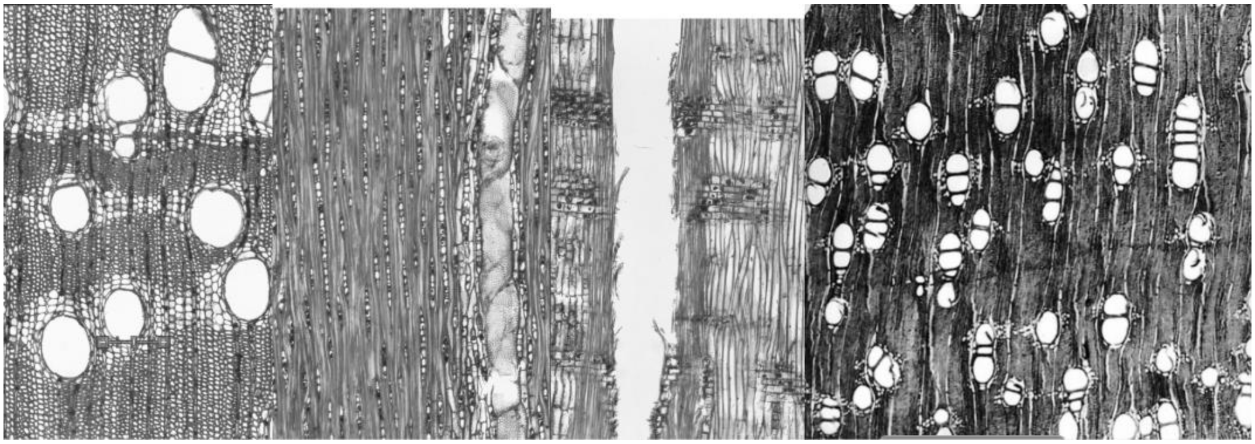
COMBRETACEAE *Laguncularia racemosa*
*(*mangle blanco, white mangrove) *Only species in Costa Rica within this genus*

- Vessels 50-100 µm, 5-20/mm^2, tyloses common
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma vasicentric, diffuse, aliform, confluent



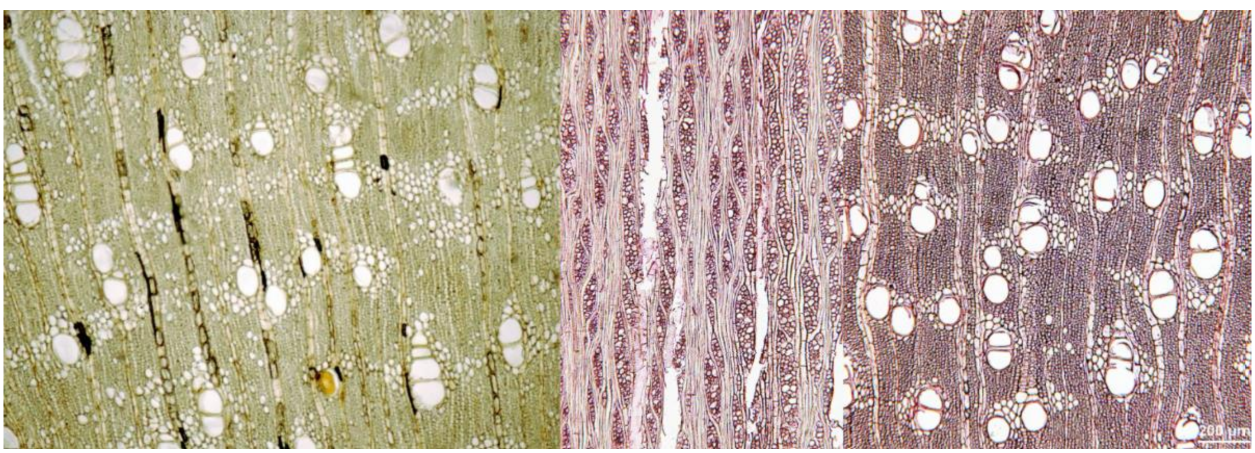
COMBRETACEAE *Terminalia amazonia* *buceras, bucidoides, catappa, costaricensis, oblonga*, *tetraphylla* (amarillo, roble amarillo, carabazuelo)

- Vessels 100-200 µm, 5-20/mm^2, Tyloses common
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma vasicentric, winged, unilateral, marginal bands



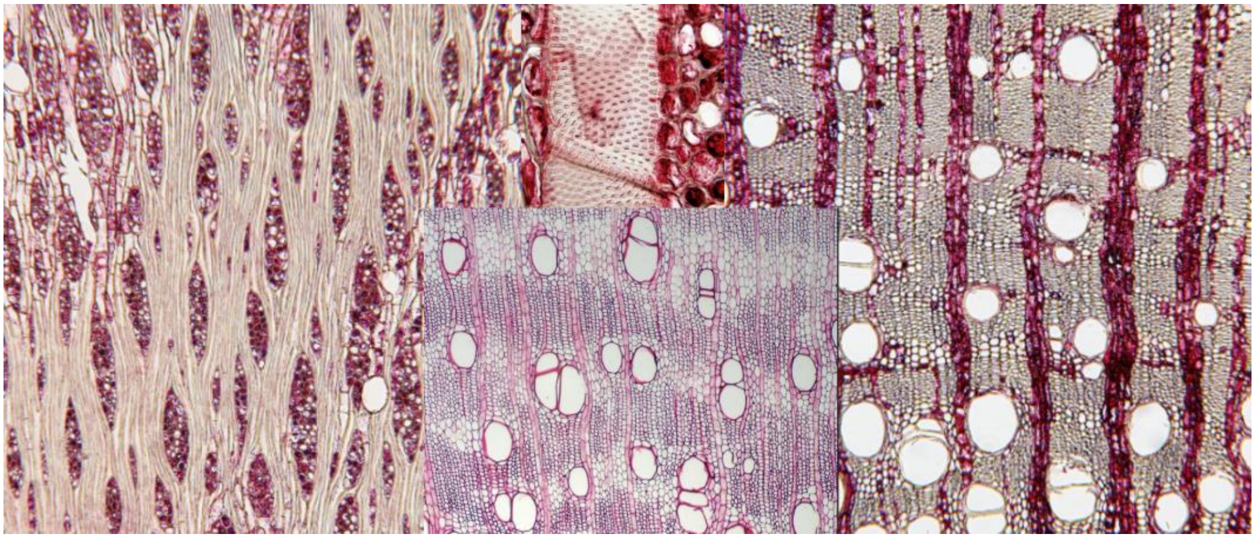
COMBRETACEAE *Terminalia buceras* *(black olive), amazonia, bucidoides, catappa, costaricensis, oblonga, tetraphylla*

- Vessels 50-200 µm, 5-20/mm^2, Gums in heartwood vessels
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma vasicentric, winged, diffuse, confluent



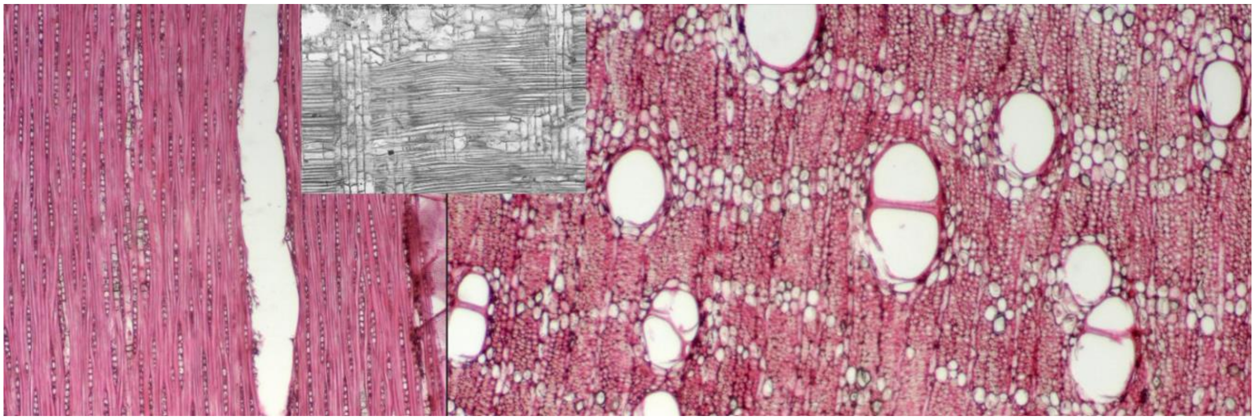
COMBRETACEAE ***Terminalia catappa*** (tropical almond) *amazonia, buceras, bucidoides, oblonga*

- Vessels 100-200+ µm, 5-40/mm^2, Gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12+/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands



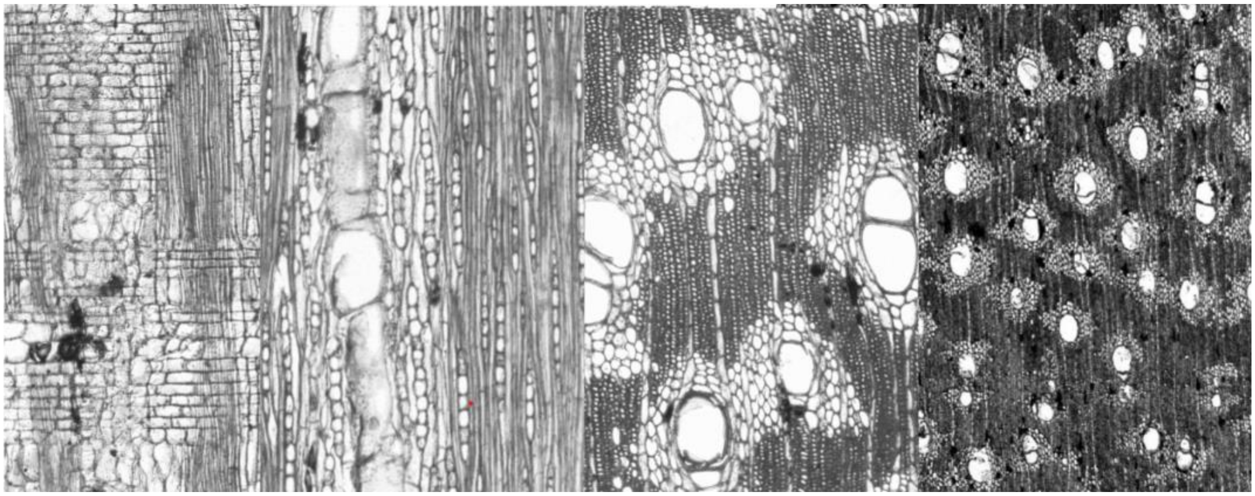
COMBRETACEAE ***Terminalia oblonga*** *amazonia, buceras, bucidoides* (same as oblonga), *catappa, costaricensis, tetraphylla (*guayabo de montaña, guayabillo, guayabón*)*

- Vessels 100-200 µm, <=5-20/mm^2, tyloses common
- Rays exclusively uniseriate, 12+/mm
- Parenchyma scanty, vasicentric, aliform, confluent, unilateral, marginal bands



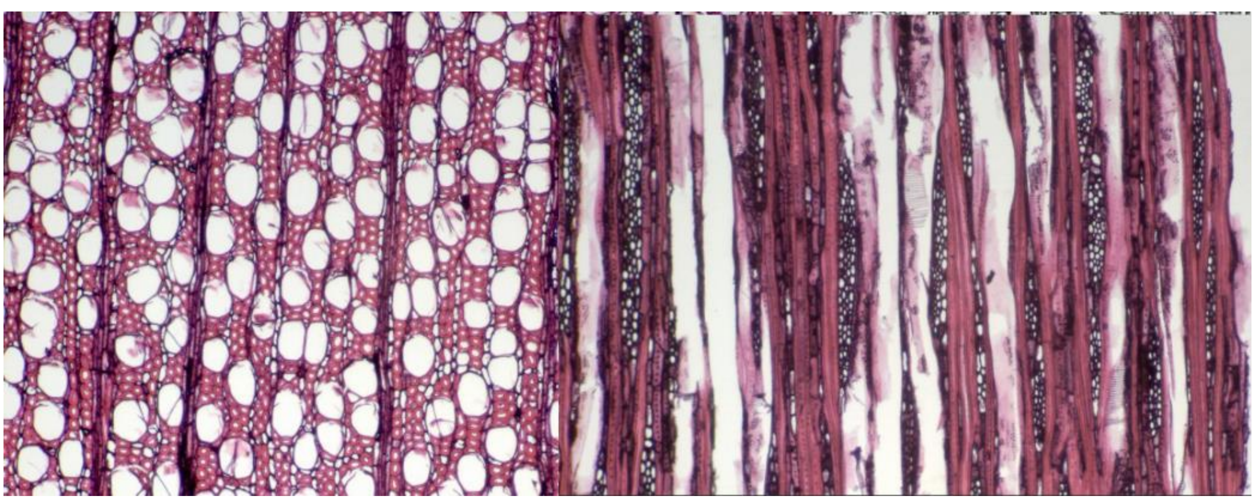
COMBRETACEAE *Terminalia tetraphylla* *amazonia, buceras, bucidoides* (same as oblonga), *catappa*, *costaricensis*, *oblonga (*guayabo de montaña, guayabillo, guayabón*)*

- Vessels 50-200 µm, 5-20/mm^2
- Rays exclusively uniseriate, 4-12, 12+/mm
- Parenchyma scanty, vasicentric, aliform, confluent, marginal bands



CORNACEAE *Cornus disciflora,* (lloró, mata hombro) **,** *florida*, *racemosa*, *peruviana*

- Vessels exclusively solitary, 50-100 µm, 40-100/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, diffuse

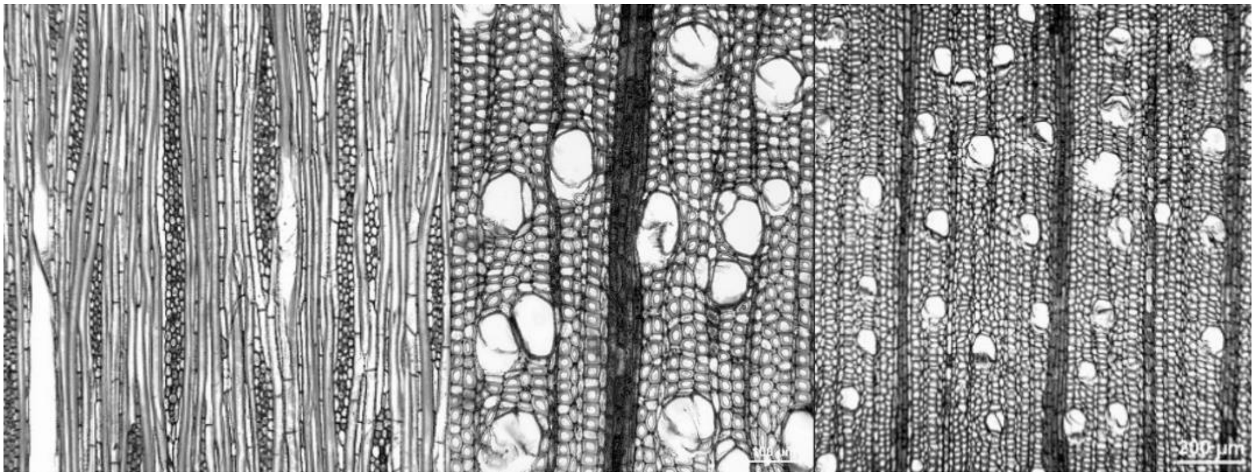


CORNACEAE *Cornus florida,* *disciflora racemosa, peruviana* (lloró, mata hombro)

- Vessels exclusively solitary, 50-100 µm, 20-100/mm^2
- Rays 4 to 10 seriate, of two sizes, 4-12/mm
- Parenchyma scanty, diffuse

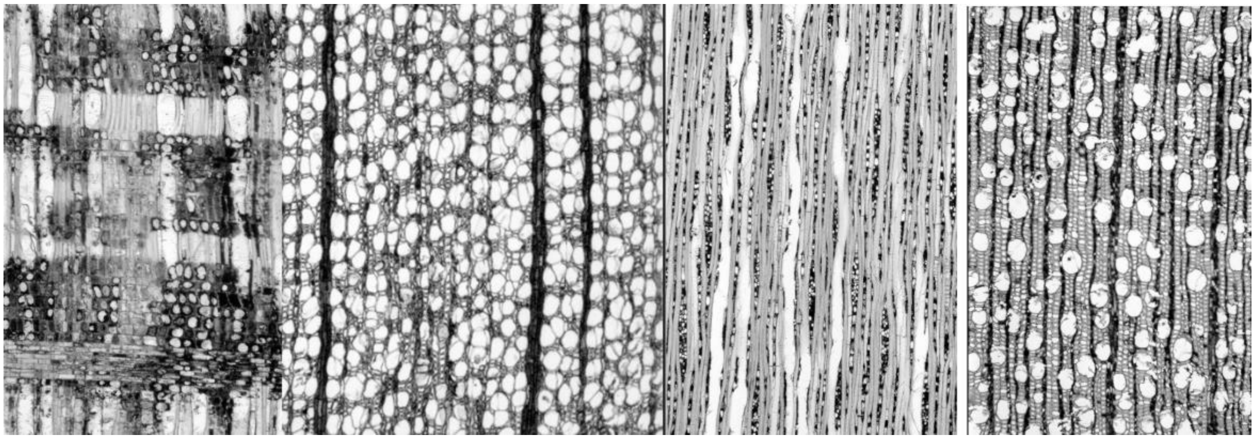
CORNACEAE *Cornus peruviana,* *florida, racemosa, disciflora* (lloró, mata hombro)

- Vessels exclusively solitary, 50-100 µm, 40-100/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, diffuse



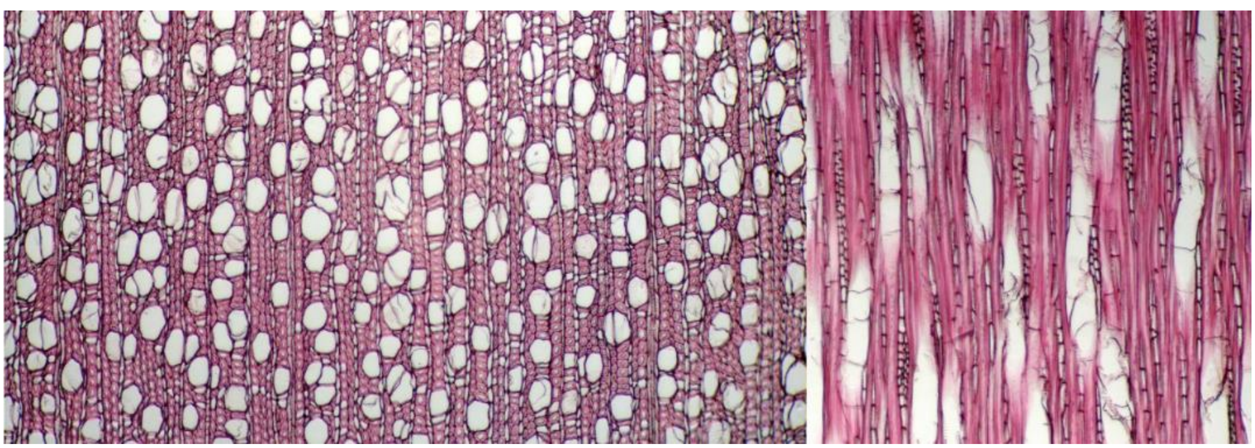
CUNONIACEAE ***Weinmannia pinnata***, (white myrtle, bastard braziletto, arrayán) *balbisiana, fagaroides, horrida, karsteniana, vulcanicola, wercklei*

- Vessels exclusively solitary, <=50-100 µm, 40-100+/mm^2
- Tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent, rare, diffuse



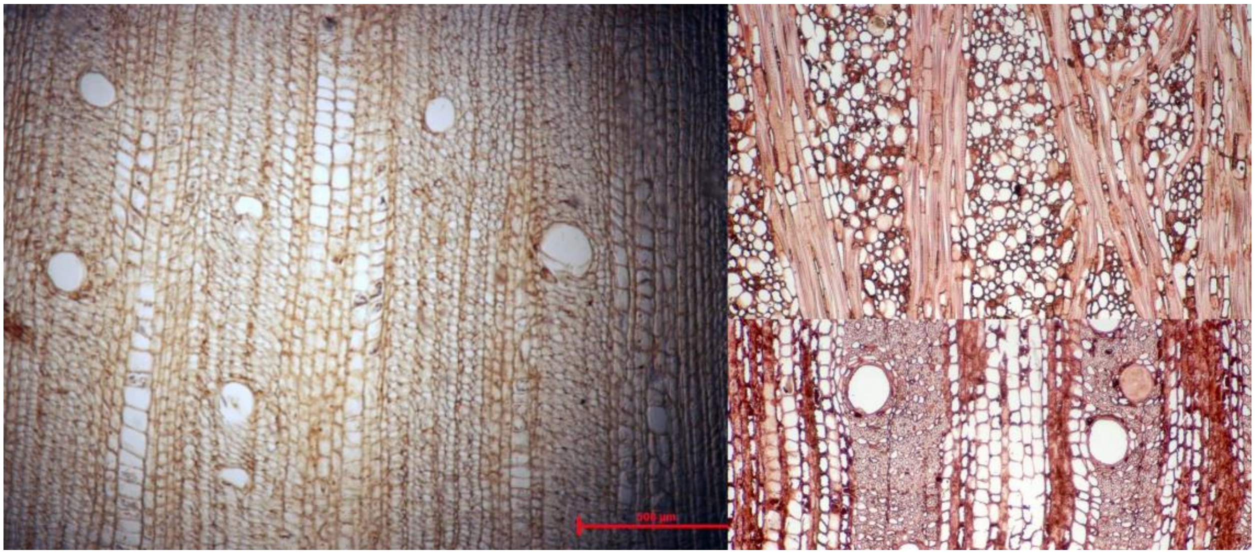
CUNONIACEAE ***Weinmannia wercklei*** *pinnata, balbisiana, fagaroides, horrida, karsteniana, vulcanicola* (arrayán)

- Vessels exclusively solitary, <=50-100 µm, 40-100+/mm^2, Tyloses common
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent, rare, diffuse



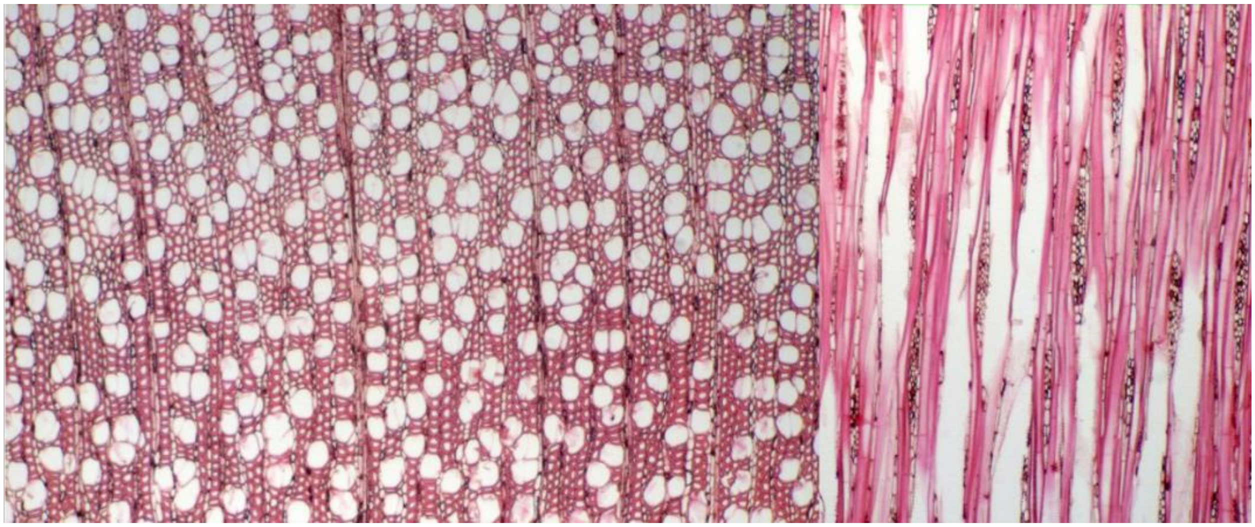
DILLENIACEAE *Curatella americana* (chumico) Only species in Costa Rica within this genus

- Vessels exclusively solitary, 100-200 µm, <=5-20/mm^2, Gums in heartwood vessels
- Rays commonly>10 cells, of two sizes, >=4/mm
- Parenchyma scanty, diffuse in aggregates



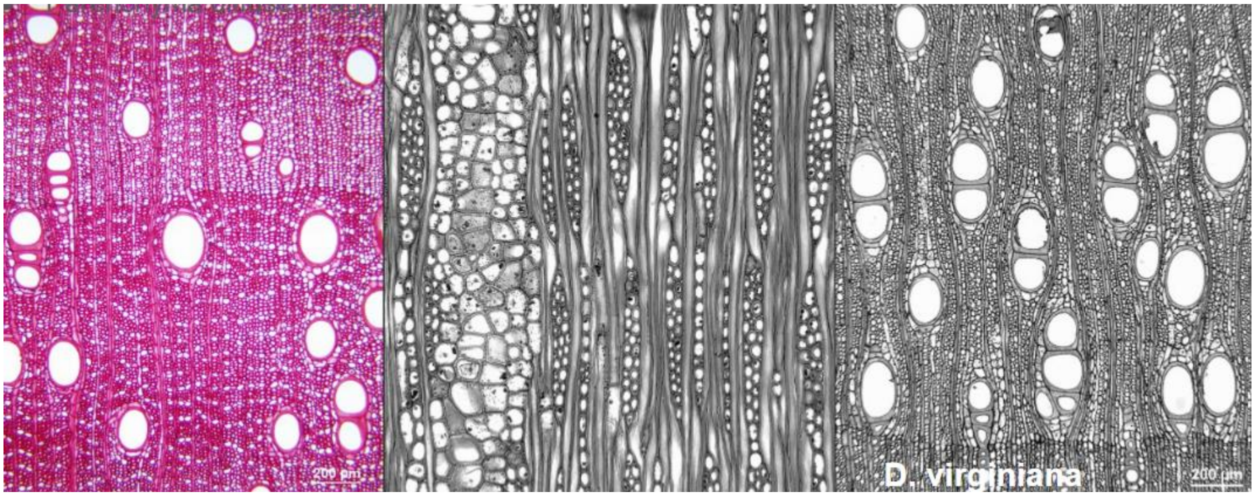
DIPENTODONTACEAE *Perrottetia longistylis,* *multiflora, ovata, sessiflora* (olomea)

- Vessels exclusively solitary, 50-100µm, 40-100/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma absent, rare, diffuse



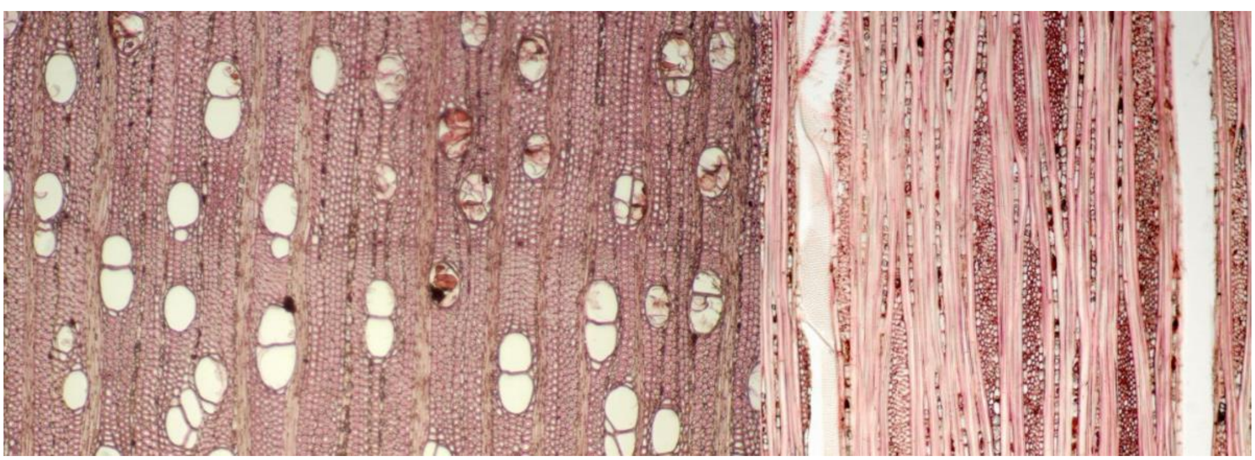
EBENACEAE *Diospyros* (sapote negro) *acapulcensis, blancoi, campechiana, conzattii, crotalaria, digyna, dendo, hartmanniana, loureiriana, salicifolia*

- Vessels 100-200 µm, <=5-20/mm^2, Gums in heartwood vessels
- Rays 1 to 3 cells, 12+/mm
- Parenchyma diffuse in aggregates, vasicentric, reticulate



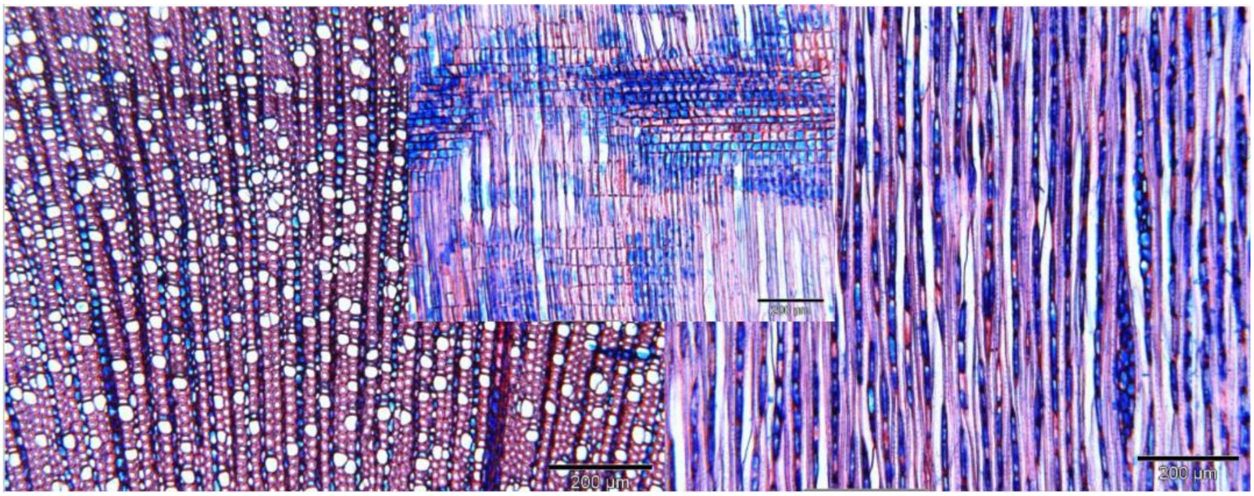
ELAEOCARPACEAE *Sloanea guianensis,* (carabeen, terciopelo, mameicillo, casaco) *ampla, brachytepala, brenesii, damonsmithii, eugenifloresiae, faginea, geniculata, laevigata, longipes, picapica, rugosa, ternifolia, zuliaensis*

- Vessels 50-200µm, 5-40/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma rare, scanty paratracheal, marginal bands



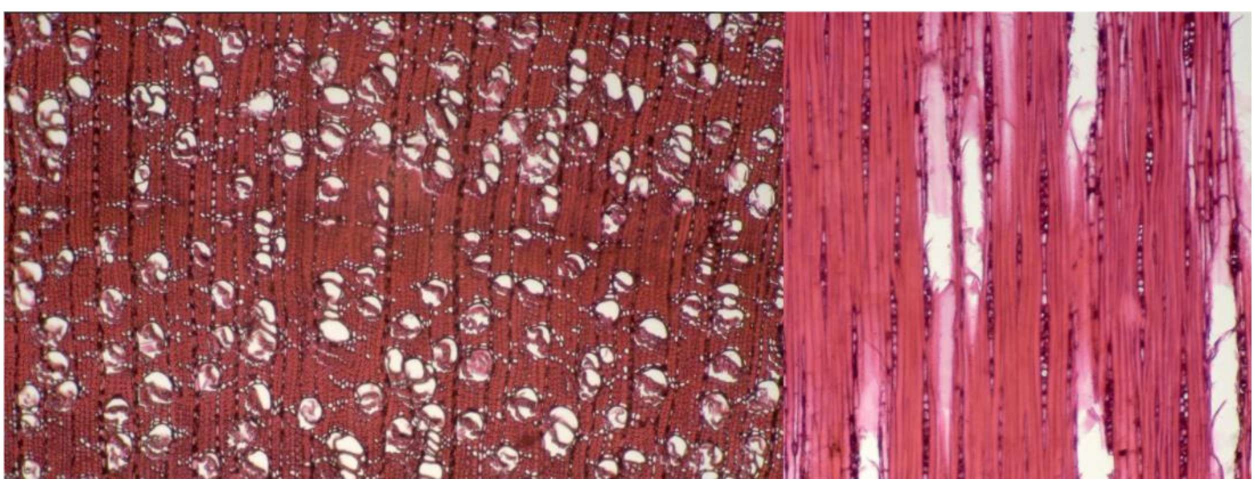
ERICACEAE *Gaultheria erecta*, *G. gracilis* (uvita, mortiño)

- Vessels <50µm, 100+/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, >12/mm
- Parenchyma absent, rare, scanty



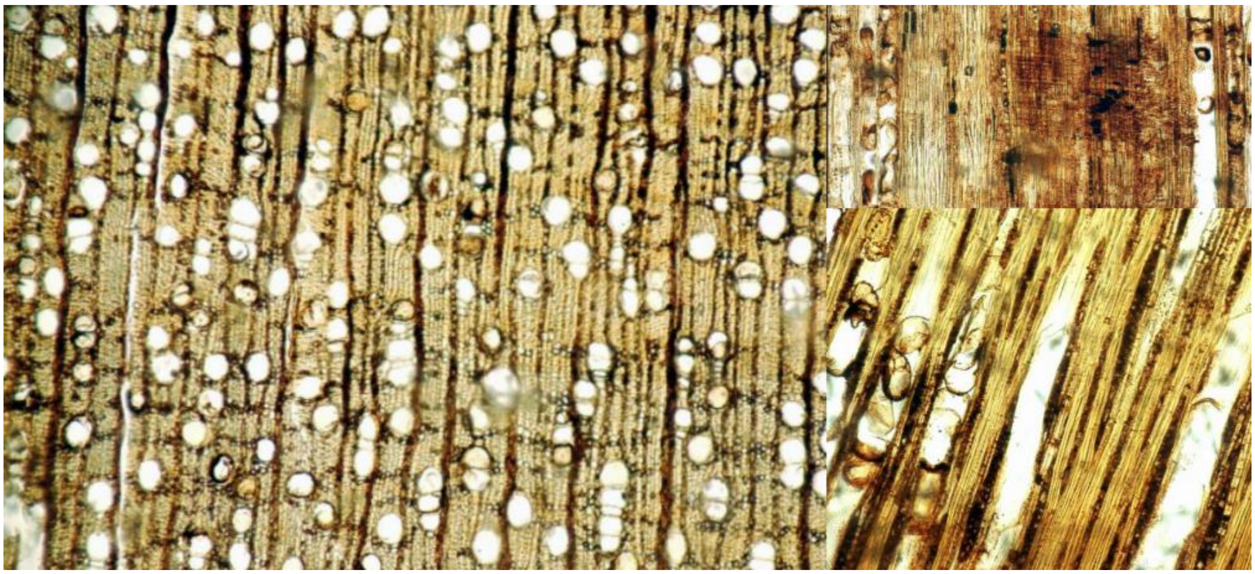
ERYTHROXYLACEAE *Erythroxylum citrifolium* (alcarreto)**,** *macrophyllum, areolatum, coca, confusum, fimbriatum, havanense*

- Vessels 50-100µm, 40-100/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, vasicentric, winged-aliform

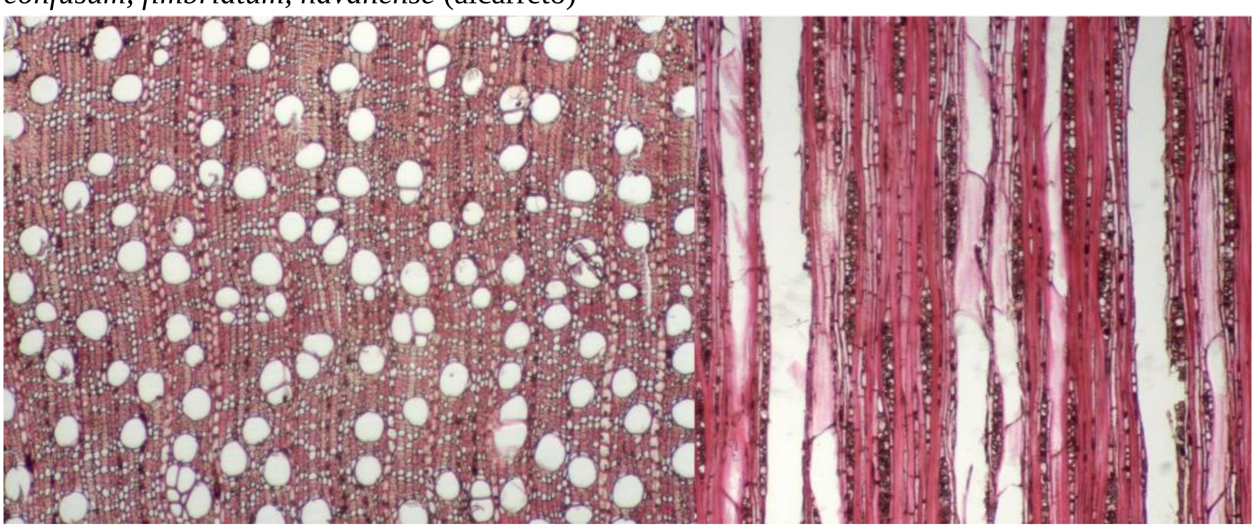


ERYTHROXYLACEAE *Erythroxylum areolatum,*
macrophyllum, citrifolium, coca, confusum, fimbriatum, havanense (alcarreto)

- Vessels 50-100µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates, vasicentric, aliform, confluent

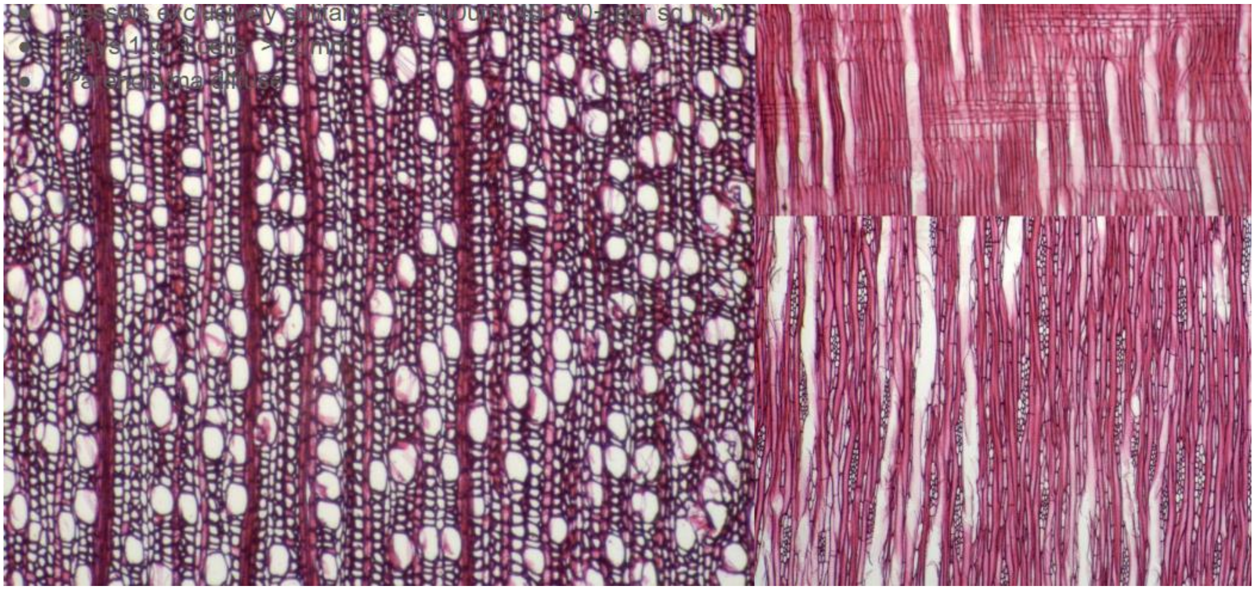


ERYTHROXYLACEAE *Erythroxylum macrophyllum,* *citrifolium, coca, areolatum, confusum, fimbriatum, havanense* (alcarreto)



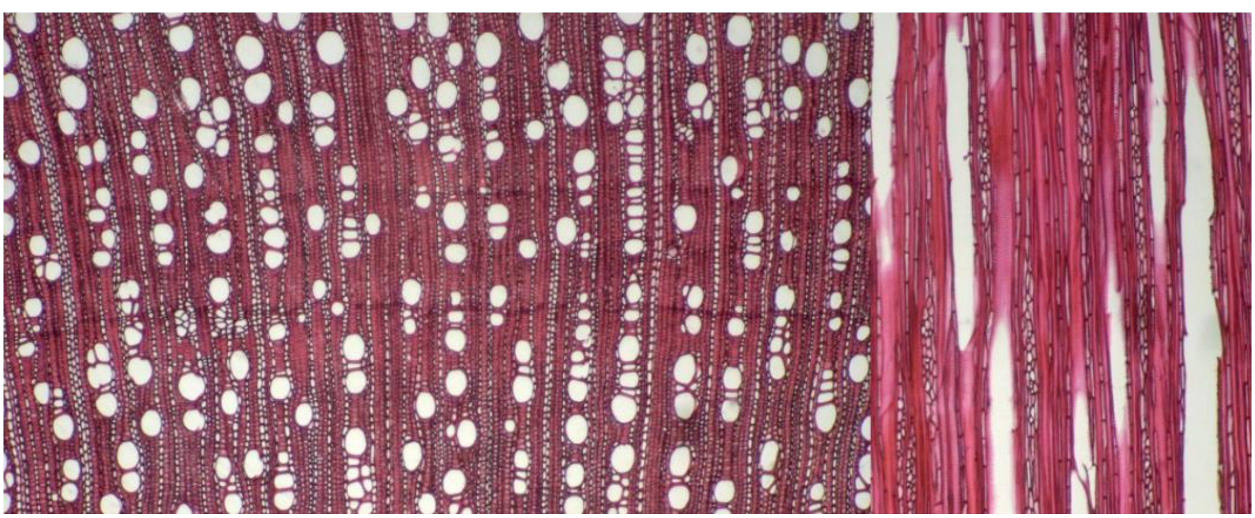
ESCALLONIACEAE *Escallonia poasana* *myrtilloides, tucumanensis, , paniculata, angustifolia* (madrono, corontillo)

- Vessels exclusively solitary, <50-100µm, 40-100+ /mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse



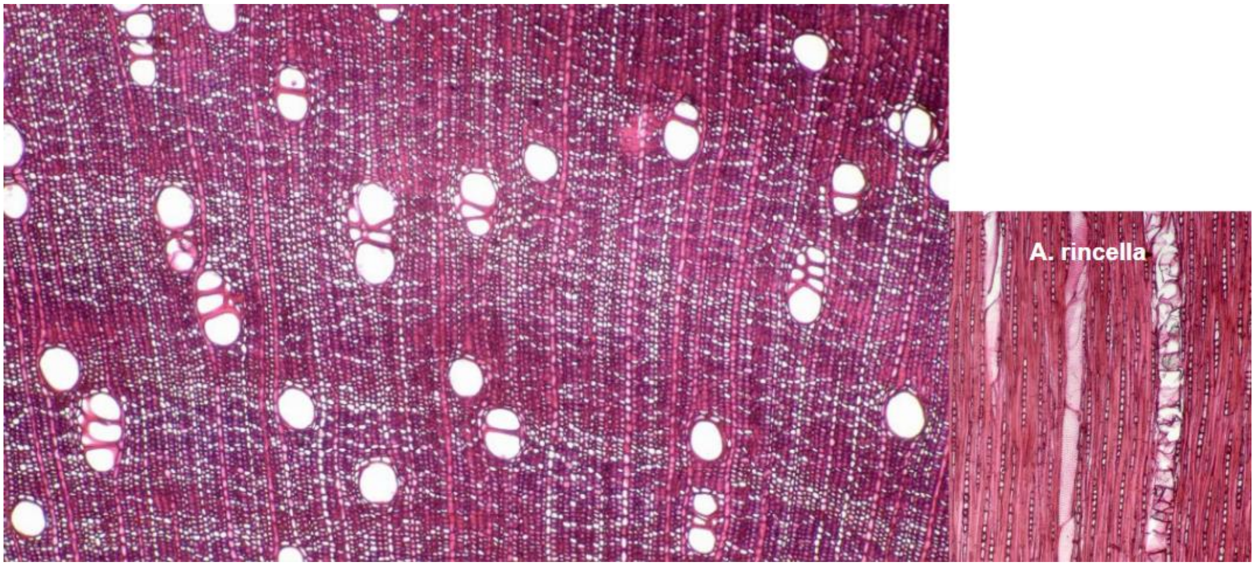
EUPHORBIACEAE *Acalypha diversifolia,* (palito feo, prende-prende) *apodanthes, arvensis, costaricensis, ferdinandii, leptopoda, macrostachya, mortoniana, schiedeana, villosa, wilkesiana*

- Vessels 100-200µm, 20-40/mm^2
- Rays 4-10 iseriate, 12+/mm
- Parenchyma absent or rare



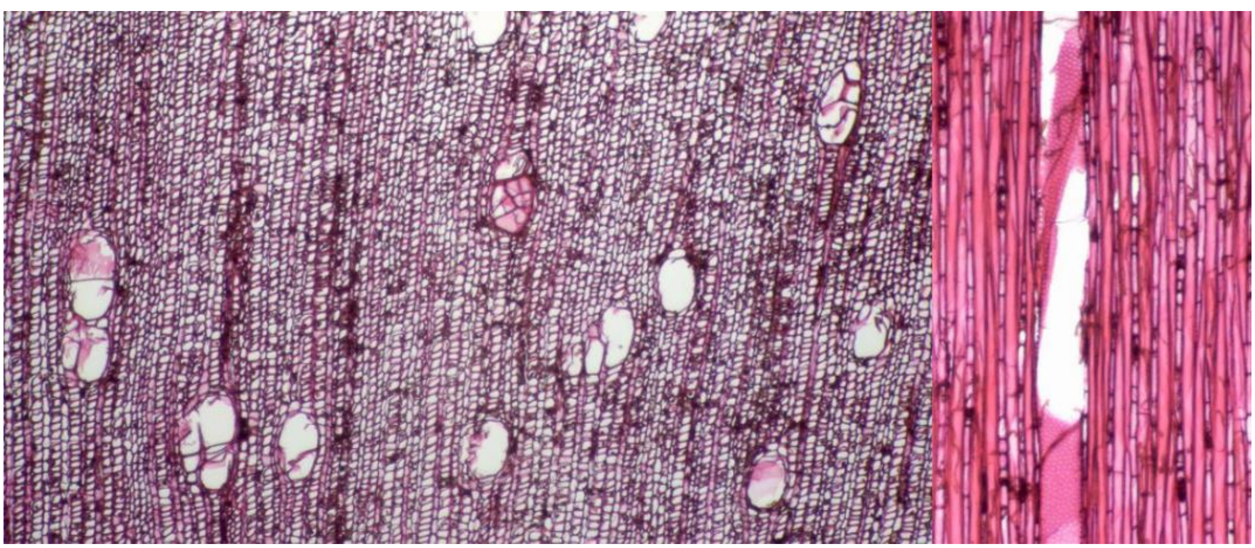
EUPHORBIACEAE *Adelia triloba,* *barbinervis* (espino amarillo, bagre)

- Vessels 50-100µm, <5-20/mm^2
- Rays exclusively uniseriate, 12+/mm
- Parenchyma diffuse in aggregates, narrow bands, reticulate



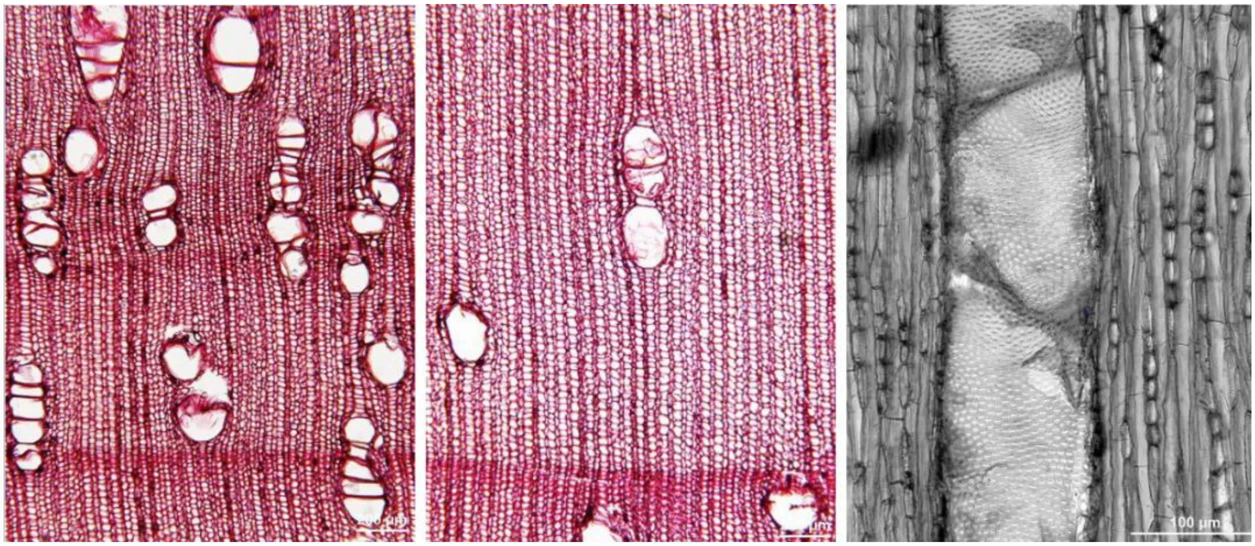
EUPHORBIACEAE *Alchornea grandis,* *costaricensis, glandulosa, latifolia, triplinervia* (achiotillo)

- Vessels 100-200µm, <5-20/mm^2
- Tyloses common
- Rays 1 to 3 cells, 12+/mm
- Parenchyma diffuse in aggregates



EUPHORBIACEAE ***Alchornea latifolia,*** *costaricensis, glandulosa, grandis, triplinervia* (achiotillo)

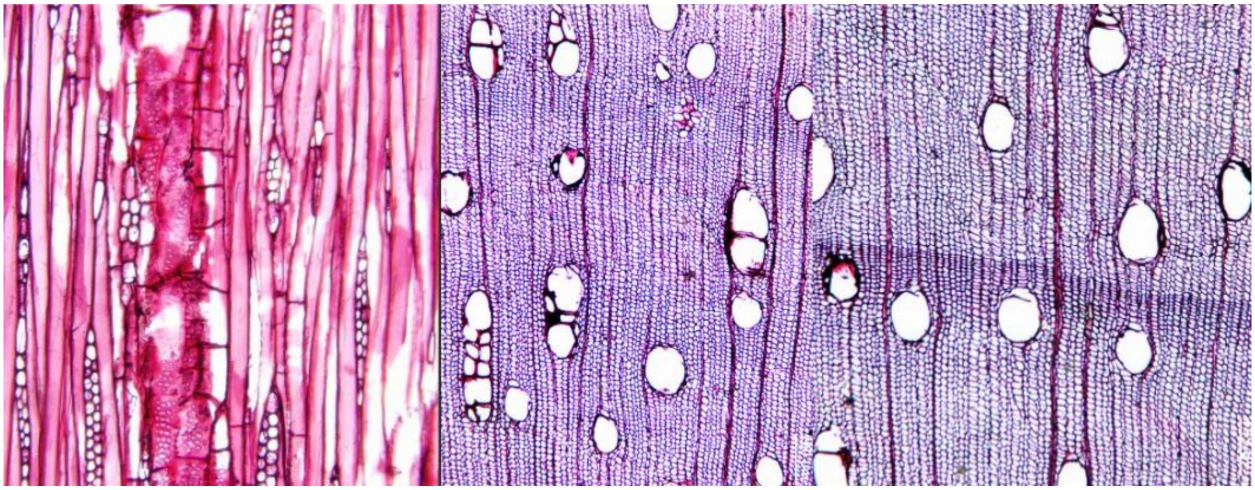
- Vessels 100-200+µm, <5-20/mm^2
- Rays exc. uniseriate, 12+/mm
- Parenchyma diffuse in aggregates



EUPHORBIACEAE ***Croton billbergianus,*** *belintae, decalobus, draco, hirtus, hoffmannii, insularis, morifolius, punctatus, niveus, tonduzii, verreauxii, xalapensis* (sangrillo, sangare, algodoncillo)

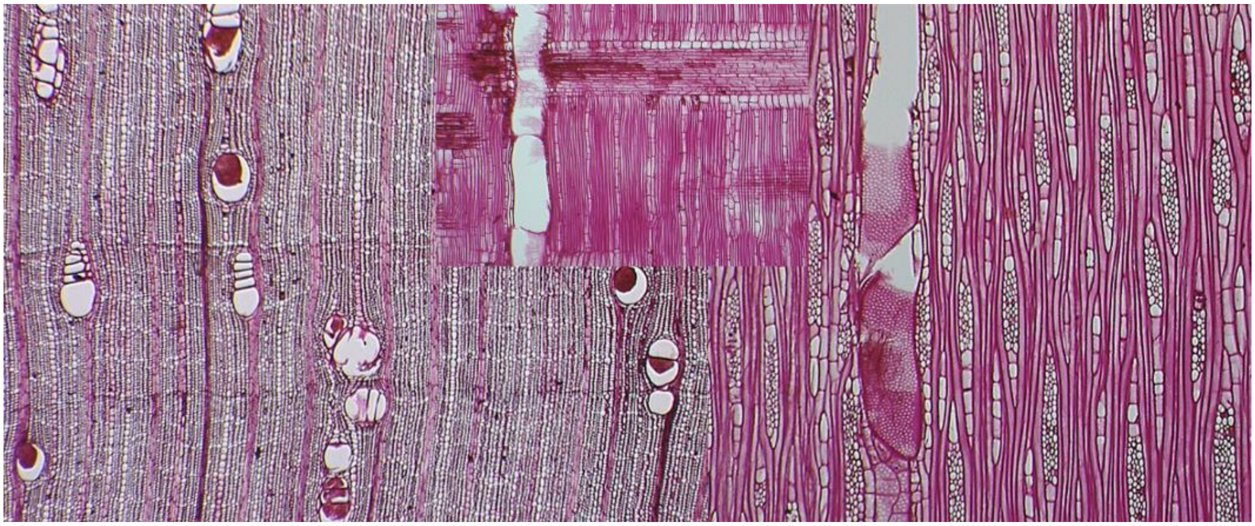
EUPHORBIACEAE ***Croton draco,*** *billbergianus, belintae, decalobus, hirtus, hoffmannii, insularis, morifolius, punctatus, niveus, tonduzii, verreauxii, xalapensis* (sangrillo, sangare, algodoncillo)

- Vessels 100-200µm, <5 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, scanty

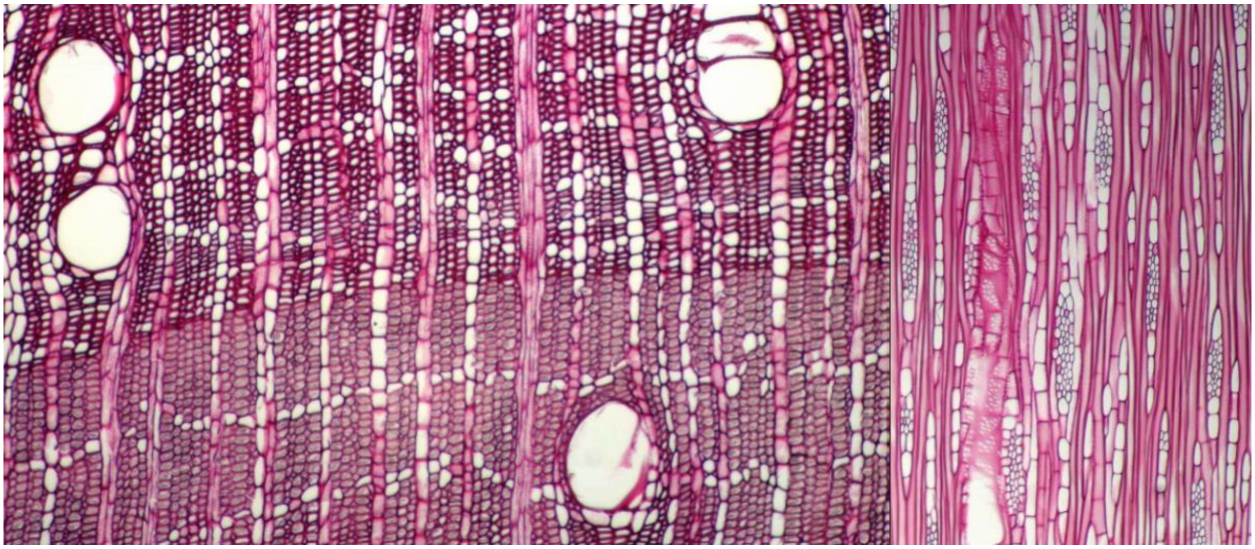


EUPHORBIACEAE ***Hevea brasiliensis,*** *nitida, pauciflora* (rubber, caucho)

- Vessels 100-200+µm, <5-20/mm^2, tyloses common **(rubber, caucho)**
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma marginal, reticluate, narrow bands



EUPHORBIACEAE *Hevea pauciflora,* *brasilienses, nitida* (rubber, caucho)

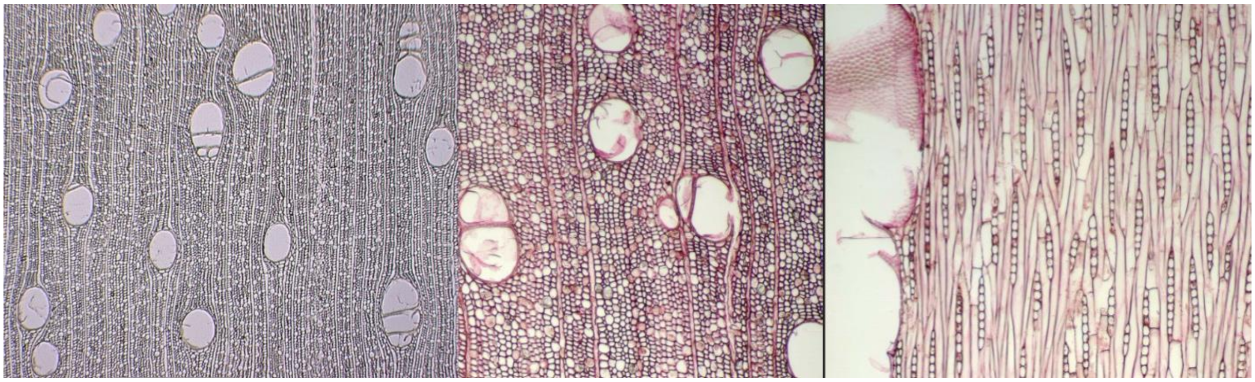


EUPHORBIACEAE *Hippomane mancinella* (manzanillo de la playa, manchineel, manzanillo)
Only species in Costa Rica within this genus

- Vessels 50-200µm, 5-20/mm^2
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma diffuse in aggregates, narrow bands

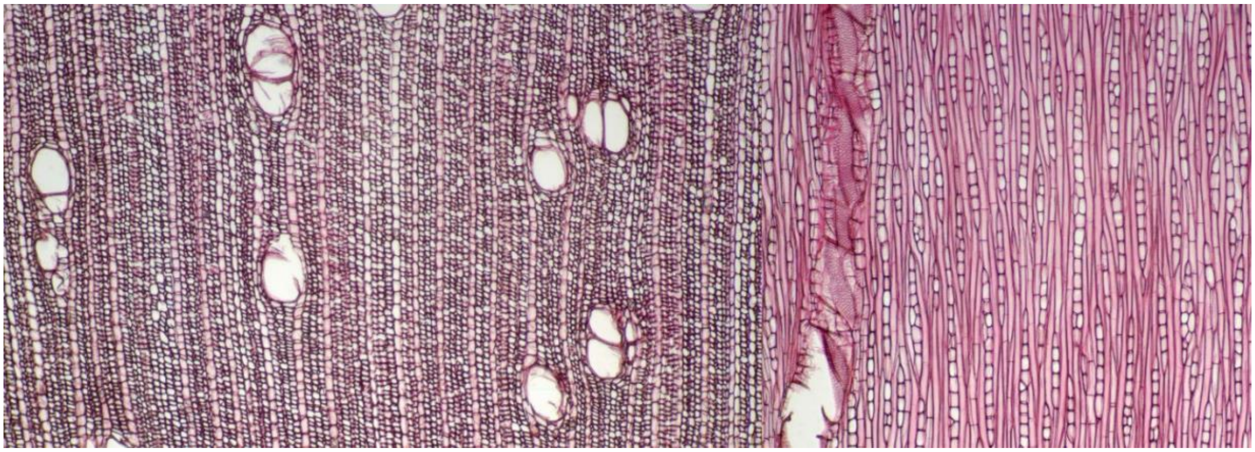
EUPHORBIACEAE ***Hura crepitans*** (nuno, tronador, havillo, ceibo, sandbox tree) *Only species in Costa Rica within this genus*

- Vessels 100-200+µm, <5-20/mm^2
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma diffuse in aggregates, narrow bands



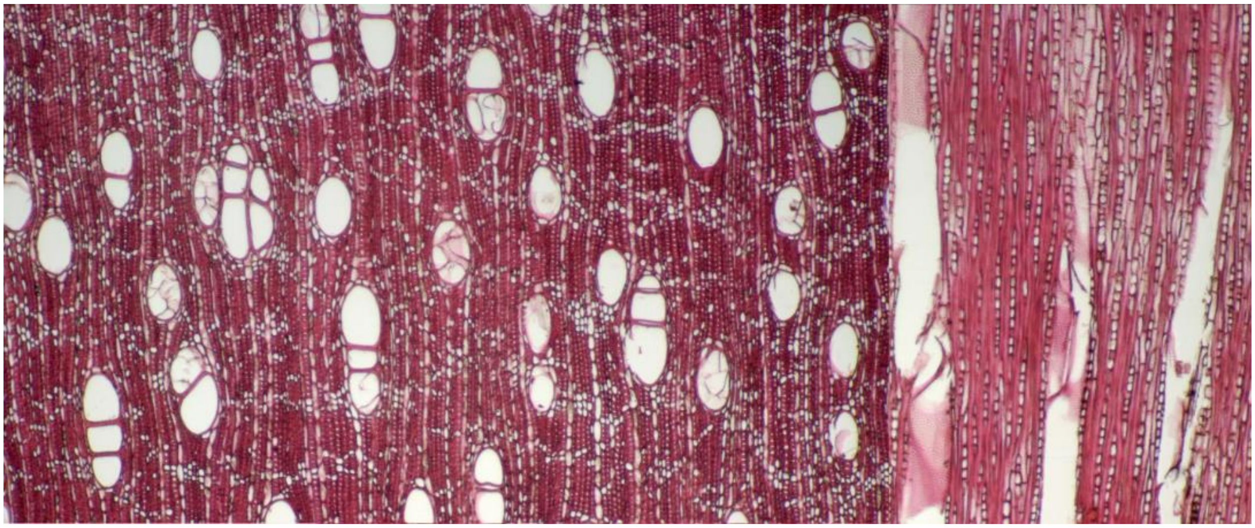
EUPHORBIACEAE ***Jatropha curcas,*** *costaricensis, gossypifolia, integerrima, podacrica, stevensii* (coquillo)

- Vessels 100-200µm, <5-20/mm^2
- Rays exclusively uniseriate, 1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates



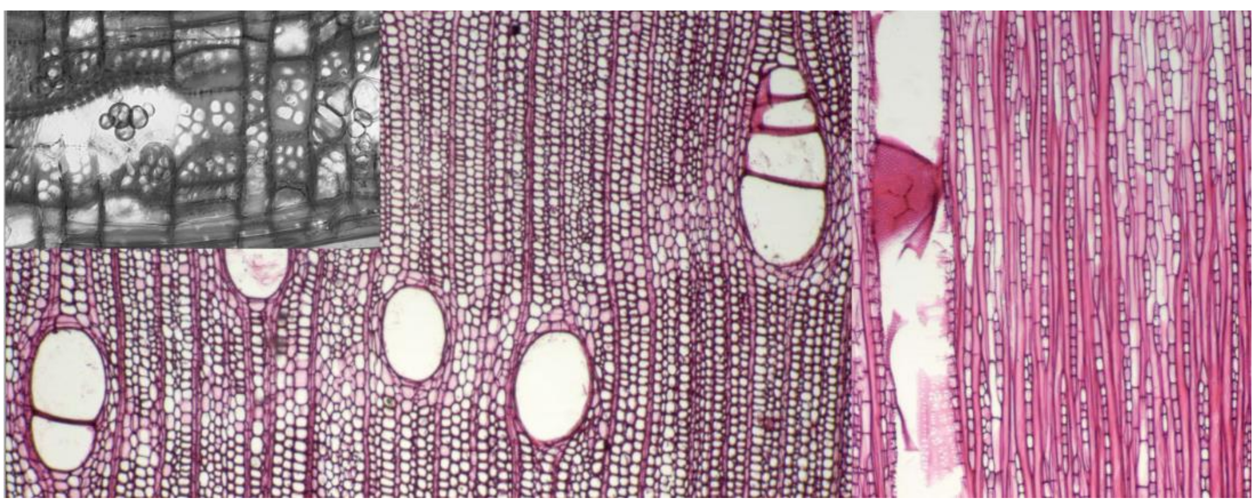
EUPHORBIACEAE *Mabea montana,* (casiquillo) *anadena, excelsa, occidentalis, klugii*

- Vessels 100-200µm, 20-40/mm^2, tyloses common
- Rays 1 to 3, 12+/mm
- Parenchyma scanty



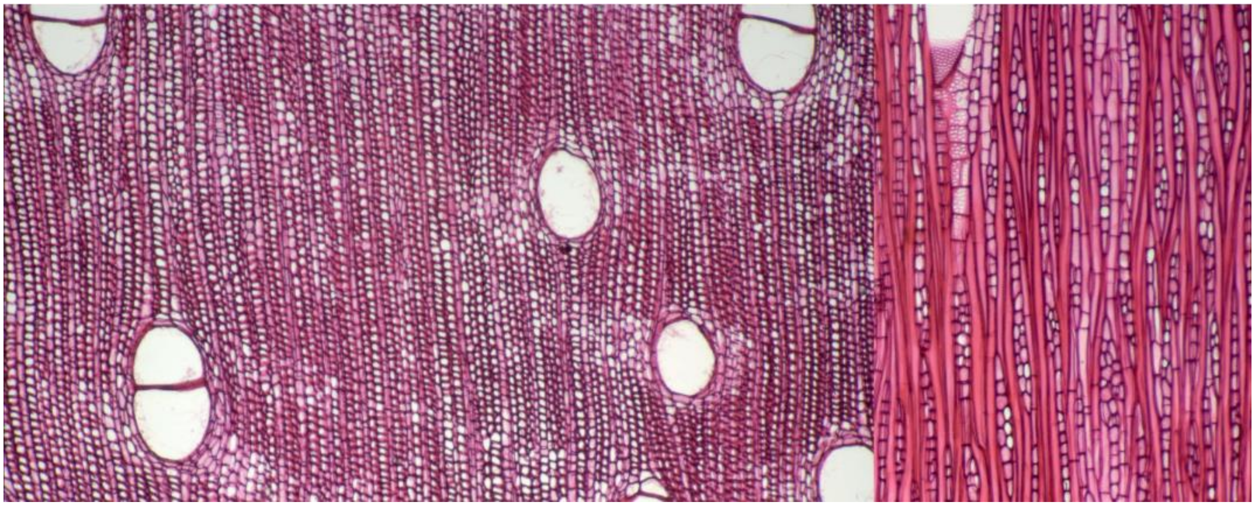
EUPHORBIACEAE *Manihot glaziovii,* *esculenta, aesculifolia, brachyloba*
(cassava, ceara rubber tree)

- Vessels 100-200µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, narrow bands



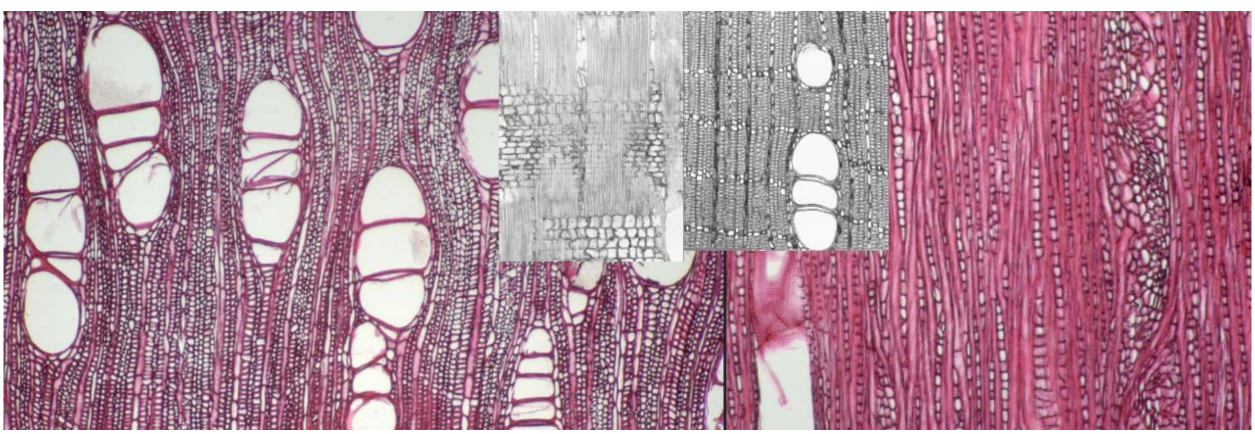
EUPHORBIACEAE *Manihot esculenta,* (manioc, yuca) *glaziovii, aesculifolia, brachyloba*

- Vessels 100-200µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, narrow bands



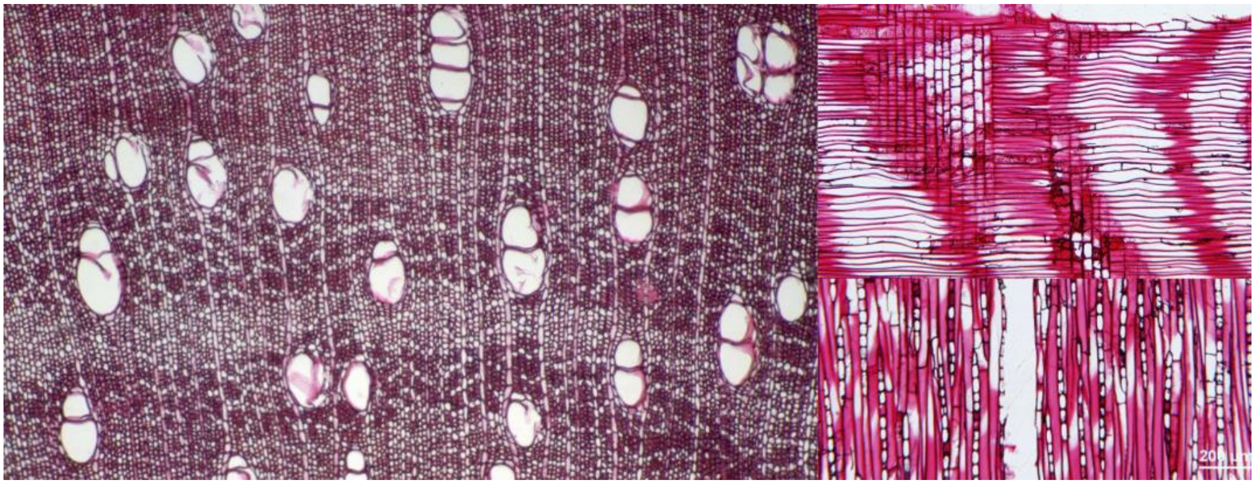
EUPHORBIACEAE *Pera arborea,* *oppositifolia* (sapito, clavito, pellejo de gallina, felí)

- Vessels 100-200µm, <5-20/mm^2
- Rays exclusively uniseriate, 12+/mm
- Parenchyma reticulate, narrow bands



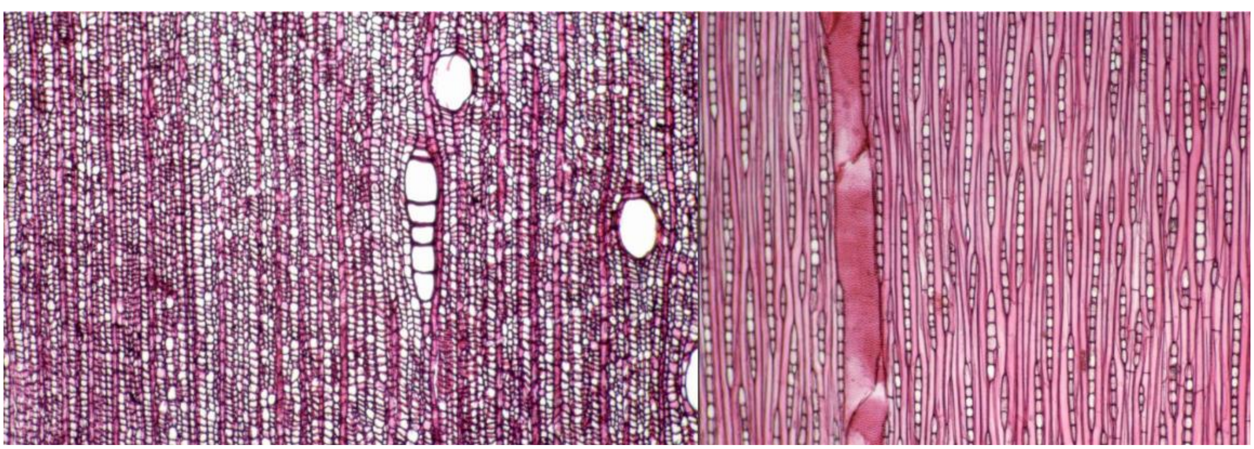
EUPHORBIACEAE ***Sapium glandulosum,*** *allenii, laurifolium, pachystachys, rigidifolium, macrocarpum* (olivo)

- Vessels 100-200+µm, <5-20/mm^2
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma diffuse in aggregates, narrow bands, reticulate



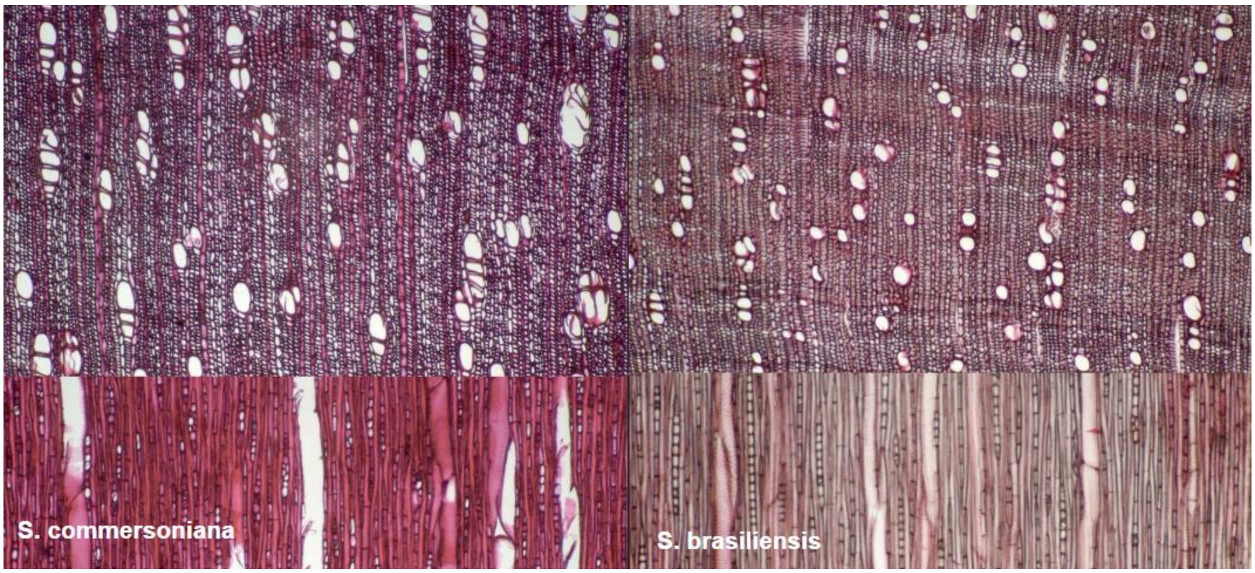
EUPHORBIACEAE ***Sapium laurifolium,*** (olivo) *allenii, glandulosum, pachystachys, rigidifolium, macrocarpum*

- Vessels 100-200µm, <5/mm^2, tyloses common
- Rays exclusively uniseriate, 1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates



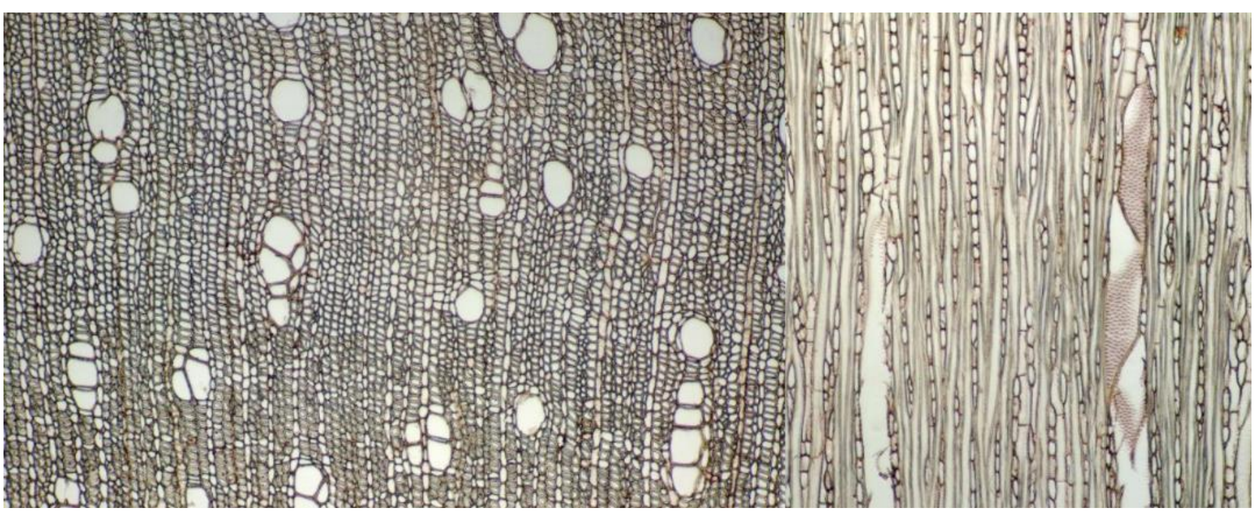
EUPHORBIACEAE *Sebastiania* *pavoniana, panamensis, tuerckheimiana, cruenta, corniculata* (milkwood)

- Vessels 50-200µm, 5-20 /mm^2
- Rays exclusively uniseriate, >12/mm
- Parenchyma diffuse in aggregates, scanty



EUPHORBIACEAE *Tetrorchidium* *costaricense, euryphyllum, gorgonae, rotundatum* (no known common name)

- Vessels 100-200µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates, narrow bands, reticulate

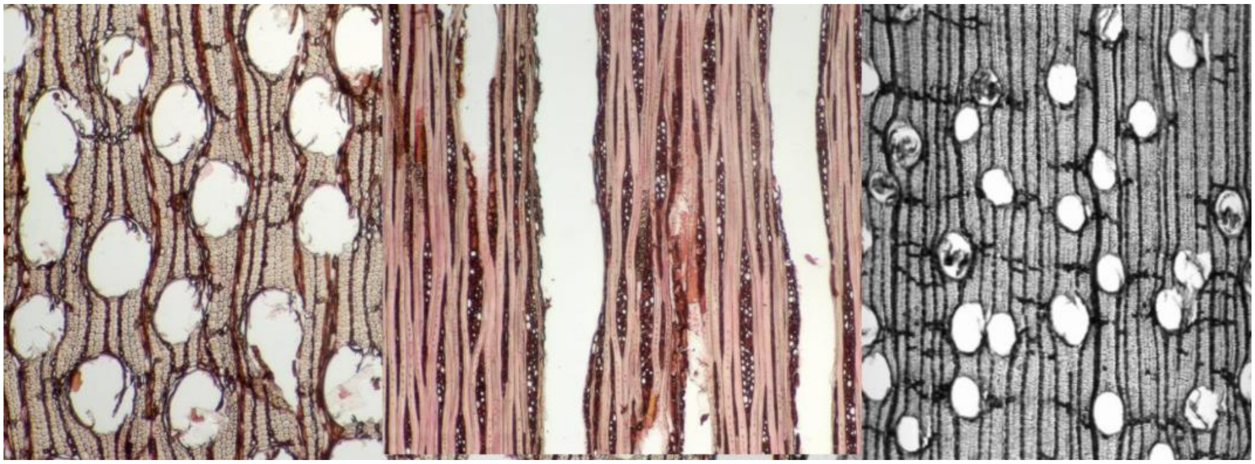


FAGACEAE *Quercus acutissima,* (roble, encino) *benthamii, bumelioides, copeyensis, corrugata, cortesii, costaricensis, insignis, nigra, virginiana, rugosa, salicifolia, segoviensis, tonduzii*

- Vessels exclusively solitary, +200µm, tyloses common
- Rays of two distinct sizes, 4-12/mm
- Parenchyma diffuse in aggregates

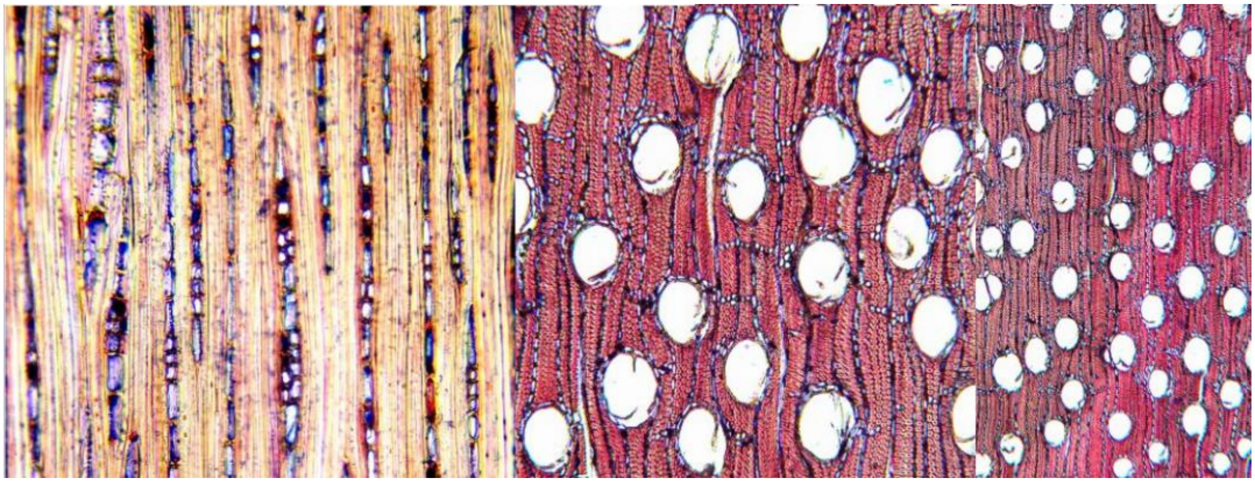
HUMIRIACEAE *Humiriastrum* *diguense* (corocito, corozo) ***Images of H. excelsum***

- Vessels 5 to 20/mm^2, 100-200µm
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma vasicentric, alifrom, unilateral



HUMIRIACEAE *Sacoglottis* *trichogyna* ***images of S. guianensis*** (corocito, corozo)

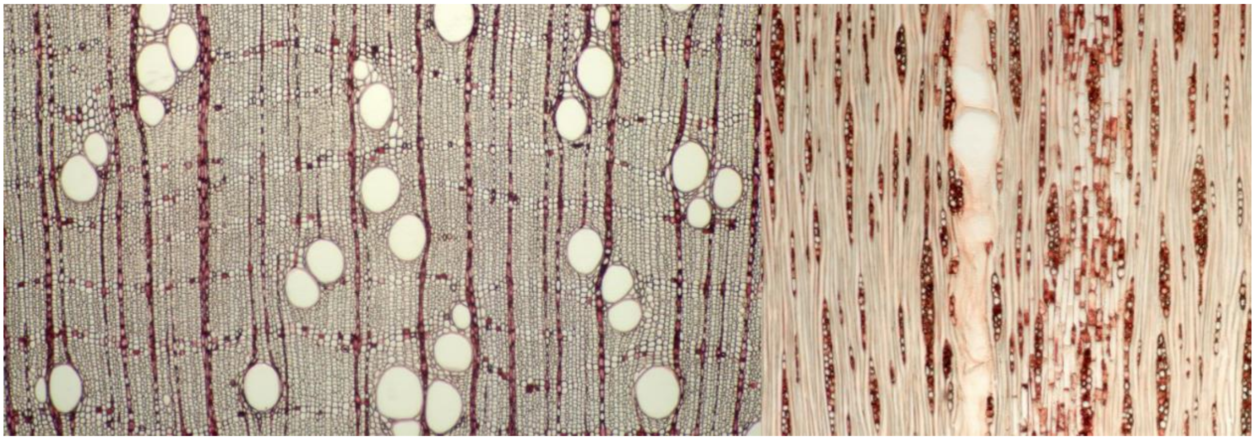
- Vessels exclusively solitary, 100-200µm, 5-20/mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse in aggregates, scanty, unilateral



HYPERICACEAE *Vismia* *baccifera*, *billbergiana*, *macrophylla* (pinta mozo, achiote, sangrillo)

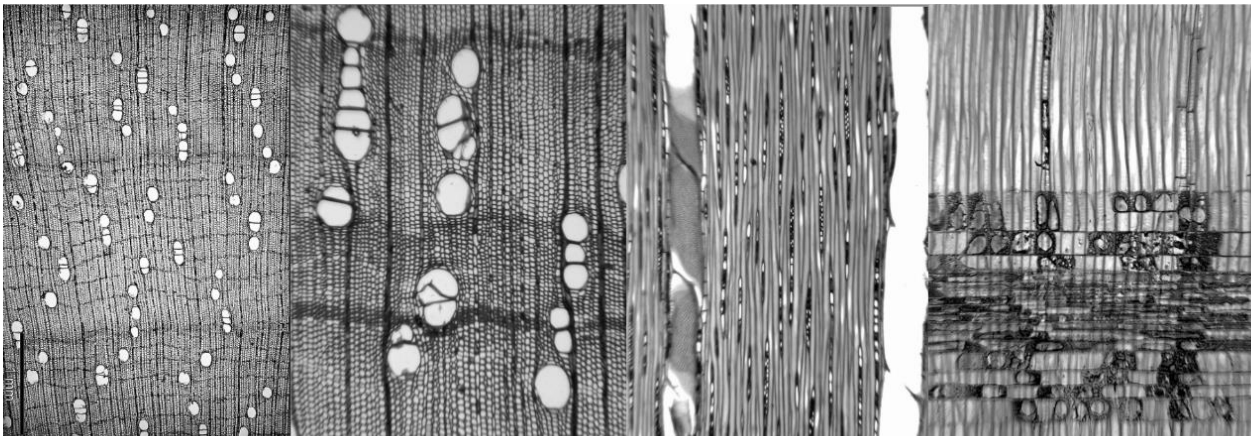
→ images of *V. macrophylla*, technical description of *V. baccifera*

- Vessels 5-20/mm^2, 100-200µm
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma scanty paratracheal, narrow bands, scalariform



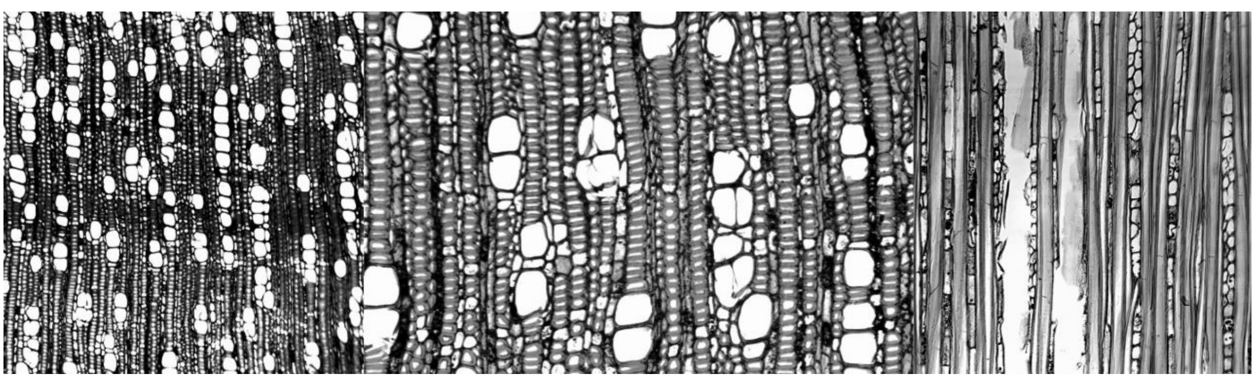
JUGLANDACEAE *Alfaroa costaricensis* (campano chile)

- Vessels in diagonal or radial pattern, 100-200µm, 5-20/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma vasicentric, narrow bands, scalariform



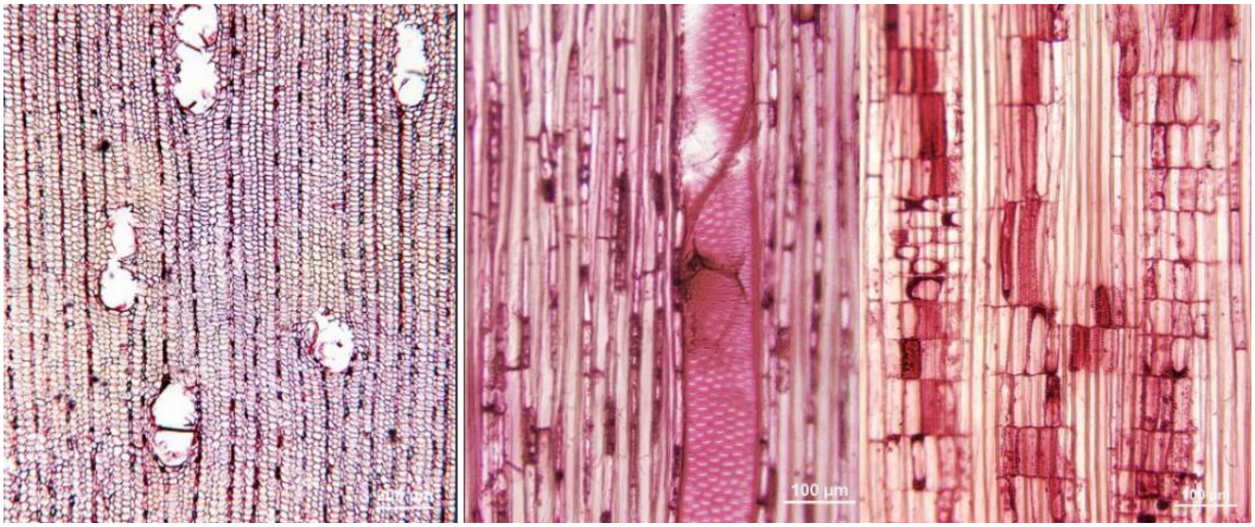
LACISTEMATACEAE *Lacistema aggregatum* (huesito)
only species within this genus in Costa Rica

- Vessels 50-100 µm, 20-40/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse



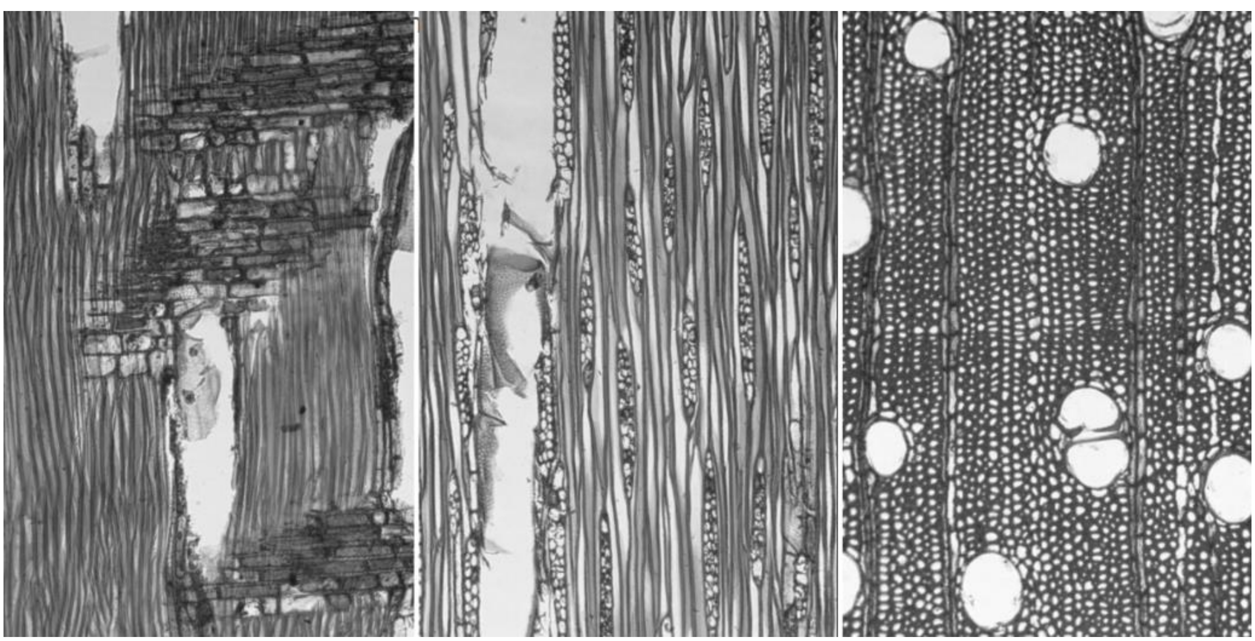
EUPHORBIACEAE ***Alchornea glandulosa,*** *costaricensis, grandis, latifolia, triplinervia* (achiotillo)

- Vessels 100-200µm, <5-20/mm^2
- Tyloses common
- Rays 1 to 3 cells, 12+/mm
- Parenchyma diffuse in aggregates



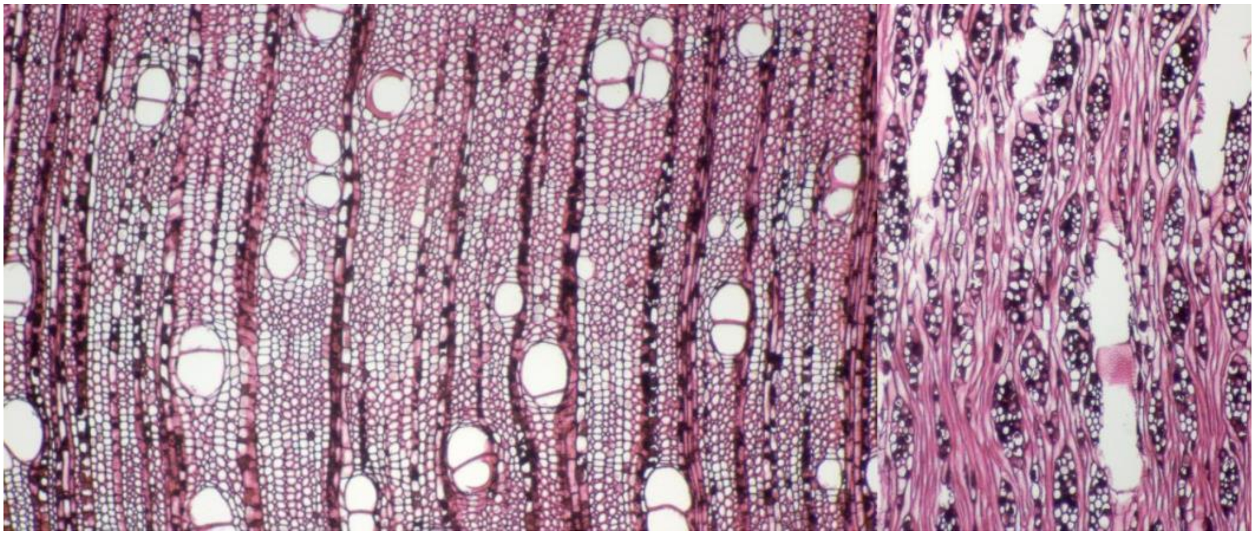
LAMIACEAE ***Vitex guameri,*** *cooperi, cymosa,* (cuajado, flor azul)

- Vessels 50-200 µm, 5-20/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, vasicentric

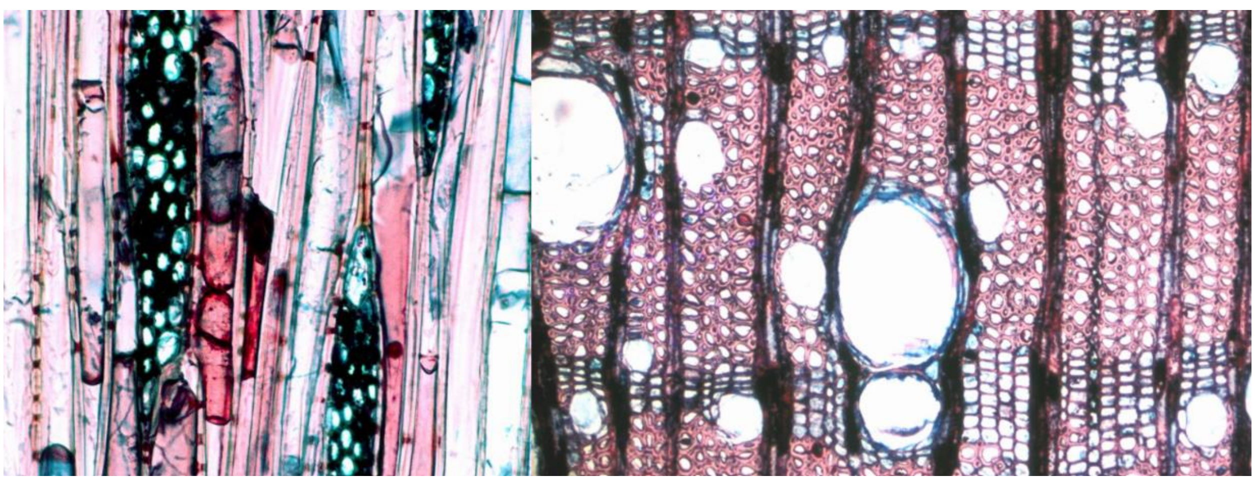


LAURACEAE *Beilschmiedia ovalis,* *brenesii, pendula, alloiophylla, costaricensis, tovarensis* (aguacatillo, torpedo)

- Vessels 100-200 µm, <5-20/mm^2
- Rays 1 to 3 cells, commonly 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands

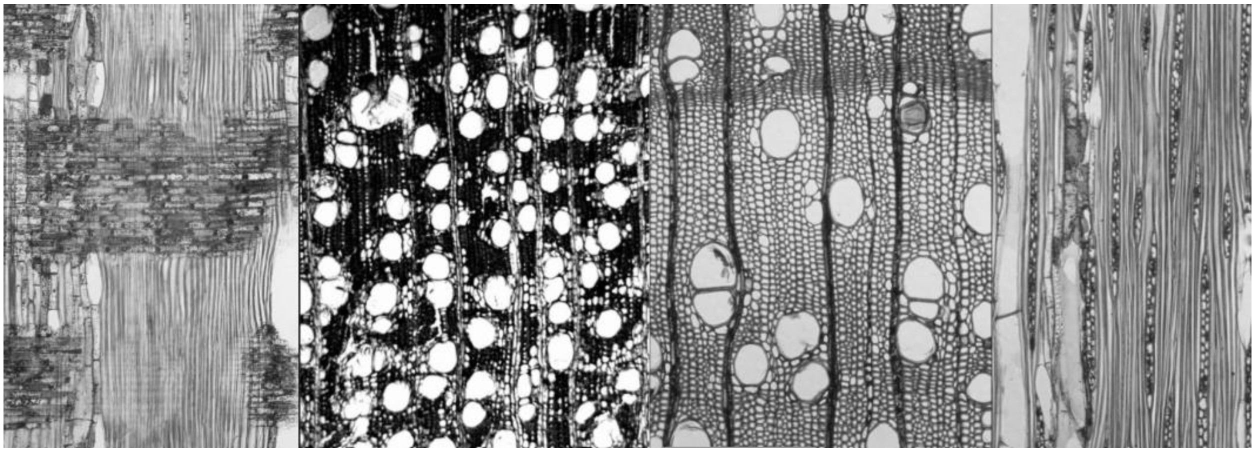


LAURACEAE *Beilschmiedia costaricensis,* *brenesii, pendula, alloiophylla, ovalis, tovarensis* (aguacatillo, torpedo)

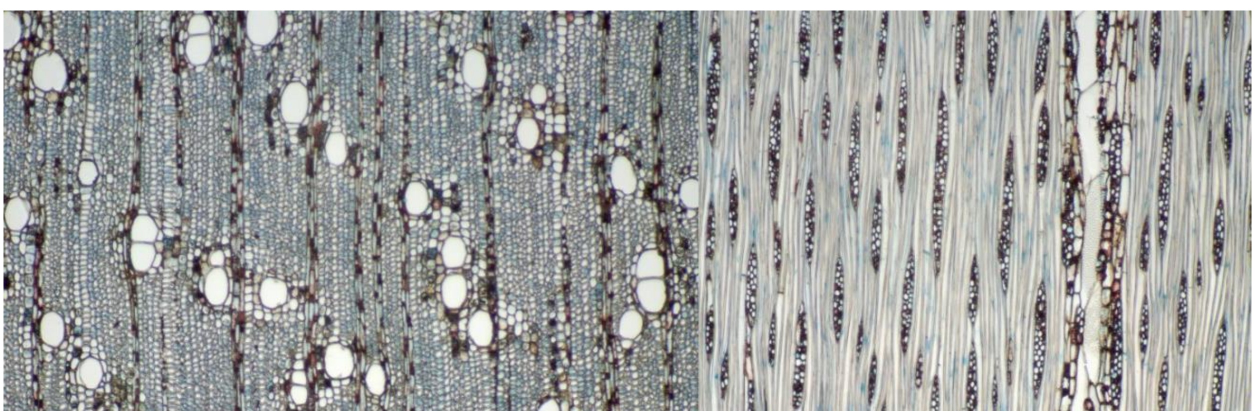


LAURACEAE *Cinnamomum verum (*not native- but the others are), *costaricanum, chavarrianum, hammelianum, neurophyllum, tonduzii, triplinerve* (sigua, sigua blanca)

- Vessels 100-200µm, 5-40/mm^2
- Rays 1 to 3 cells, 4 to 10, 4-12/mm
- Parenchyma in narrow bands

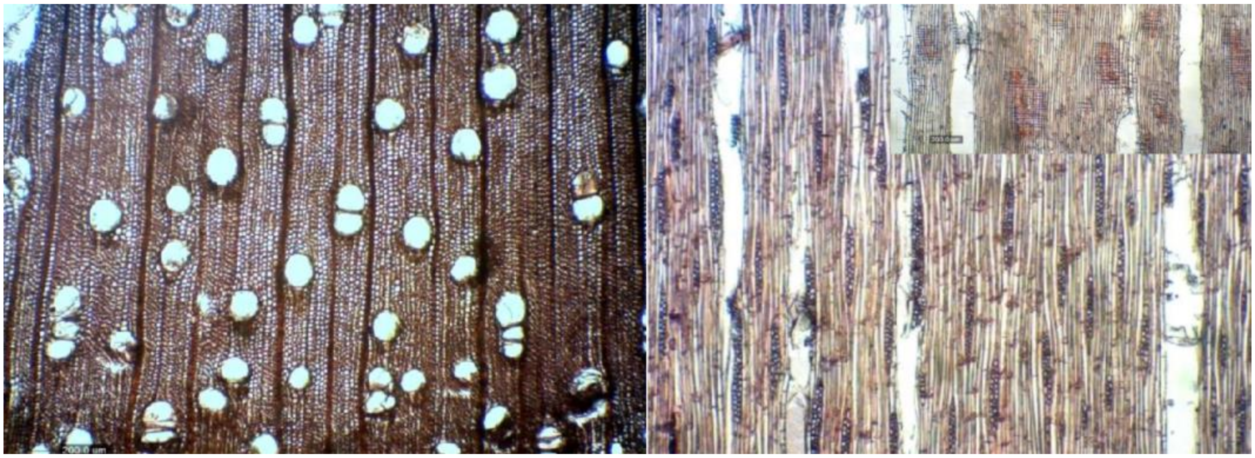


LAURACEAE *Nectandra cufodontisii,* (sigua) *hihua, hypoleuca, lineata, longipetiolata, membranacea, purpurea, reticulata, salicina, smithii, umbrosa*



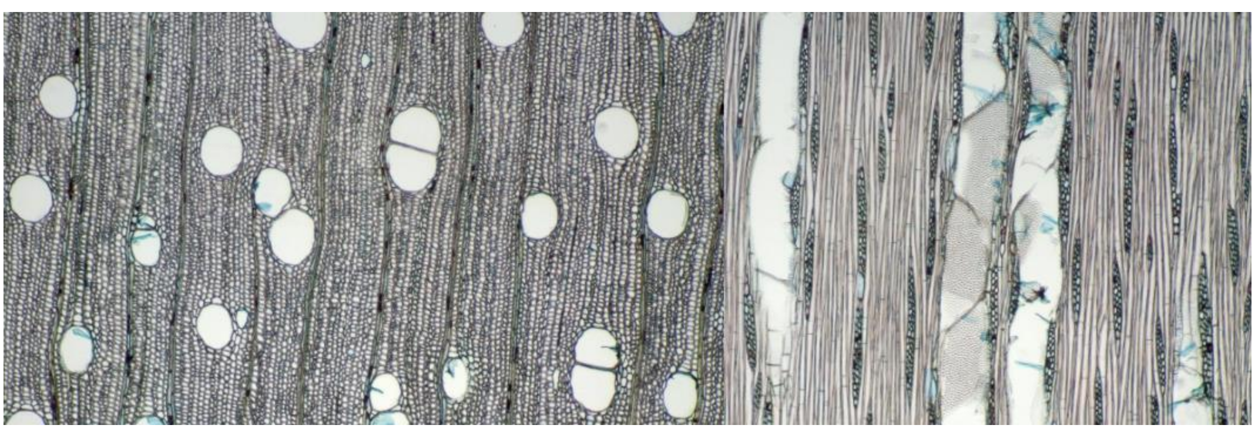
LAURACEAE *Nectandra membranacea,* (sigua) *cufodontisii, hihua, hypoleuca, lineata, longipetiolata, purpurea, reticulata,salicina, smithii, umbrosa*

- Vessels 100-200+µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty paratracheal
- Simple perforation plates, intervessel pits alternate

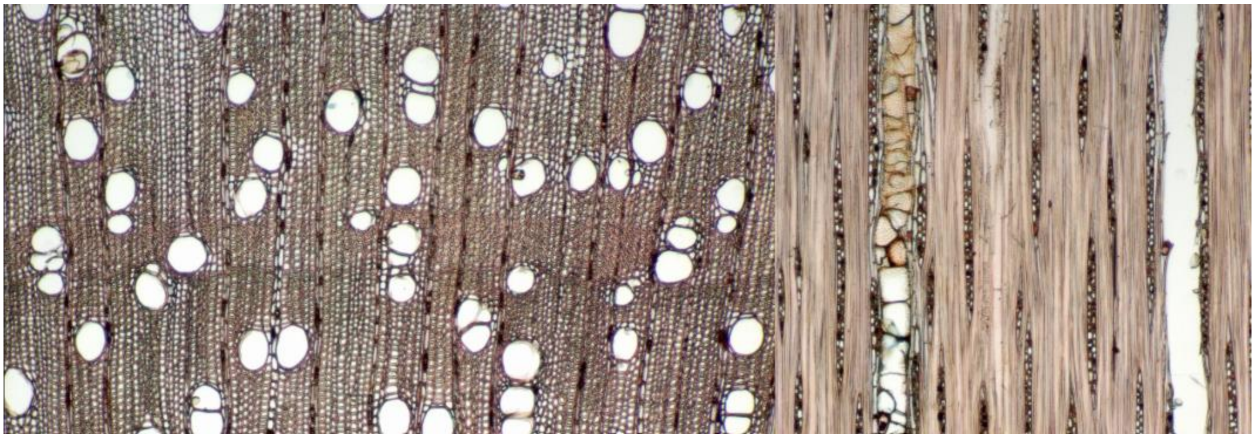


LAURACEAE *Nectandra reticulata,* (sigua) *cufodontisii, hihua, hypoleuca, lineata, longipetiolata, membranacea, purpurea, salicina, smithii, umbrosa*

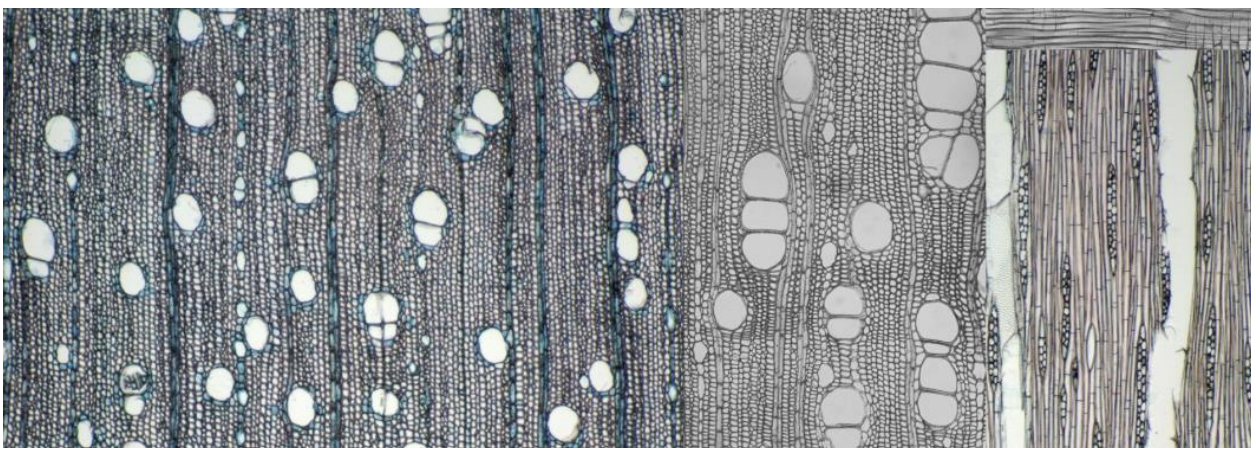
- Vessels 100-200µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, aliform, confluent
- Simple perforation plates, scalariform, intervessel pits alternate



LAURACEAE *Ocotea cernua,* (sigua) *atirrensis, austinii, brenesii, cernua, dendrodaphne, floribunda, haberi, helicterifolia, insularis, laetevirens, leucoxylon, meziana, mollifolia, monteverdensis, pentagona, praetermissa, rivularis, rubra, schomburgkiana, sinuata, tonduzii, valeriona, veraguensis*

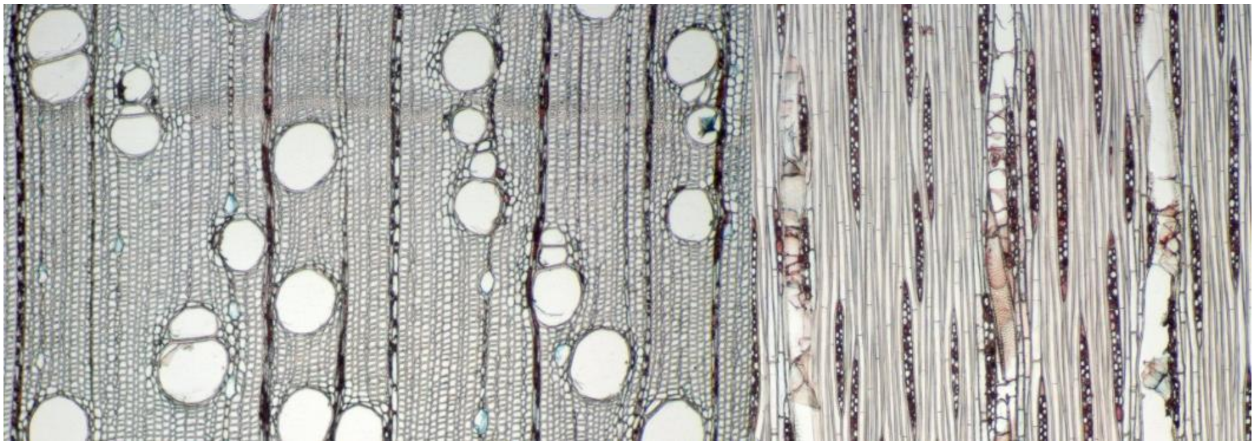


LAURACEAE *Ocotea leucoxylon,* *atirrensis, austinii, brenesii, cernua, dendrodaphne, floribunda, haberi, helicterifolia, insularis, laetevirens, meziana, mollifolia, monteverdensis, pentagona, praetermissa, rivularis, rubra, schomburgkiana, sinuata, tonduzii, valeriona, veraguensis* (sigua)



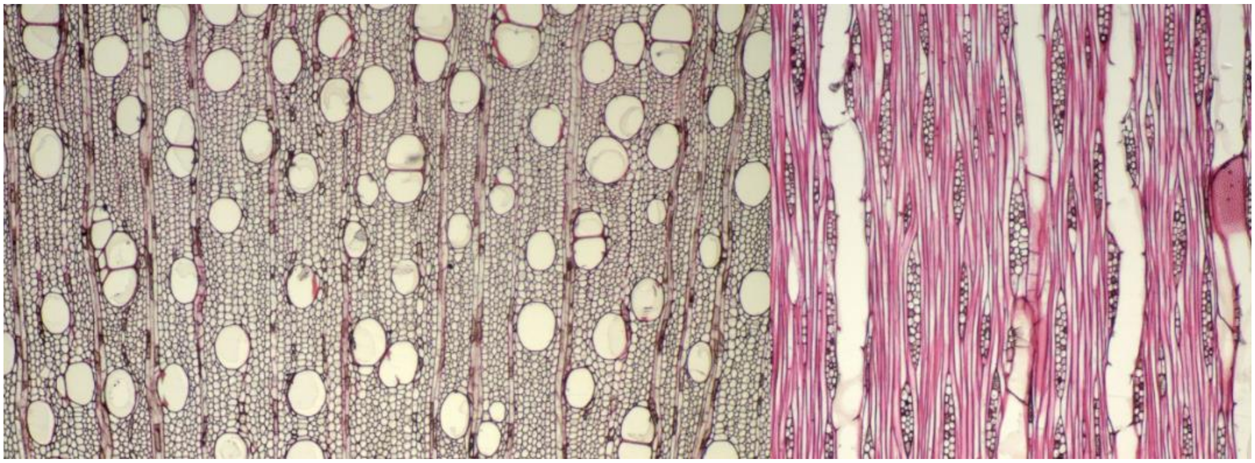
LAURACEAE *Ocotea* (sigua) ***schomburgkiana,*** *atirrensis, austinii, brenesii, cernua, dendrodaphne, floribunda, haberi, helicterifolia, insularis, laetevirens, leucoxylon, meziana, mollifolia, monteverdensis, pentagona, praetermissa, rivularis, rubra, sinuata, tonduzii, valeriona, veraguensis, whitei*

- Vessels 100-200µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric



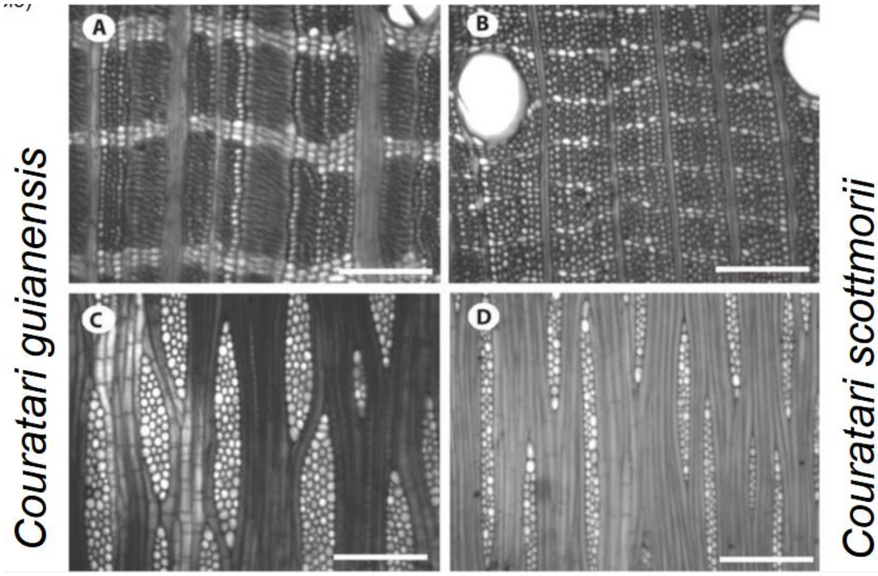
LAURACEAE *Persea americana* (avocado, aguacate) *brenesii, caerulea, obtusifolia, cuneata*

- Vessels 50-100µm, 5-20 /mm^2
- Rays 1 to 3, 4 to 10 seriate, 4-12/mm
- Parenchyma scanty vasicentric
- Simple perforation plates, intervessel pits alternate



LECYTHIDACEAE *Couratari guianensis, scottmorii* (coquito, condon de mono, zorro, carapelo, congolo)

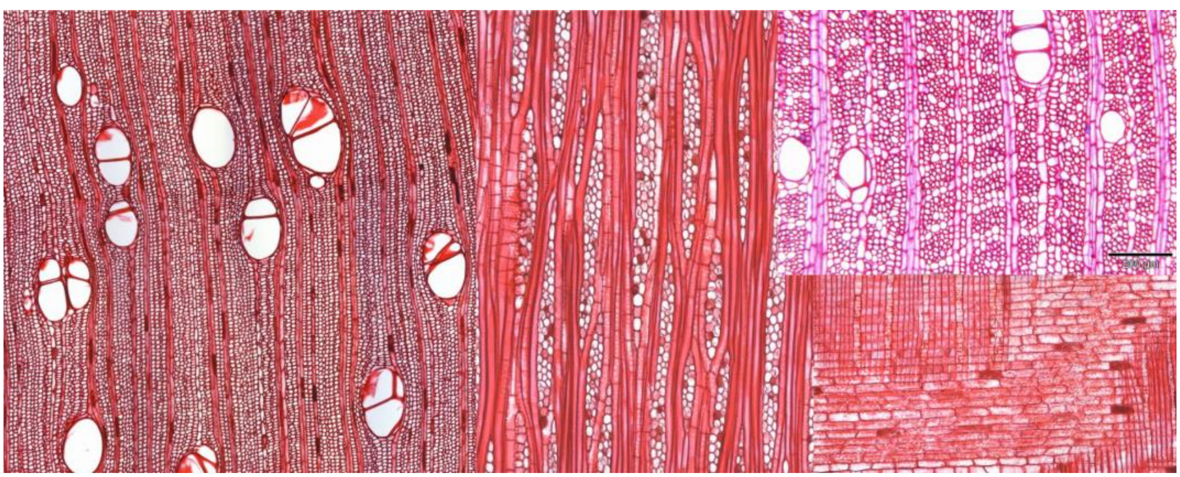
- Vessels 100-200+µm, <5-20 /mm^2, tyloses common
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma narrow bands, reticulate



Roque, Roger & Wiemann, Michael & Olivares, Carlos. (2013). Identification of endangered or threatened Costa Rican tree species by wood anatomy and fluorescence activity. Revista de biología tropical. 61. 1133-56.

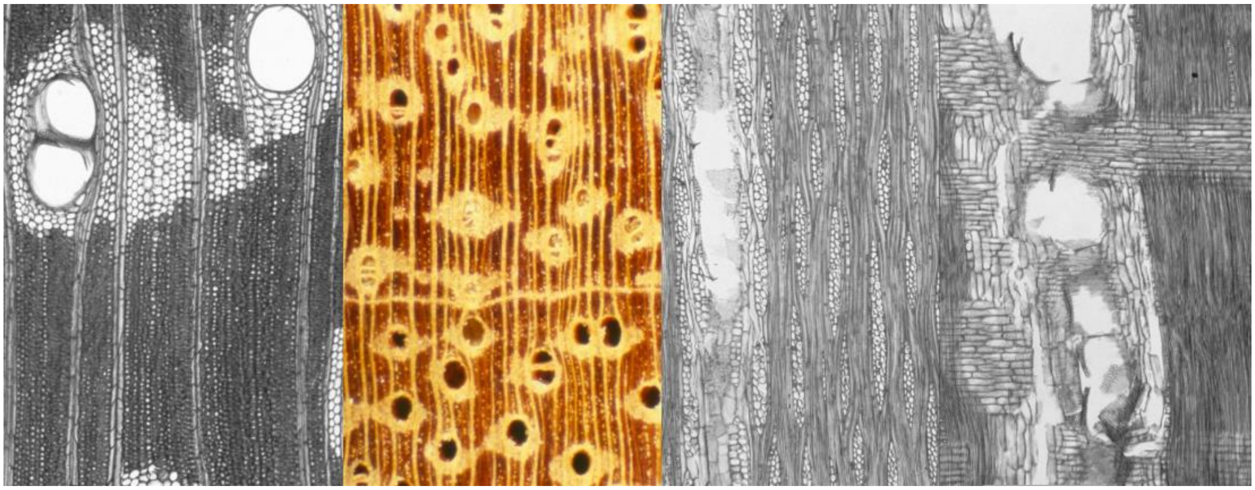
LECYTHIDACEAE *Couroupita guianensis* (cannonball tree, bala de cañón, palo de paraíso, coco, palo santo)

- Vessels 100-200+µm, <5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, narrow bands, reticulate

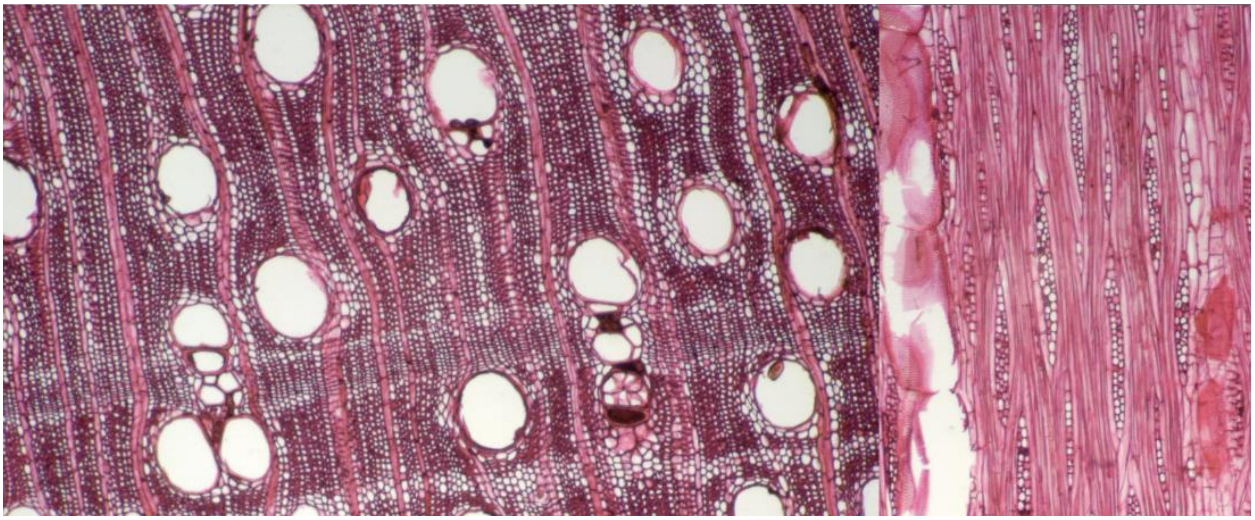


LEGUMINOSAE CAESALPINIOIDEAE *Cassia fistula* (caña fistula-not native), *grandis, fruticosa, fasciculata, caudata, circinata, bacillaris, bicapsularis, moschata* (casia amarilla, carao), *carnaval, artemisioides*

- Vessels 100-200µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands
- Gums in heartwood vessels

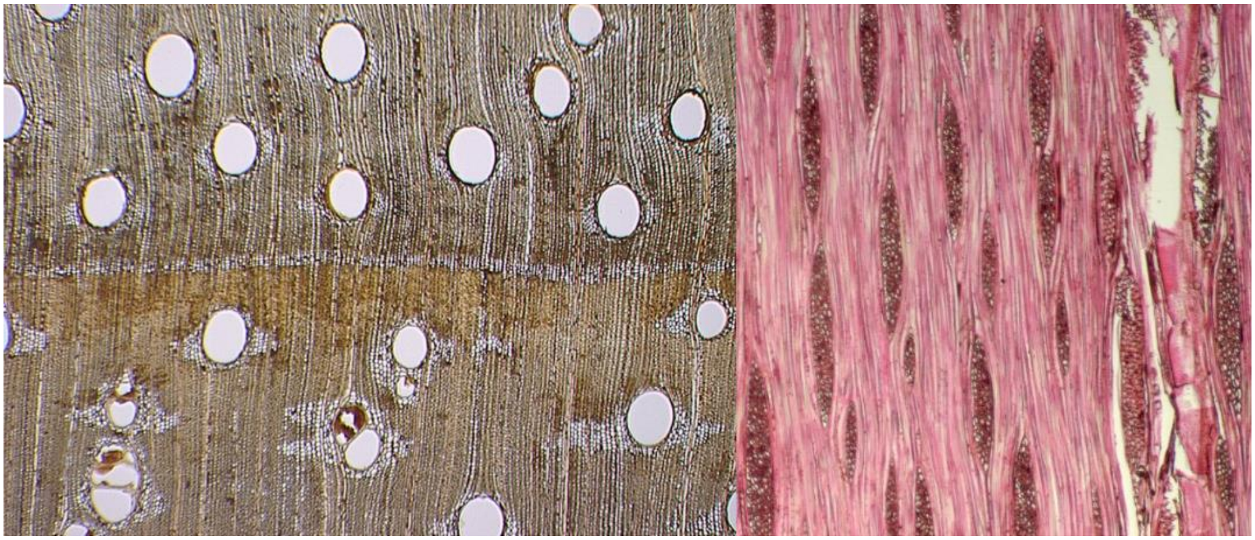


LEGUMINOSAE CAESALPINIOIDEAE *Copaifera aromatica,* *camibar* (cabimo)



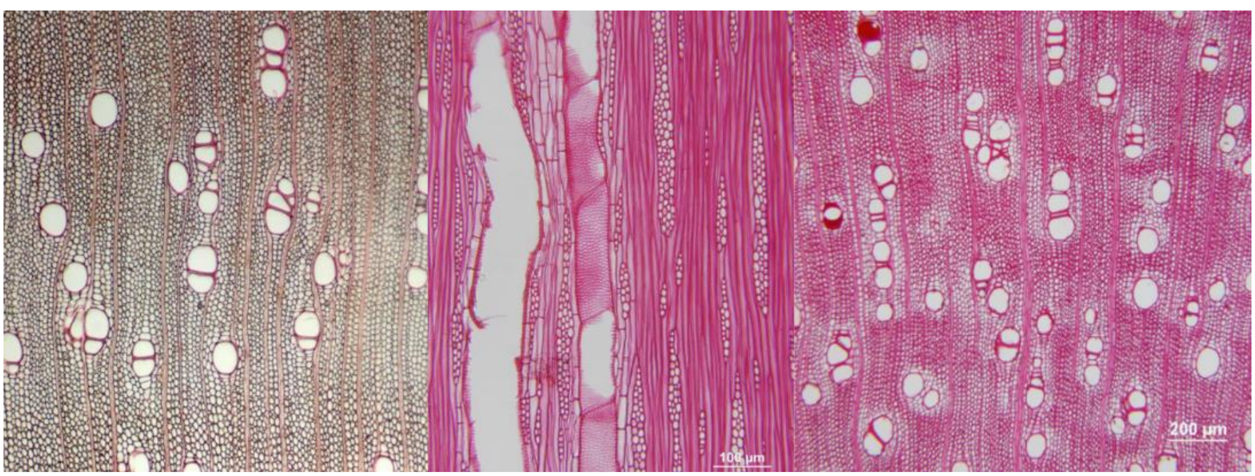
LEGUMINOSAE CAESALPINIOIDEAE *Hymenaea courbaril,* *osanigraseminae* (algarrobo, guapinol)

- Vessels 100-200+ µm, <5-20/mm^2, Gums in heartwood vessels
- Rays 4 to 10 cells, <4-12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands



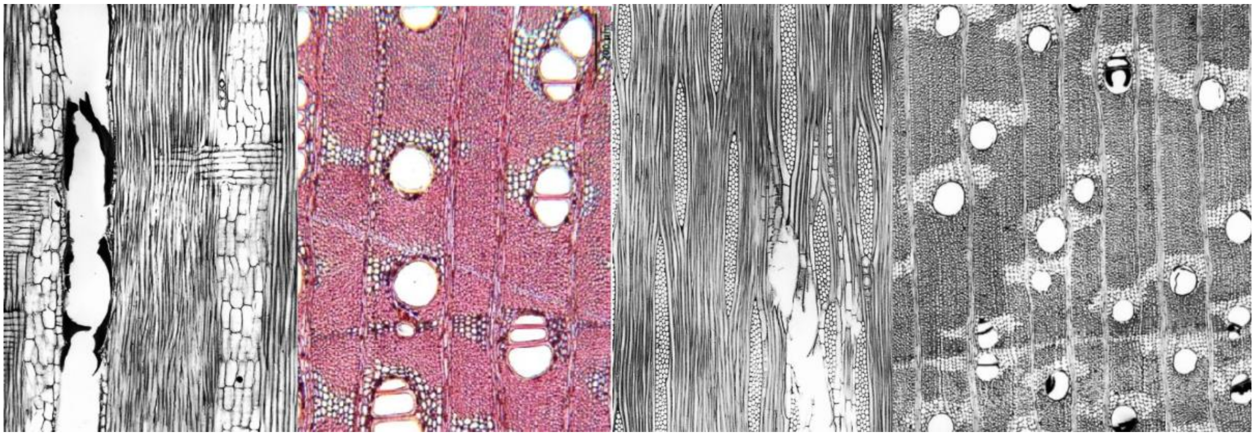
LEGUMINOSAE CAESALPINIOIDEAE *Parkinsonia aculeata* (árbol sarigua, palo verde)
Only species in Costa Rica within this genus

- Vessels 50-100 µm, 5-40/mm^2, radials common
- Rays 1 to 3 cells, 4 to 10 seriat, 4-12/mm
- Parenchyma vasicentric, confluent, diffuse
- Gums in heartwood vessels



LEGUMINOSAE CAESALPINIOIDEAE ***Peltogyne venosa,*** *purpurea* (amaranto)

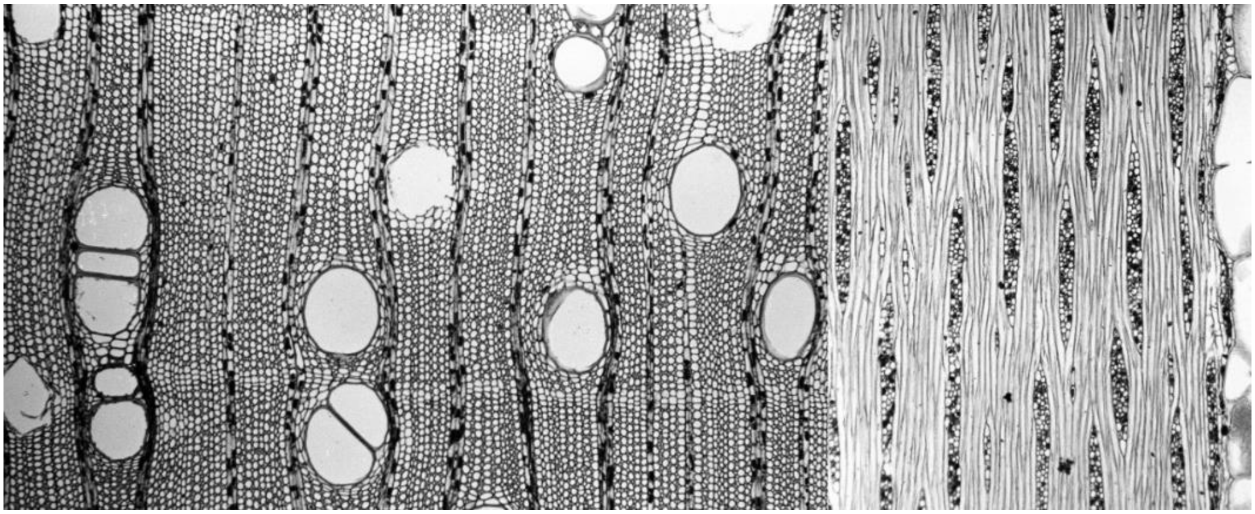
- Vessels 100-200+ µm, <5-20 /mm^2
- Rays 4 to 10, 4-12/mm
- Parenchyma aliform, confluent, unilateral paratracheal, in marginal bands
- Intervessel pits alternate simple



LEGUMINOSAE CAESALPINIOIDEAE ***Prioria copaifera*** (cativo - very coastal)

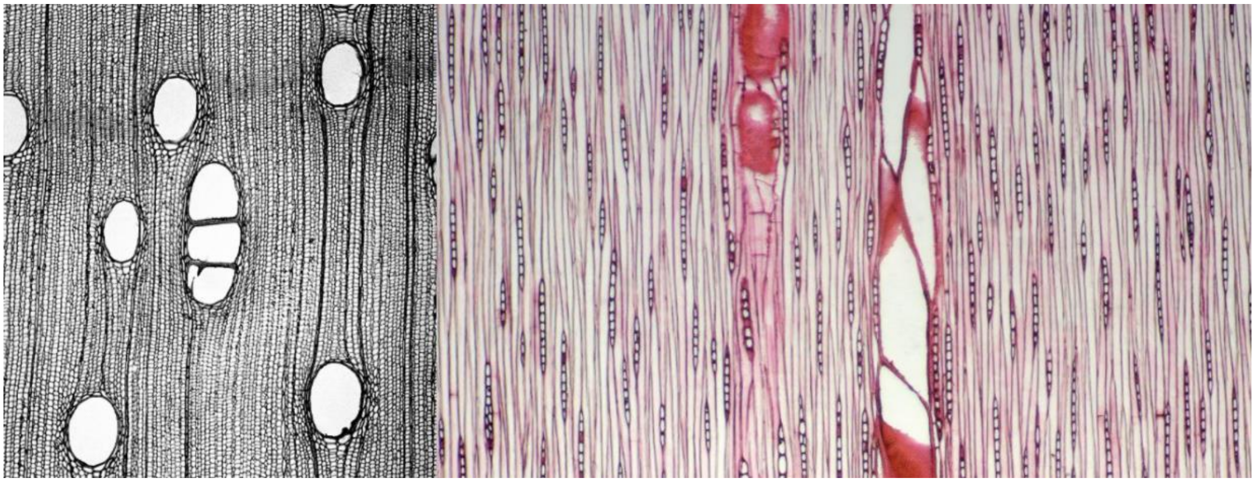
Only species in Costa Rica within this genus

- Vessels 100-200 µm, <5-20 /mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10, 4-12/mm
- Parenchyma aliform, lozenge, vasicentric, confluent, narrow bands



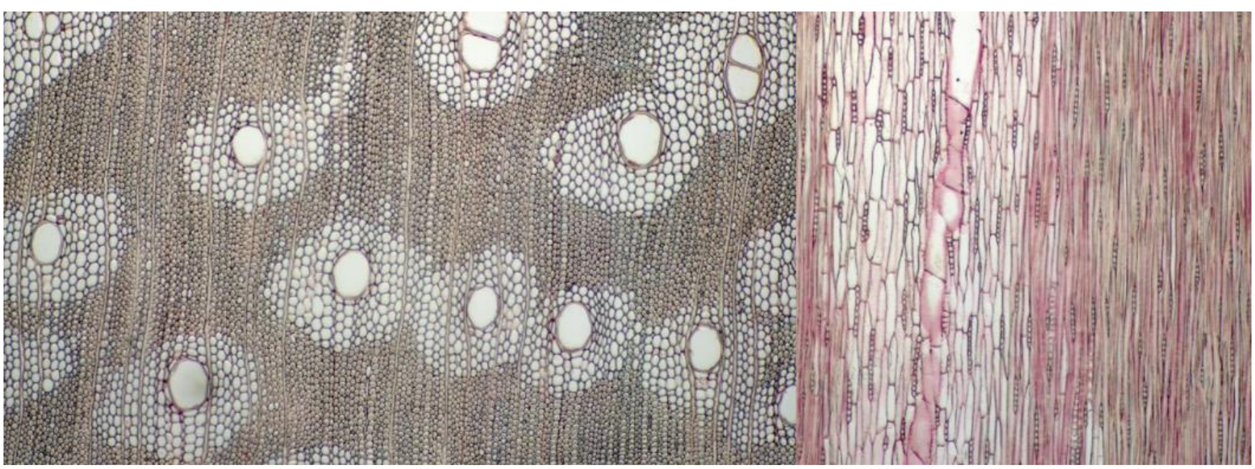
LEGUMINOSAE CAESALPINIOIDEAE ***Tachigali paniculata,*** *costaricensis, versicolor*

- Vessels 200+ µm, <5-20 $/mm^2$
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma vasicentirc, lozenge, aliform, confluent, unilateral paratracheal, in marginal bands



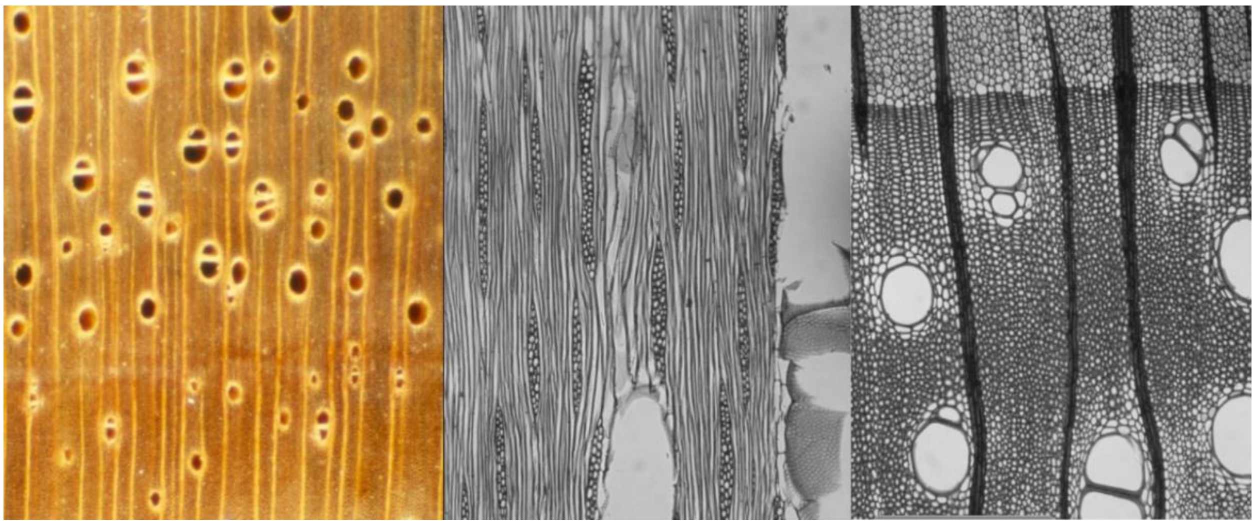
LEGUMINOSAE MIMOSOIDEAE ***Abarema barbouriana,*** *adenophora, idiopoda, macradenia, racemiflora* (abarema)

- Vessels 100-200 µm, <5-20 $/mm^2$
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma vasicentirc, lozenge, aliform, confluent, in marginal bands



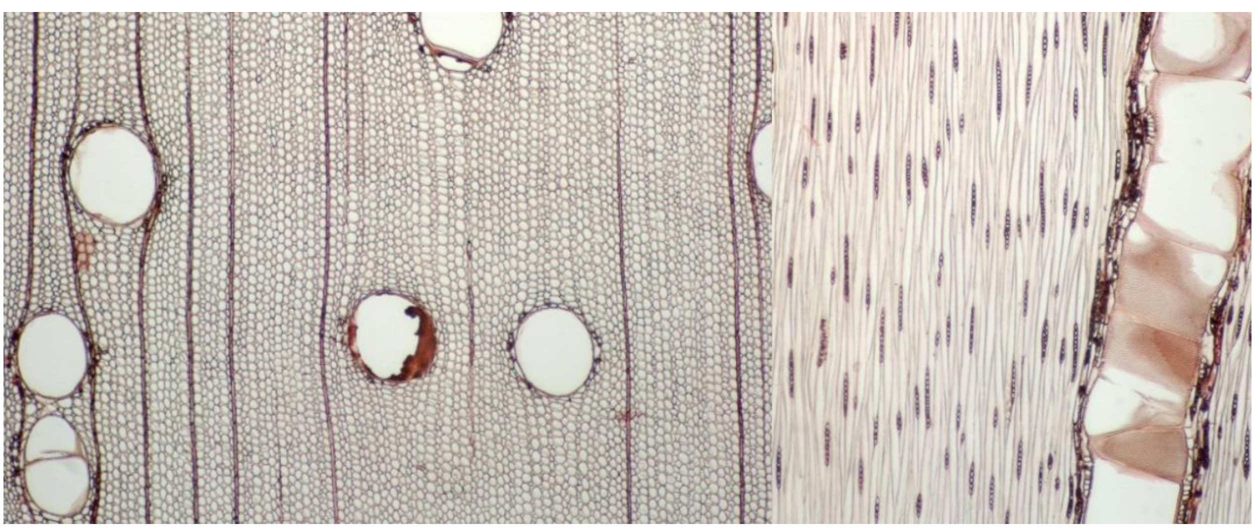
MIMOSOIDEAE *Acacia dealbata,* (acacia) *alata, allenii, angustissima, baileyana, bivenosa, collinsii, cornigera, costaricensis, cyanophylla, decipens, dentifera, farmensiana, guanacastensis, hayesii, heteroclita, heugelu, homalophylla, mangium, melanoceras, milleriana, ruddiae, saligna, tenuifolia, urophylla*

- Vessels 50-200 µm, 5-40 /mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric

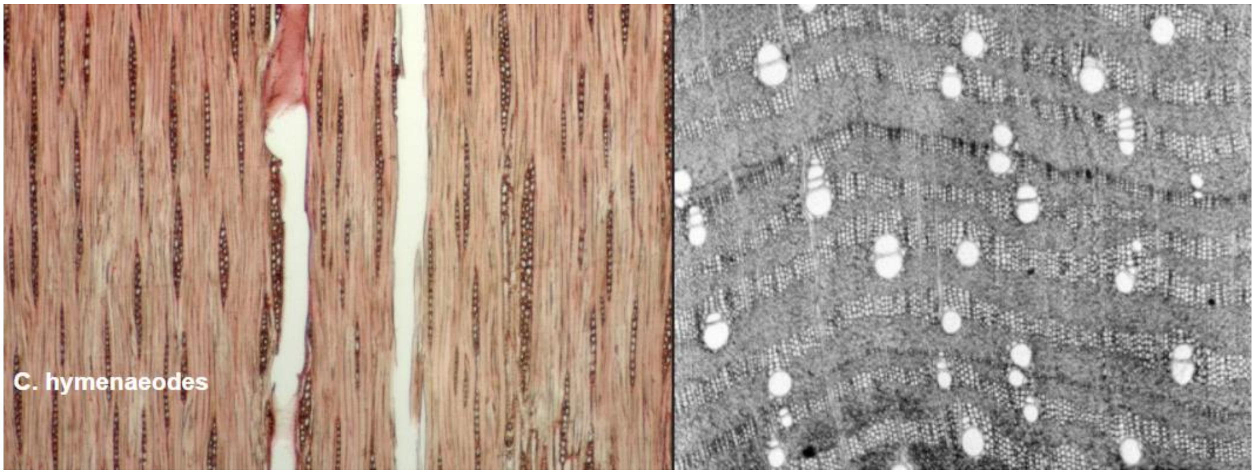


LEGUMINOSAE MIMOSOIDEAE *Albizia carbonaria,* (albizia) *adinocephala, niopoides, odinocephala*

- Vessels 50-200 µm, <5-20 /mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentirc, lozenge, aliform, confluent

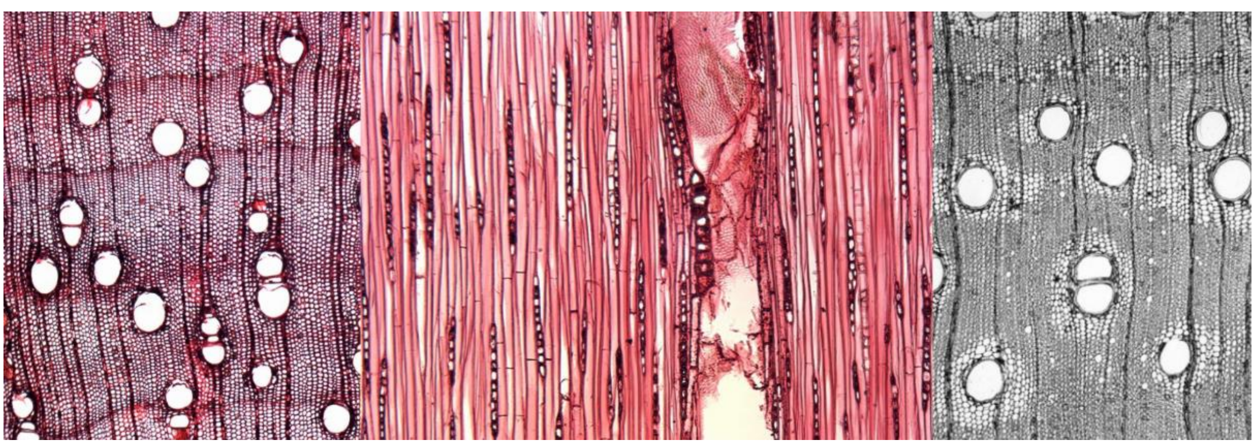


LEGUMINOSAE MIMOSOIDEAE *Calliandra coriacea,* *arborea, bijuga, brenesii, calothyrsus, emarginata, grandifolia, magdalenae, pallida, rhodocephala, rubescens, tergemina* (gallito)



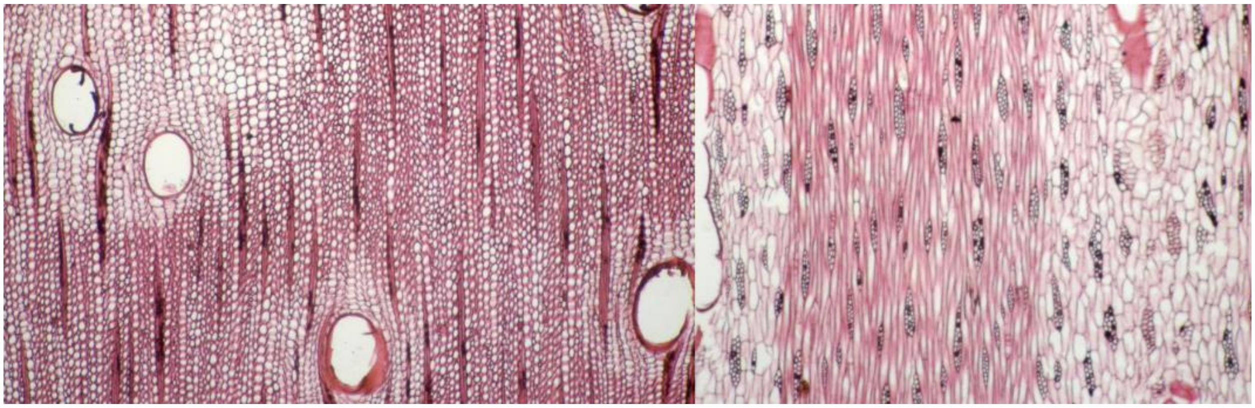
LEGUMINOSAE MIMOSOIDEAE *Cojoba arborea,* (coralillo, harino) *catenata, costaricensis, rufescens, sophocarpa, undulatomarginata, valerioi, whitefoordiae*

- Vessels 100-200 µm, <5-40 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, lozenge, aliform, confluent, in marginal bands



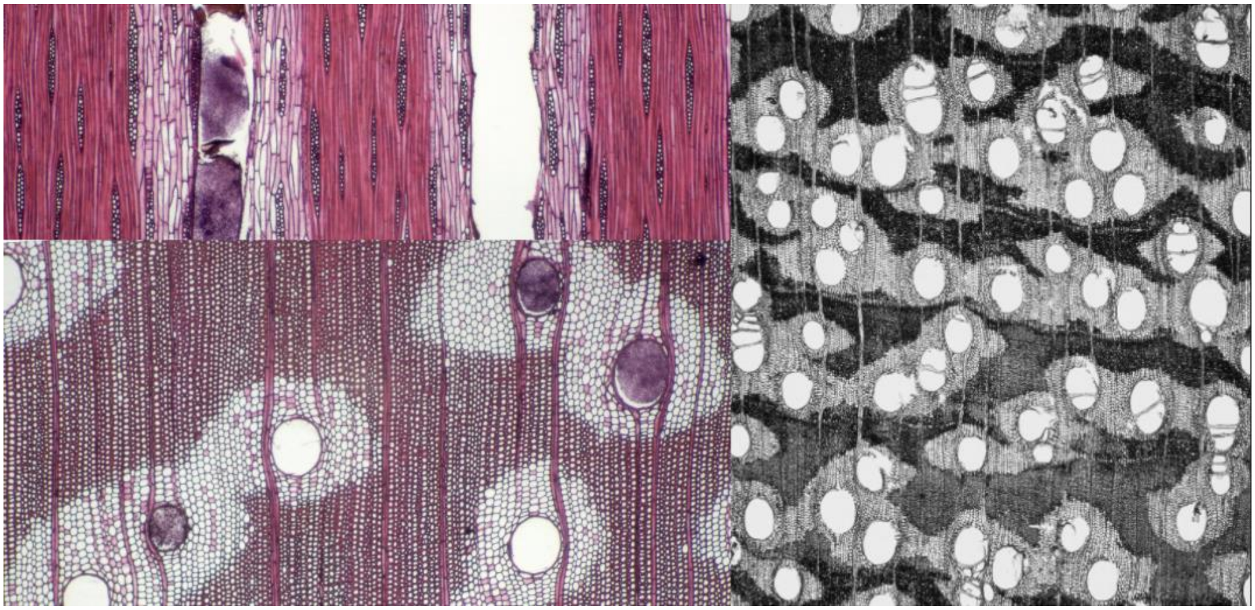
LEGUMINOSAE MIMOSOIDEAE *Enterolobium cyclocarpum,* *schomburgkii* (corotú, guanacaste)

- Vessels 100-200+ µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, marginal bands
- Gums in heartwood vessels
- Diffuse porous



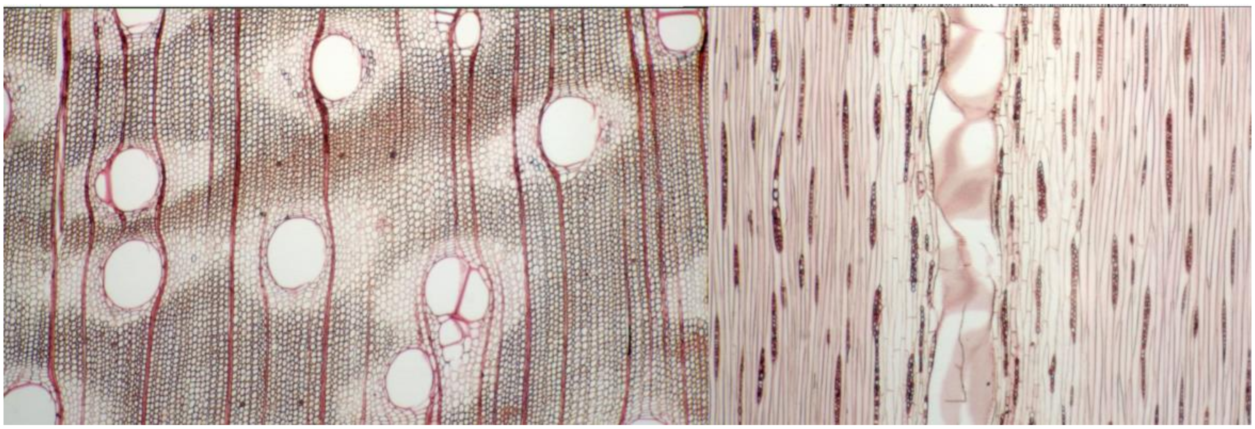
LEGUMINOSAE MIMOSOIDEAE *Enterolobium schomburgkii* (corotú de montaña, dormilón, harino, guábilo, zarza, jarino, timbauba)

- Vessels 100-200+ µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, vasicentric, aliform, confluent, marginal bands
- Gums in heartwood vessels



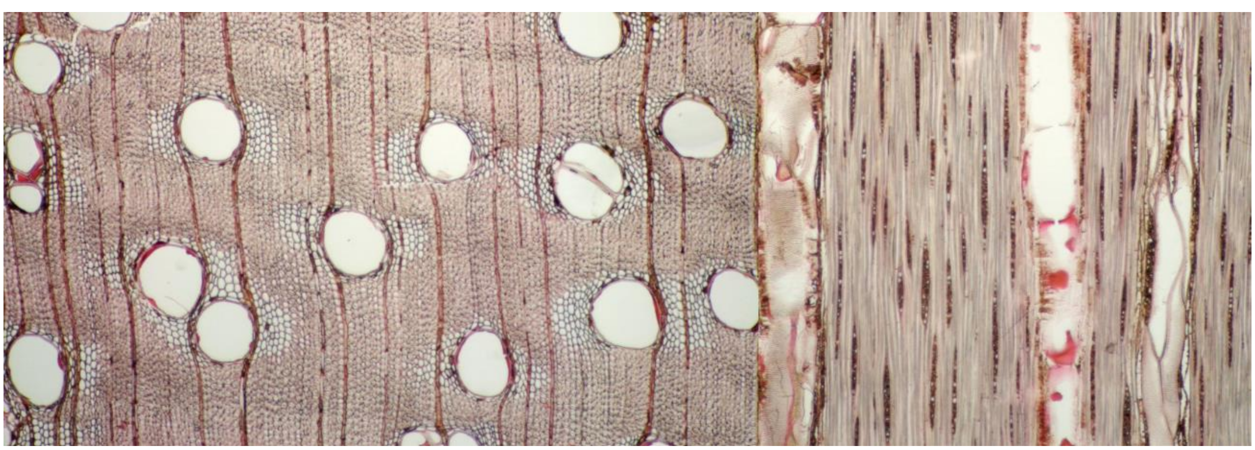
LEGUMINOSAE MIMOSOIDEAE *Inga edulis,* *bella, cocleensis, chocoensis, goldmanii, laurina, marginata, mucuna, multijuga, nobilis, oerstediana, pezizifera, punctata, ruiziana, sapindoides, spectabilis, thibaudiana, umbellifera, venusta, vera*
(guama, guaba, guabito, paterna, ice cream bean)

- Vessels 100-200+ µm, <5-20/mm^2, Gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma aliform, confluent, diffuse



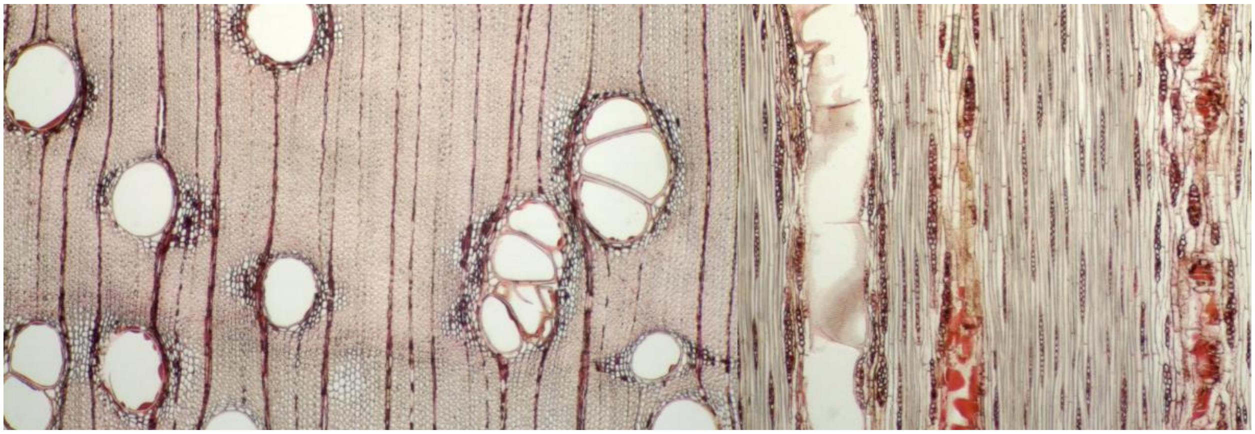
LEGUMINOSAE MIMOSOIDEAE *Inga nobilis,* *bella, cocleensis, chocoensis, edulis, goldmanii, laurina, marginata, mucuna, multijuga, oerstediana, pezizifera, punctata, ruiziana, sapindoides, spectabilis, thibaudiana, umbellifera, venusta, vera* (guama, guaba, guabito, paterna, ice cream bean)

- Vessels 100-200 µm, 5-40/mm^2, Gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, vasicentric



LEGUMINOSAE MIMOSOIDEAE *Inga pezizifera,* *bella, cocleensis, chocoensis, edulis, goldmanii, laurina, marginata, mucuna, multijuga, nobilis, oerstediana, punctata, ruiziana, sapindoides, spectabilis, thibaudiana, umbellifera, venusta, vera (*(guama, guaba, guabito, paterna, ice cream bean)

- Vessels 100-200+ µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, vasicentric, confluent, winged

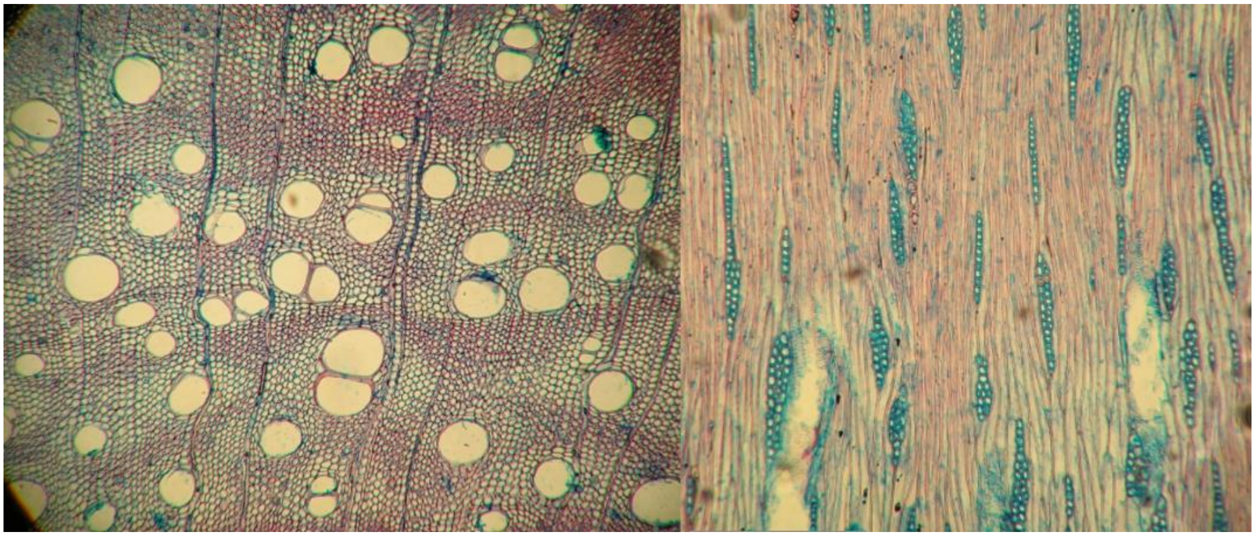


LEGUMINOSAE MIMOSOIDEAE *Inga umbellifera,* *bella, cocleensis, chocoensis, edulis, goldmanii, laurina, marginata, mucuna, multijuga, nobilis, oerstediana, pezizifera, punctata, ruiziana, sapindoides, spectabilis, thibaudiana, venusta, vera*
(guama, guaba, guabito, paterna, ice cream bean)

- Vessels 100-200 µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, vasicentric, confluent, winged

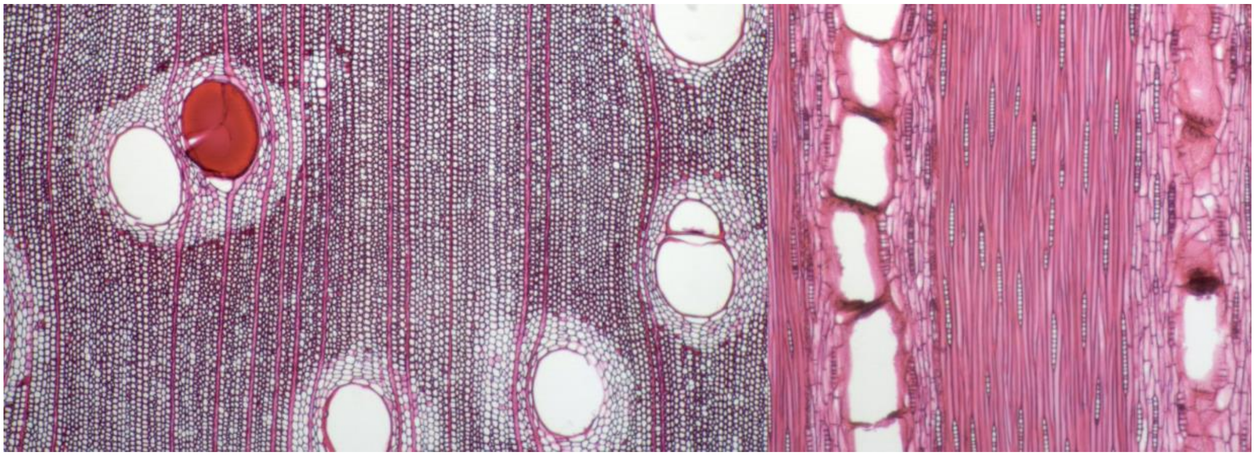
LEGUMINOSAE MIMOSOIDEAE *Prosopis juliflora* (algarrobillo, aromo, manca caballo, mesquite)

- Vessels 50-200µm, 5-40/mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma aliform, vasicentric, confluent, vasicentric



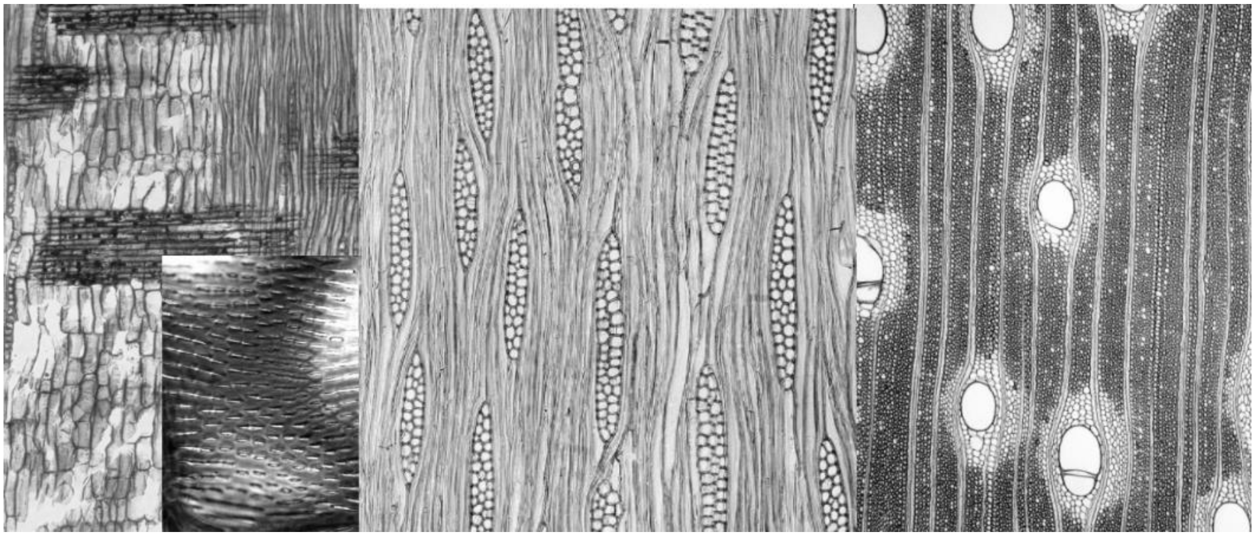
LEGUMINOSAE MIMOSOIDEAE *Pseudosamanea guachapele*
(guachapalí, guábilo, frijolillo)

- Vessels 100-200+µm, <5-20/mm^2, gums in heartwood vessels
- Rays exclusively uniseriate, 4-12/mm, all rays storied
- Parenchyma diffuse, aliform, vasicentric, confluent, vasicentric



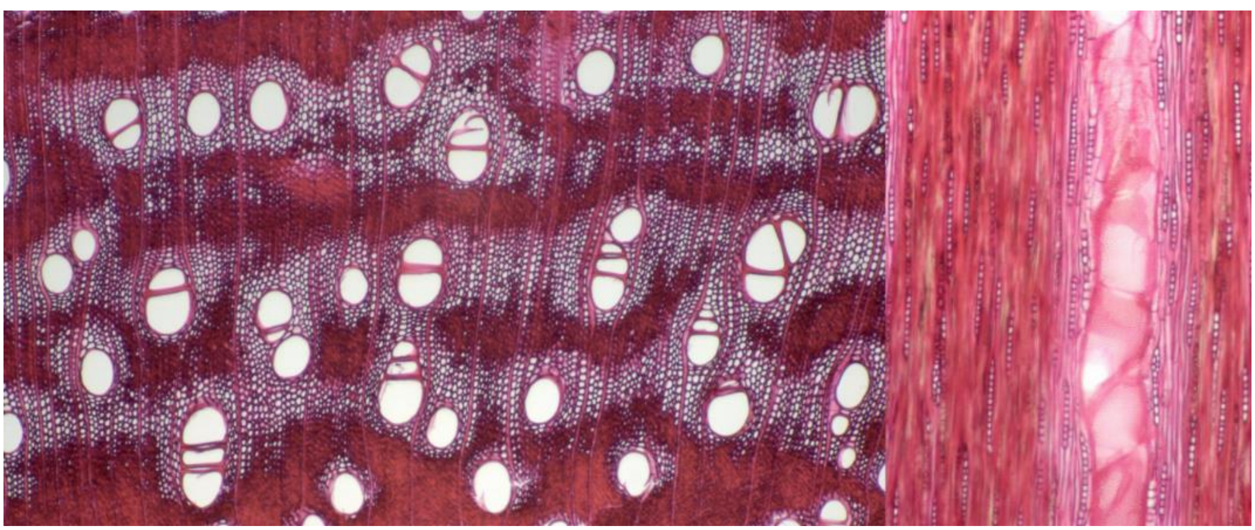
LEGUMINOSAE MIMOSOIDEAE *Samanea saman* (guachapalí, cenízaro, rain tree)
Only species in Costa Rica within this genus

- Vessels 100-200+µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm, all rays storied
- Parenchyma diffuse, aliform, vasicentric, confluent, vasicentric



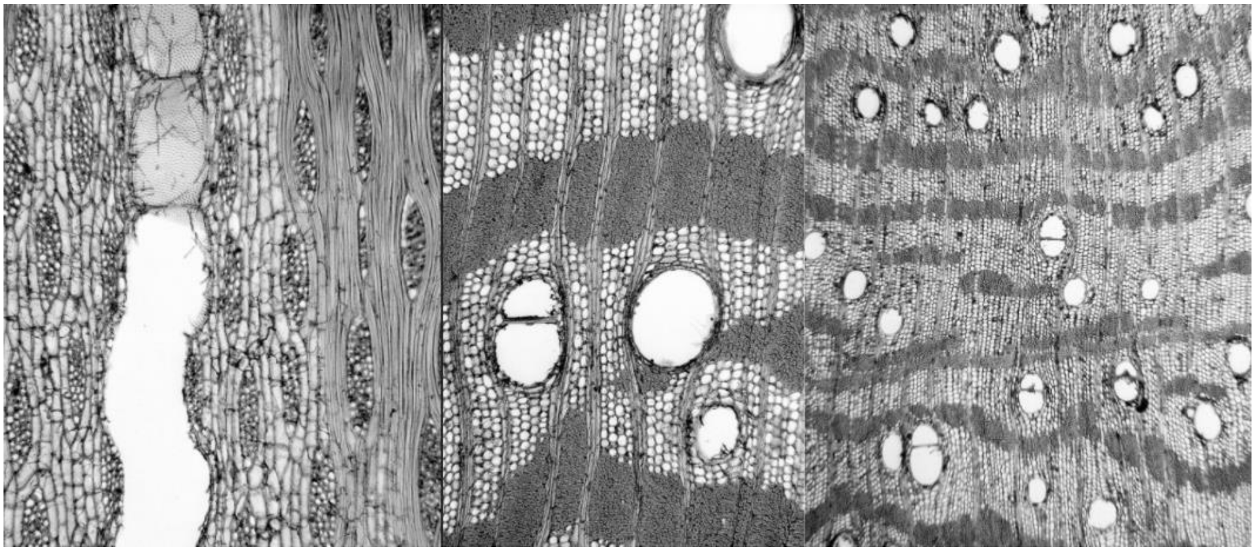
LEGUMINOSAE MIMOSOIDEAE *Zygia latifolia,* *brenesii, longifolia, palmana*
(guabito cansa boca, guabito de río, pichindé)

- Vessels 100-200µm, 5-20/mm^2, gums in heartwood vessels
- Rays exclusively uniseriate, 4-12/mm, all rays storied
- Parenchyma aliform, vasicentric, confluent, vasicentric



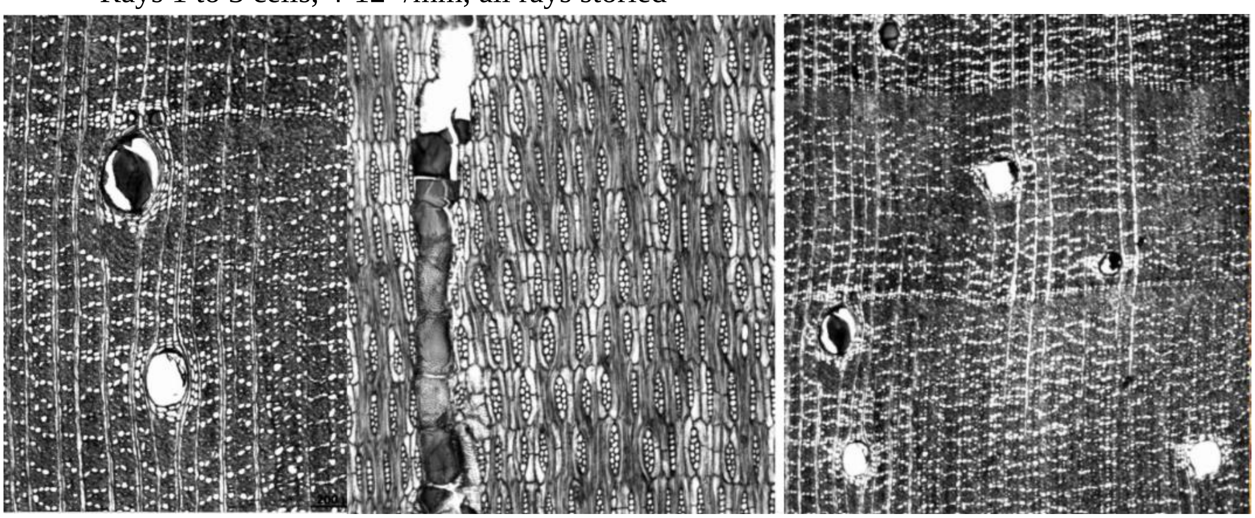
LEGUMINOSAE PAPILIONOIDEAE ***Andira inermis*** (almendro de río, harino, quira)
Only species within this genus in Costa Rica

- Vessels >200µm, <5-20/mm^2, gums in heartwood vessels
- Rays 4 to 10 seriate, 4-12+/mm, all rays storied
- Parenchyma confluent, in marginal bands



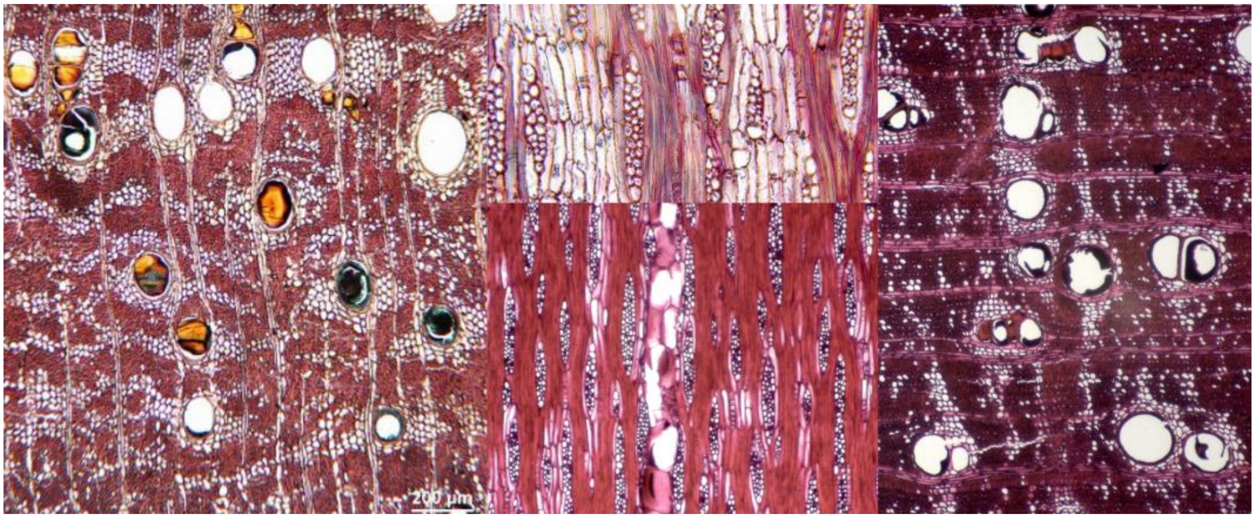
LEGUMINOSAE PAPILIONOIDEAE ***Dalbergia retusa*** (cocobolo),
brownei, calycina, ecastaphyllum, glabra, lineata

- Vessels 100-200µm, <5-20/mm^2, gums in heartwood vessels
- Parenchyma confluent, in marginal bands, reticulate, diffuse in aggregates, vasicentric, aliform
- Rays 1 to 3 cells, 4-12+/mm, all rays storied



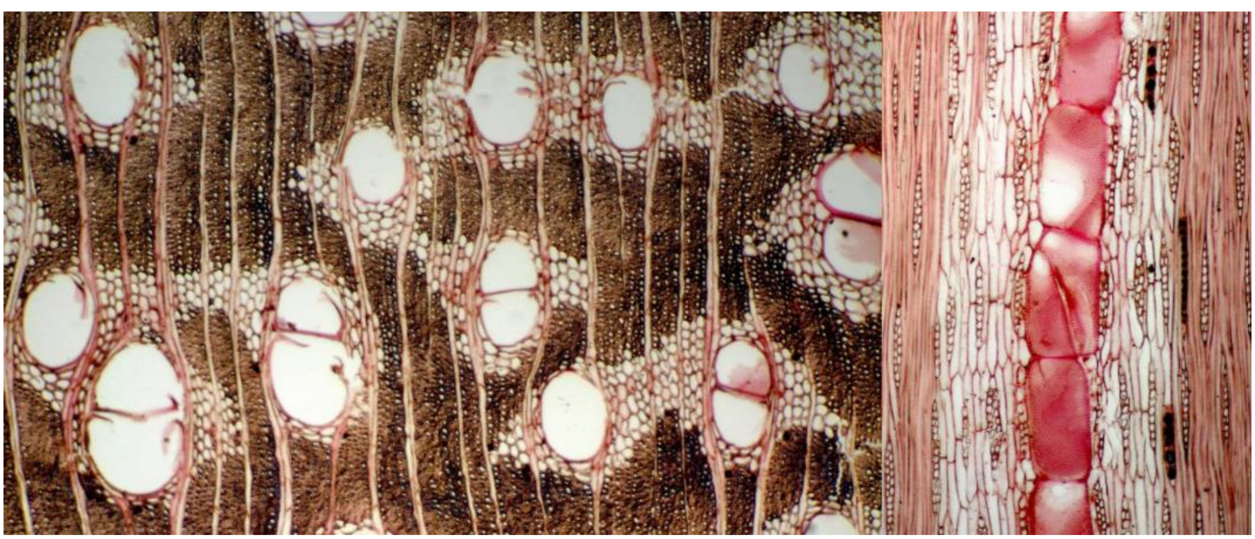
LEGUMINOSAE PAPILIONOIDEAE ***Diphysa carthagenensis,*** *americana, humilis, robinioides* (macano, cacique)

- Vessels 100-200+µm, <5-20/mm^2, gums in heartwood vessels
- Parenchyma diffuse, aliform, confluent, winged, bands
- Rays 1 to 3, 4 to 10 cells, 4-12/mm



LEGUMINOSAE PAPILIONOIDEAE ***Dipteryx oleifera,*** *panamensis* (almendro)

- Vessels 100-200µm, <5-20/mm^2, gums in heartwood vessels
- Parenchyma vasicentric, aliform, confluent, winged
- Rays 1 to 3 cells, 4-12/mm, all rays storied

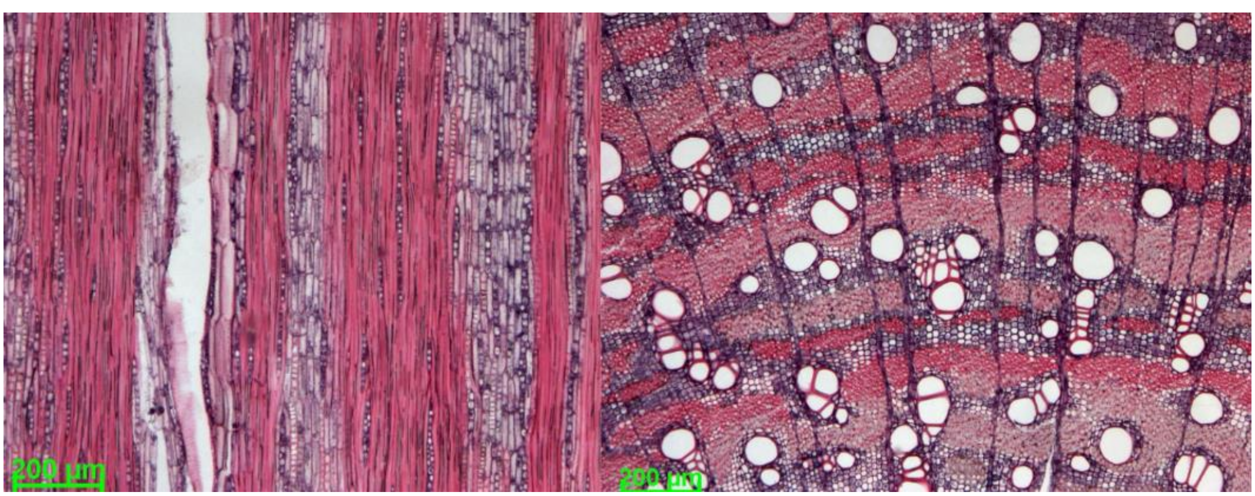


LEGUMINOSAE PAPILIONOIDEAE ***Gliricidia sepium*** (balo, madero negro)
Only species in Costa Rica within this genus

- Vessels 100-200µm, <5-20/mm^2, tyloses common
- Parenchyma confluent, winged aliform
- Rays 1 to 3 cells, 4-12/mm, all rays storied
-

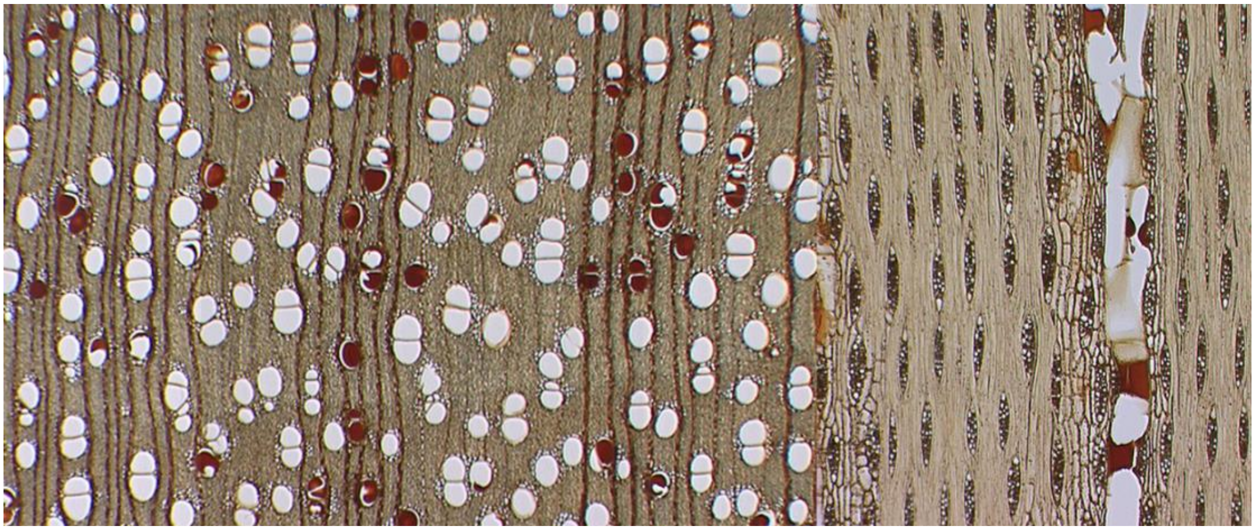
LEGUMINOSAE PAPILIONOIDEAE ***Lonchocarpus sericeus,*** *heteraphyllus*, *minimiflorus*, *velutinus* (chaperno, guabito, frijolillo, malvecino, zorro)

- Vessels 50-200µm, <5-20/mm^2
- Parenchyma confluent, aliform, bands more than 3 cells wide
- Rays 1 to 3 cells, 4-12+/mm, all rays storied



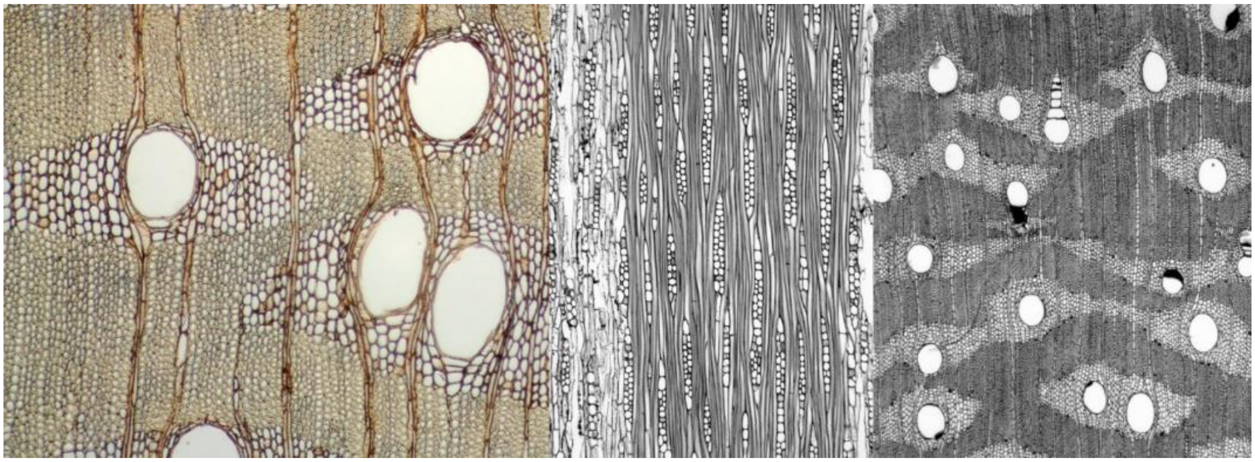
LEGUMINOSAE PAPILIONOIDEAE *Myroxylon balsamum* (bálsamo, bálsamo de tolú, sándalo) Only species within this genus in Costa Rica

- Vessels 50-200µm, 5-20/mm^2, gums in heartwood vessels
- Parenchyma scanty, vasicentric, aliform, confluent
- Rays 1 to 3 cells, 4-12/mm, all rays storied

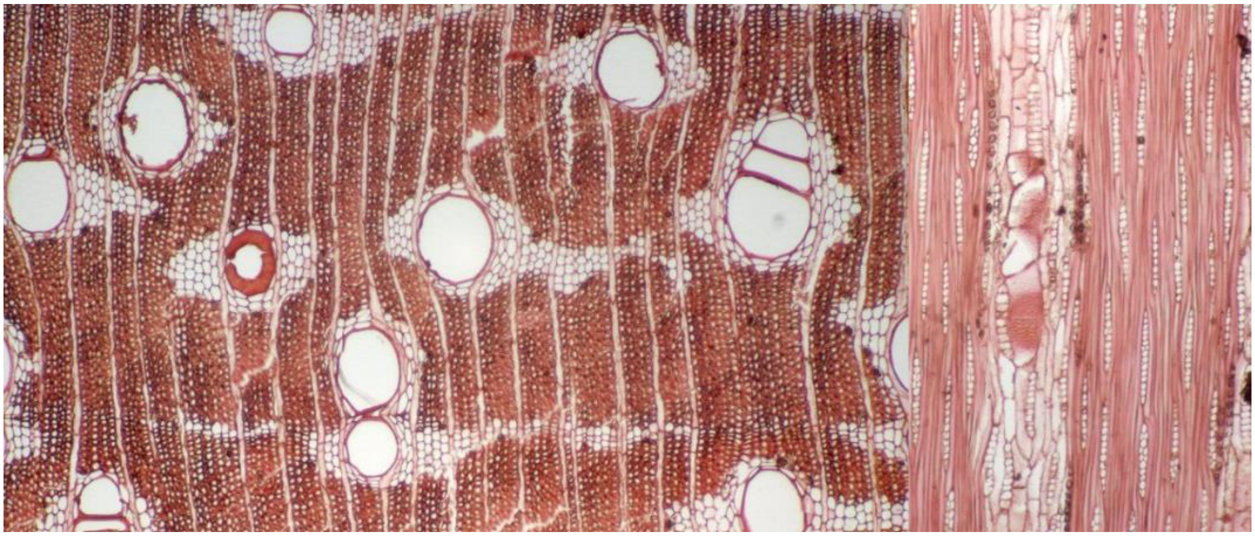


LEGUMINOSAE PAPILIONOIDEAE *Ormosia coccinea,* *amazonica, costulata, cruenta, macrocalyx, panamensis, subsimplex, velutina* (alcornoque, frijolito de la suerte, cabresto, coralillo, peronil, palo de collar, janeiro, nené)

- Vessels >200µm, <5-20/mm^2, gums in heartwood vessels
- Parenchyma confluent, in marginal bands, aliform
- Rays 1 to 3 cells, 4-12/mm



LEGUMINOSAE PAPILIONOIDEAE ***Platymiscium dimorphandrum,*** *curuense, darienense, parviflorum, pinnatum* (granadillo, quira)

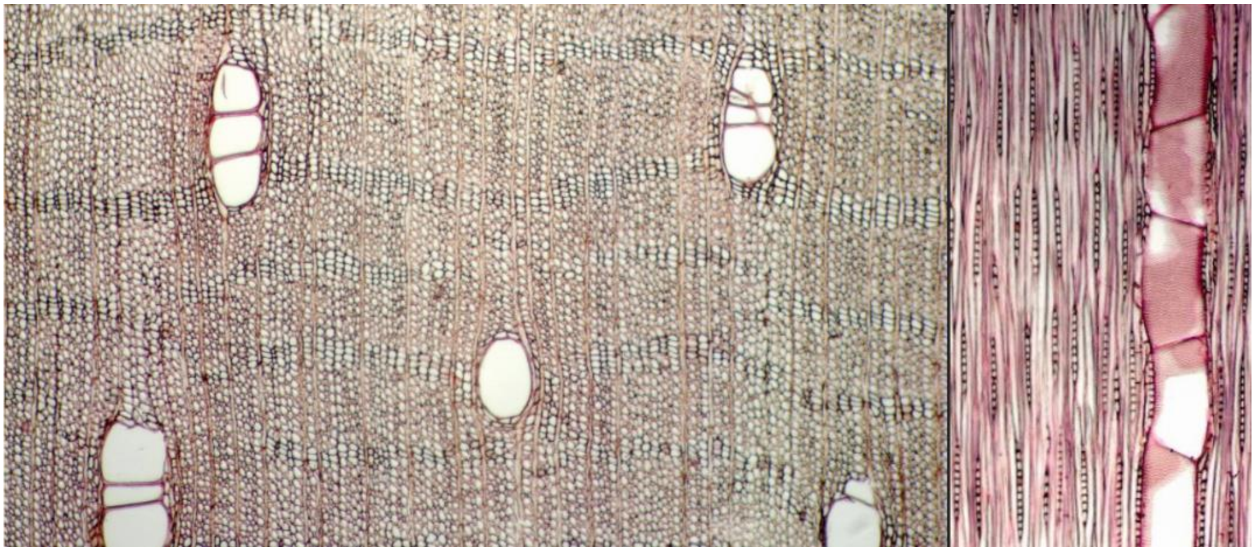


LEGUMINOSAE PAPILIONOIDEAE ***Platymiscium pinnatum*** *curuense, darienense, dimorphandrum, parviflorum* (granadillo, quira)

- Vessels 100-200µm, <5-20/mm^2
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma aliform, confluent, in marginal bands

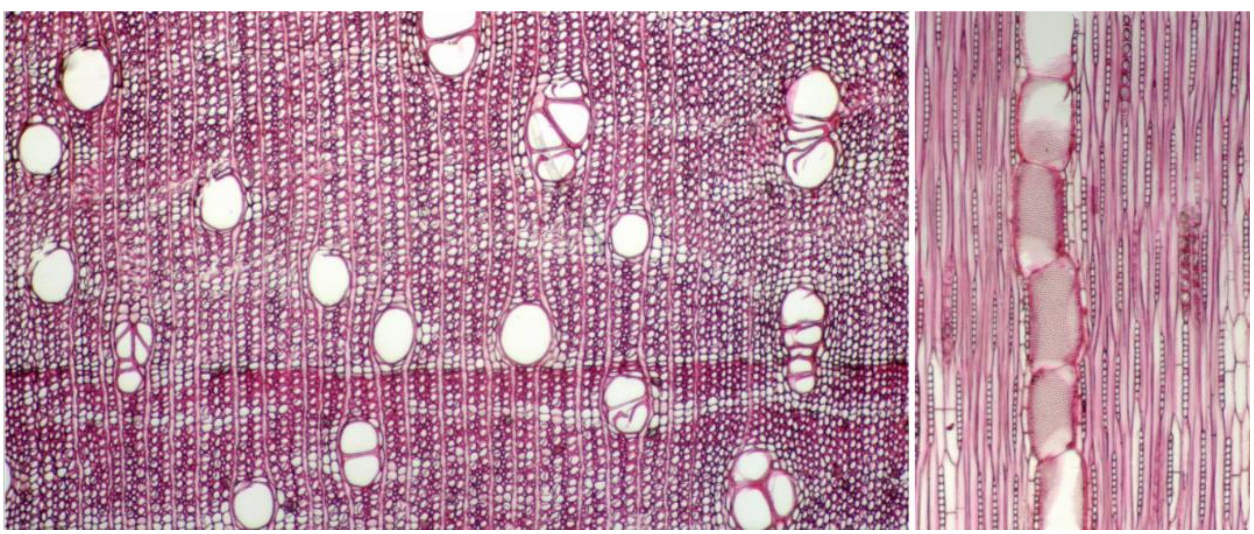
LEGUMINOSAE PAPILIONOIDEAE ***Pterocarpus officinalis,*** *rohrii* (sangre de gallo, sangre de drago, cricamola, suela, bloodwood)

- Vessels 100-200+µm, <5-20/mm^2, gums in heartwood vessels
- Rays exclusively uniseriate, 12+/mm, rays storied
- Parenchyma aliform, confluent, in narrow marginal bands

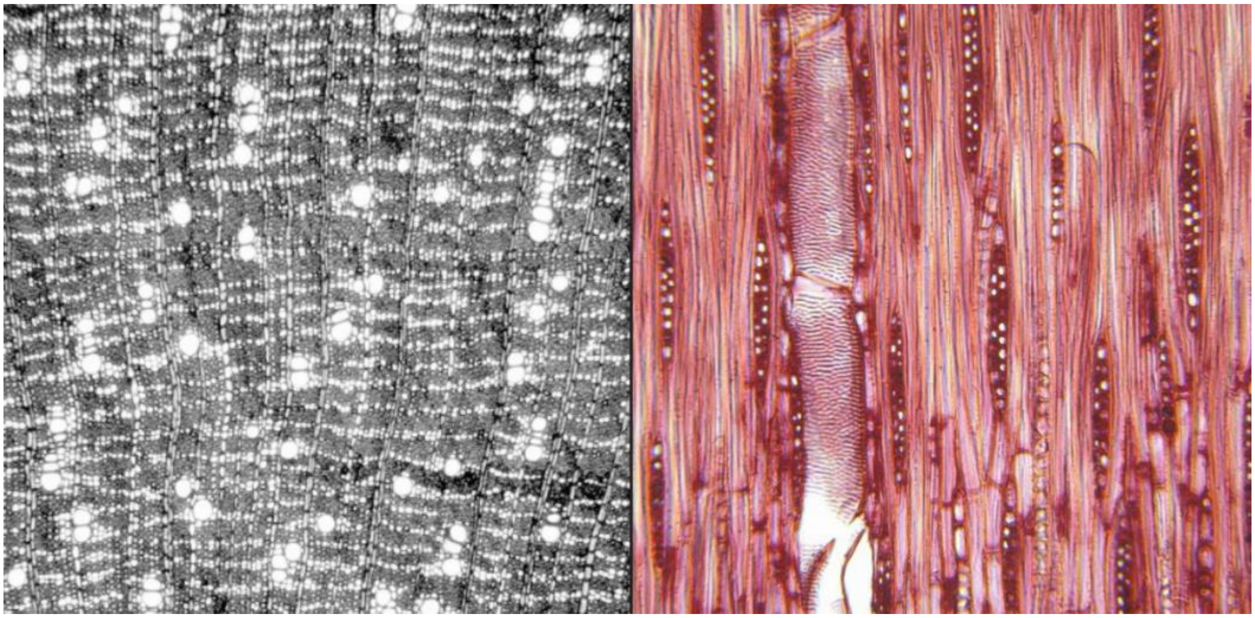


LEGUMINOSAE PAPILIONOIDEAE ***Pterocarpus rohrii,*** *officinalis* (sangre de gallo, cricamola, suela, bloodwood)

- Vessels 100-200+µm, <5-20/mm^2, gums in heartwood vessels
- Rays exclusively uniseriate, 12+/mm
- Parenchyma diffuse, aliform, confluent, in narrow marginal bands

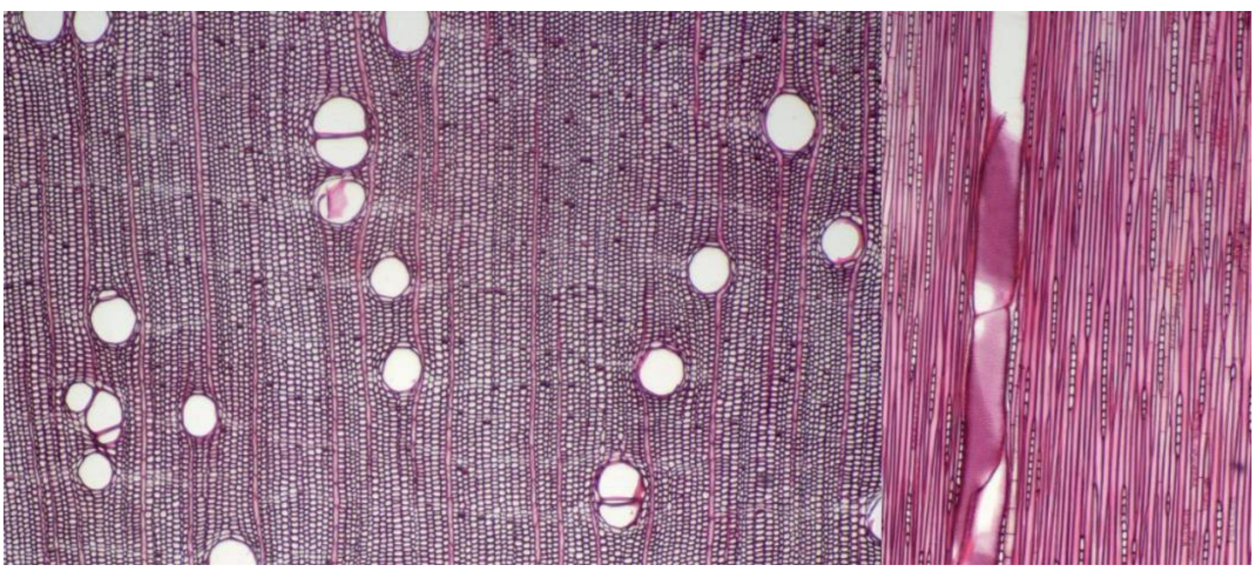


LEGUMINOSAE PAPILIONOIDEAE ***Swartzia simplex,*** *panamensis* (naranjita, naranjo de monte, limoncillo, cutarro, malvecino)



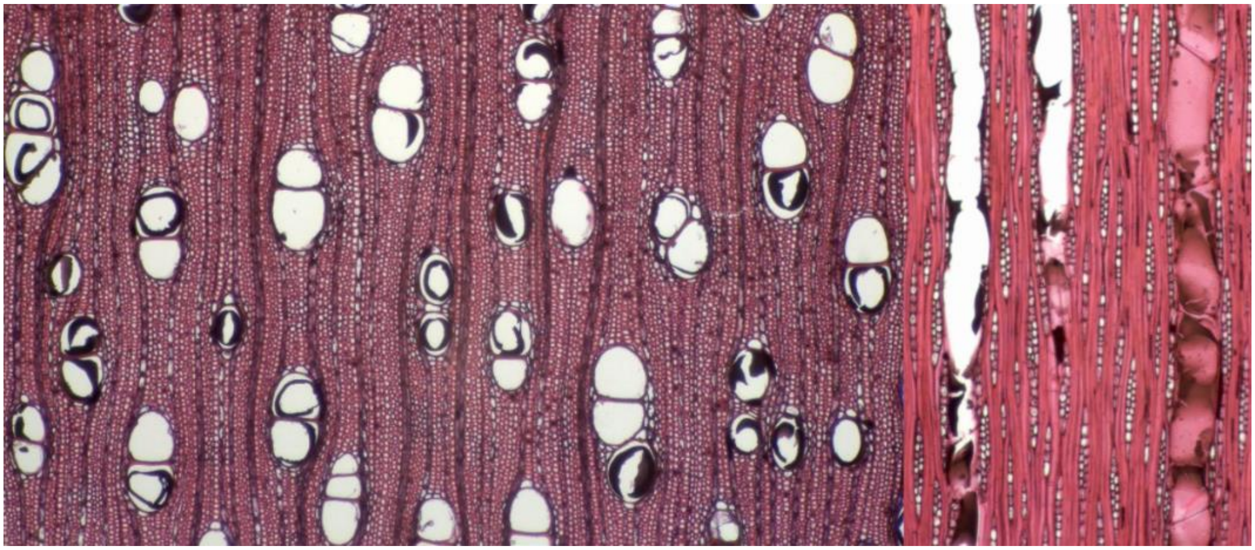
LEPIDOBOTRYACEAE ***Ruptiliocarpon caracolito*** (cedro caracolito)

- Vessels 100-200µm, <5-20/mm^2
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma diffuse, aliform, in narrow marginal bands



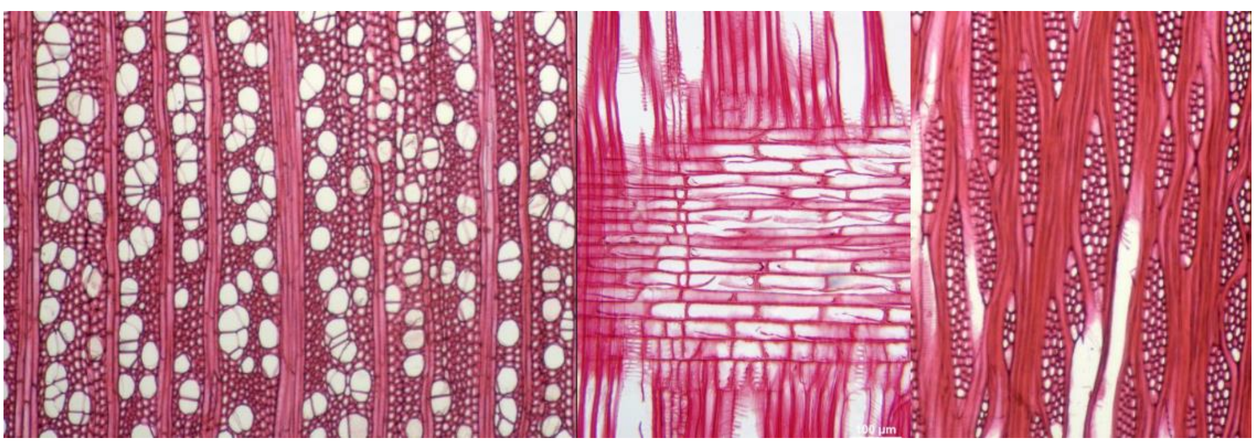
LYTHRACEAE ***Lafoensia punicifolia*** (amarillo, calabacito)

- Vessels in radials, 50-100µm, 20-40/mm^2
- Gums and other deposits in heartwood vessels
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse, scanty, vasicentric



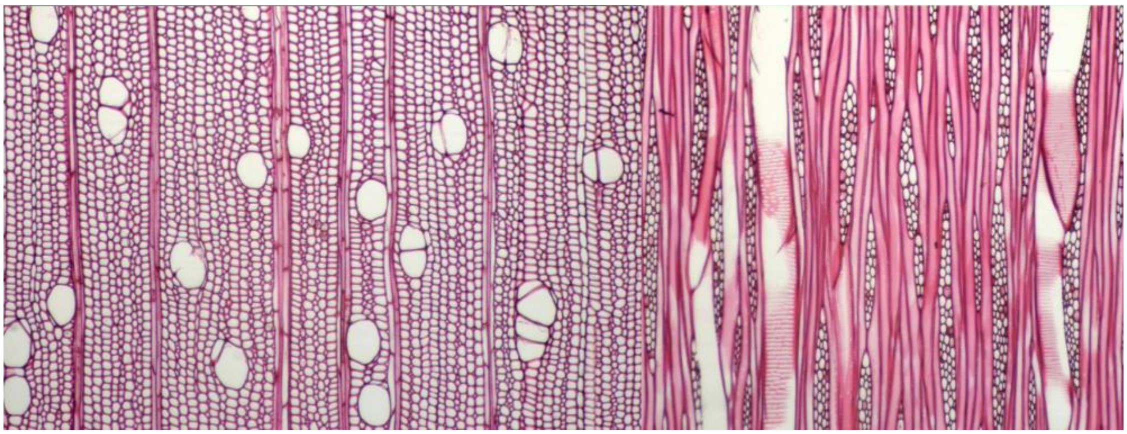
MAGNOLIACEAE ***Magnolia grandiflora*** *(magnolia) M. guatemalensis, kobus, poasana, sororum, virginiana, wetterii*

- Vessels in radials, <50-100µm, 40-100/mm^2, scalariform pitting
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma in marginal bands



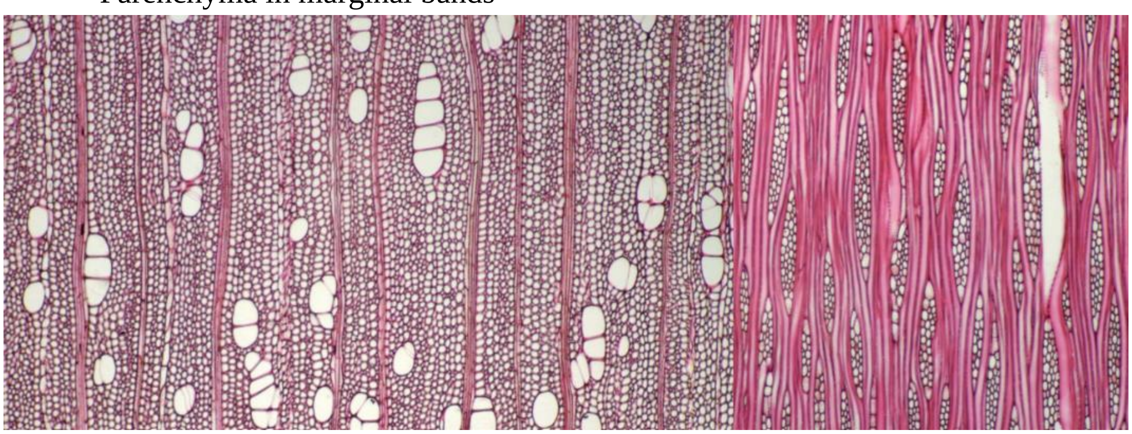
MAGNOLIACEAE *Magnolia kobus* (candelilla, poas magnolia)
M. granidflora, *guatemalensis*, *poasana*, *sororum*, *virginiana*, *wetterii*

MAGNOLIACEAE *Magnolia poasana* (candelilla, poas magnolia)
M. granidflora, *guatemalensis*, *kobus*, *poasana*, *sororum*, *virginiana*, *wetterii*



MAGNOLIACEAE *Magnolia sororum* (baco) *M. grandiflora*, *guatemalensis*, *kobus*, *poasana*, *virginiana*, *wetterii*

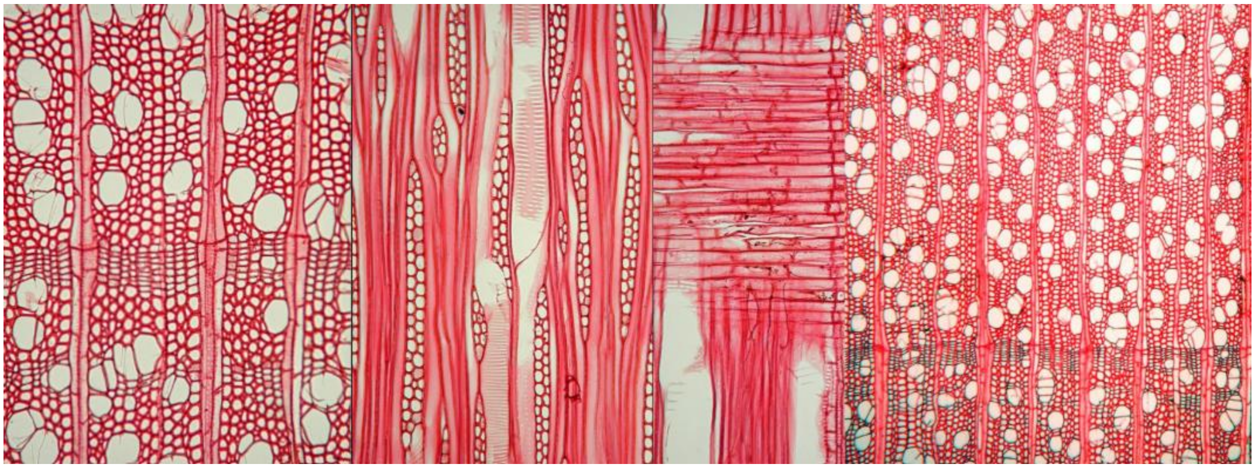
- Vessels in radials, <50-100µm, 40-100/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma in marginal bands



MAGNOLIACEAE *Magnolia virginiana*

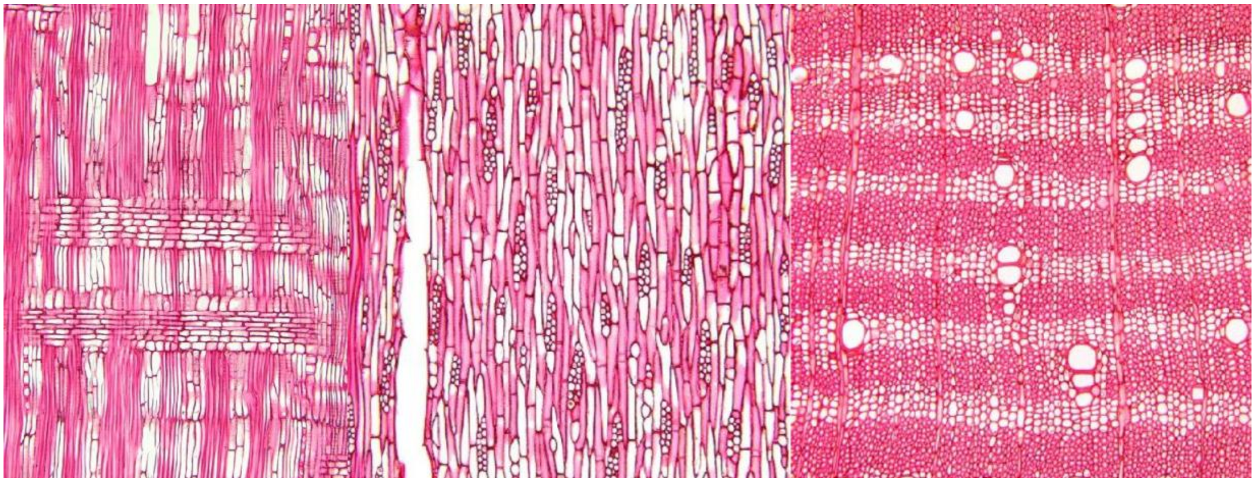
M. grandiflora, *guatemalensis*, *kobus, poasana*, *sororum* (baco), *virginiana, wetterii*

- Vessels in radials, <50-100µm, 40-100/mm²
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma in marginal bands



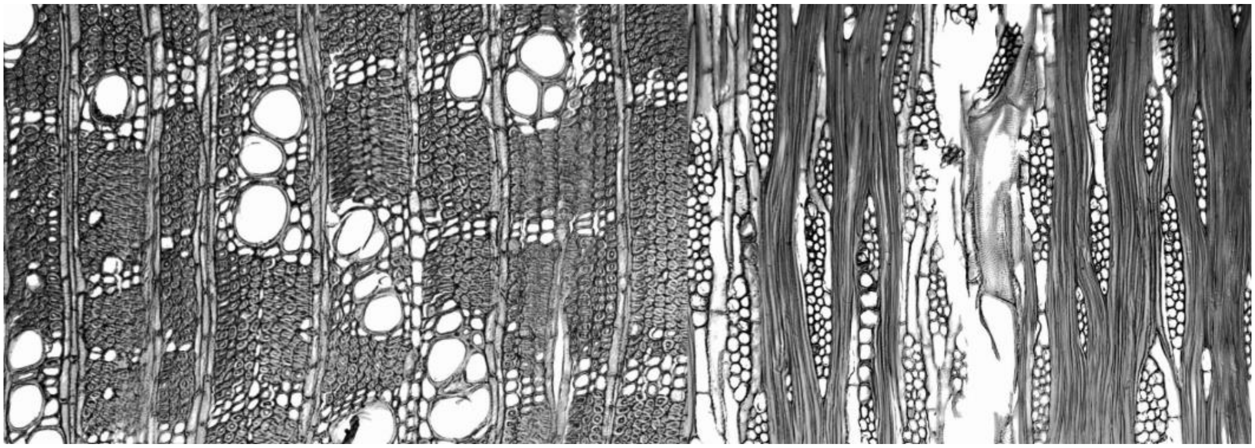
MALPIGHIACEAE *Bunchosia argentea,* *argentea*, *cornifolia*, *costaricensis*, *dwyeri*, *grayumii*, *lindeniana*, *macrophylla*, *media*, *mesoamericana*, *nitda*, *polystachia*, *ternata*, *ursana*, *volcaniaca*, *veluticarpa*, *swartziana* (cerezo de monte)

- Vessels 50-200µm, 5-20 /mm²
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma confluent, bands more than 3 cells wide

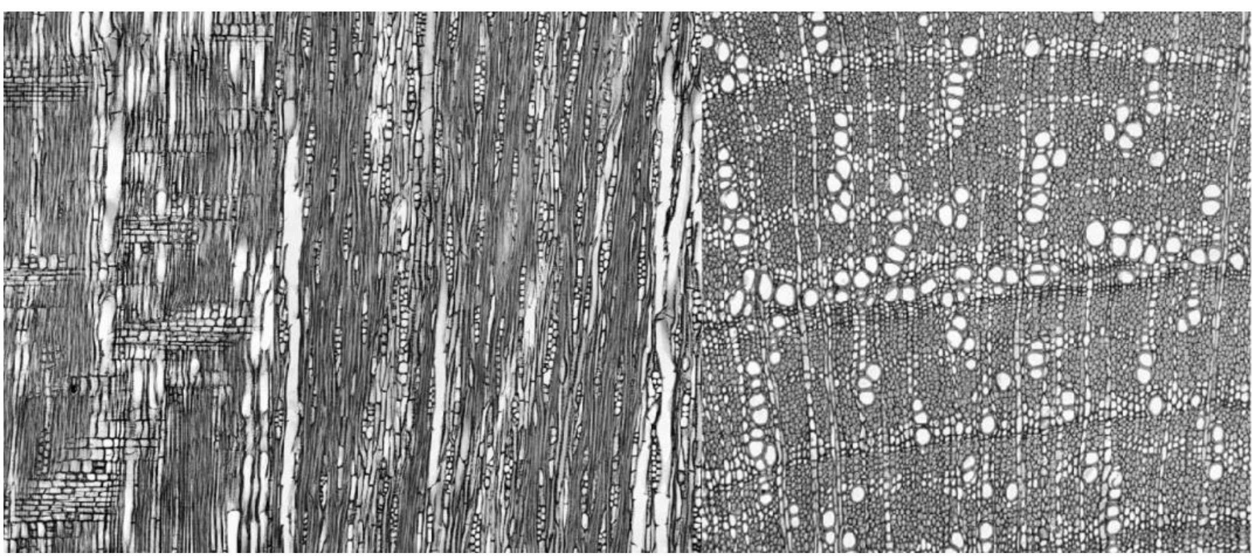


MALPIGHACEAE *Bunchosia nitida,* *argentea, cornifolia, costaricensis, dwyeri, grayumii, lindeniana, macrophylla, media, mesoamericana, polystachia, ternata, ursana, volcaniaca, veluticarpa, swartziana* (cerezo de monte)

- Vessels 50-100µm, 5-20 /mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse, scanty, aliform, confluent, narrow bands

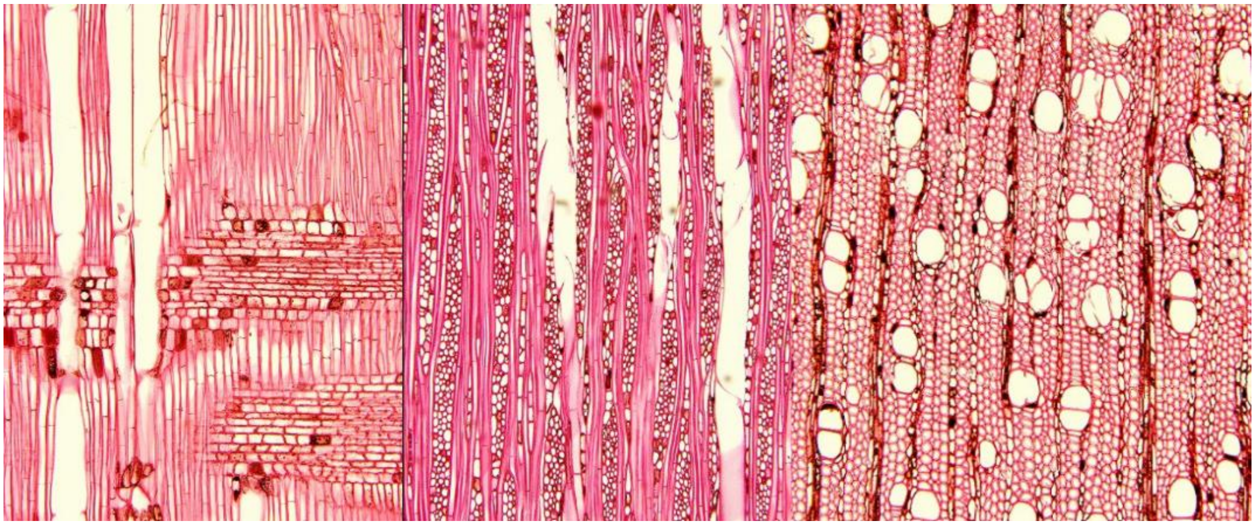


MALPIGHACEAE *Bunchosia swartziana,* *argentea, cornifolia, costaricensis, dwyeri, grayumii, lindeniana, macrophylla, media, mesoamericana, nitda, polystachia, ternata, ursana, volcaniaca, veluticarpa, swartziana* (cerezo de monte)



MALPIGHIACEAE ***Byrsonima crassifolia,*** *anthropoda* (nance, nancillo)

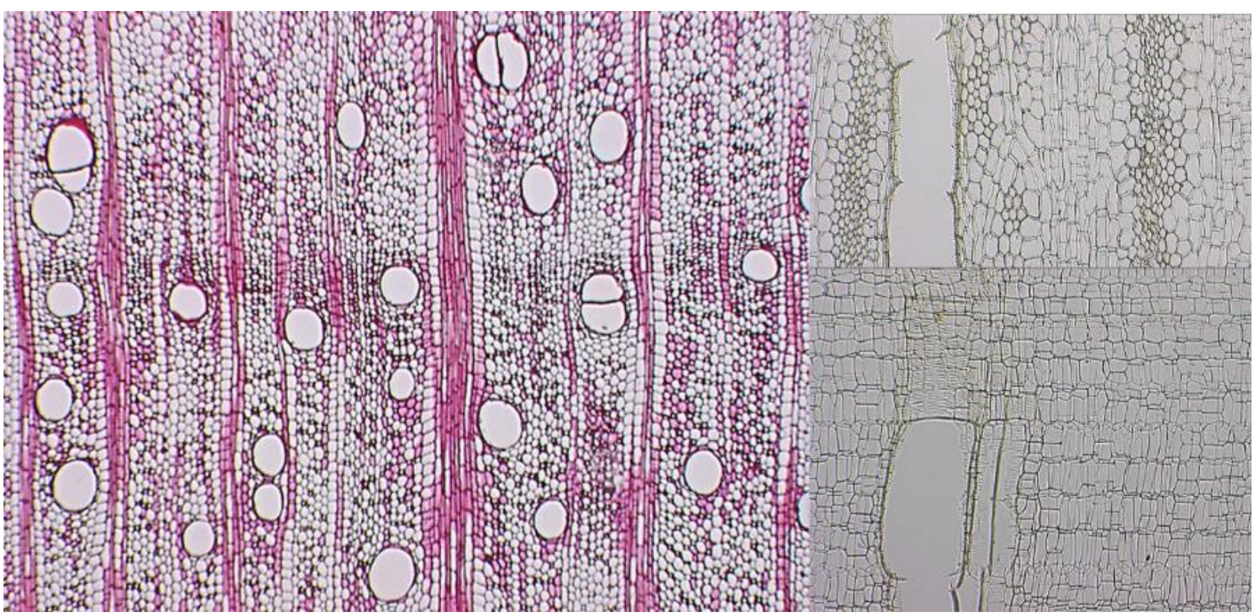
- Vessels 50-200µm, 5-40 /mm^2
- Rays 4 to 10 seriate, <4-12/mm
- Parenchyma diffuse, scanty, marginal bands



MALVACEAE ***Cavanillesia platanifolia*** (pijio, bongo, cuipo, petrino)

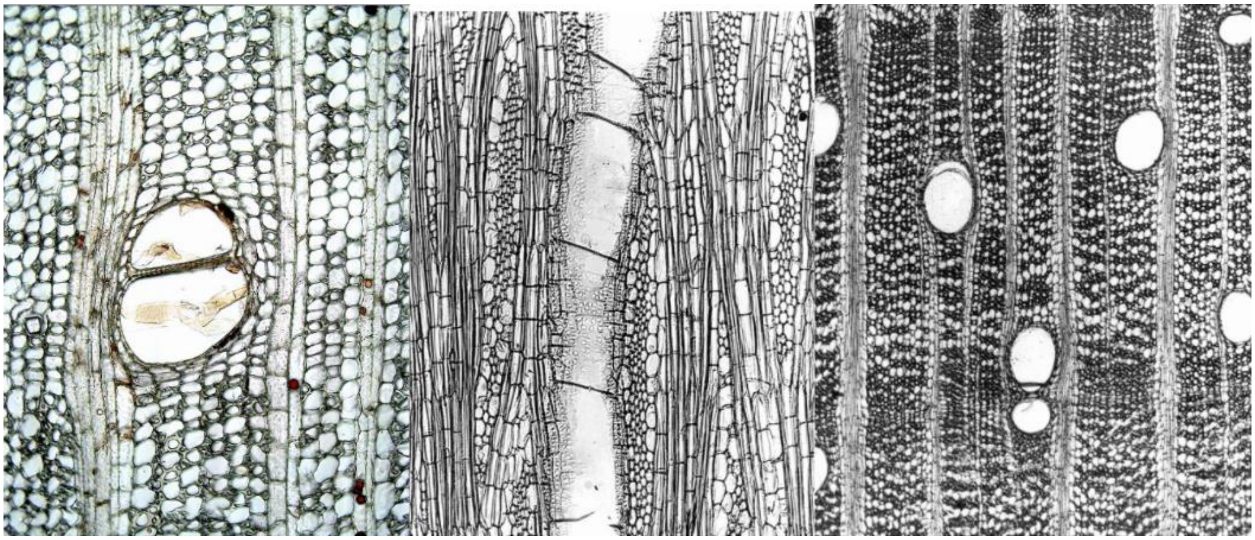
Only species in Costa Rica within this genus

- Vessels >200µm, <5 /mm^2
- Rays 4 to 10 seriate, <4/mm
- Parenchyma diffuse in aggregates, scanty, vasicentric



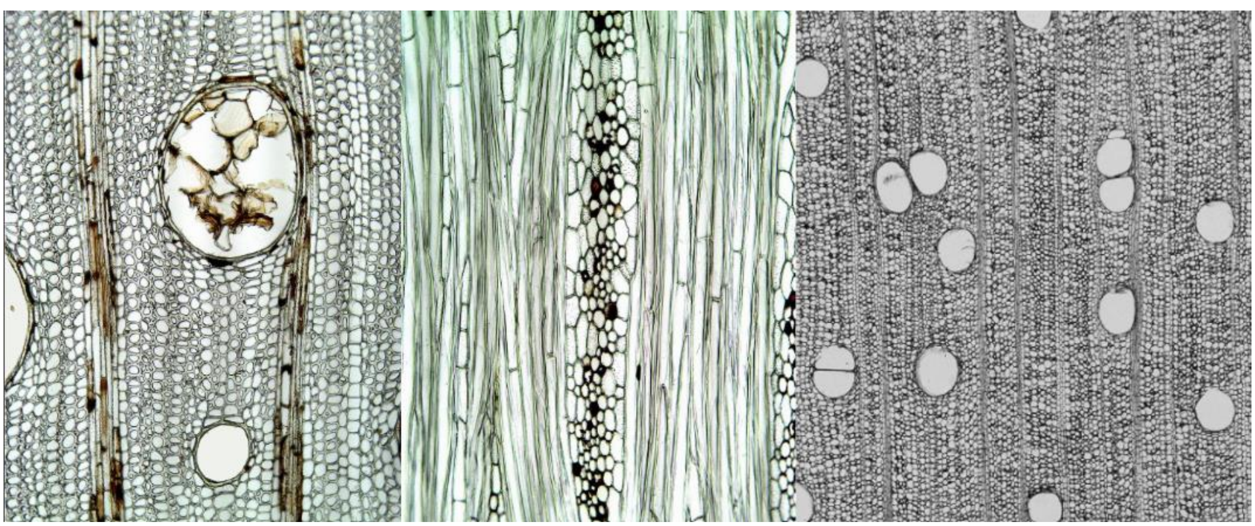
MALVACEAE BOMBACOIDEAE *Ceiba pentandra*, *aescuifolia* (kapok, ceibo)

- Vessels >200µm, >5-20 /mm^2, tyloses common
- Rays 4 to 10+ seriate, <4-12/mm
- Parenchyma diffuse in aggregates, narrow bands, vasicentric



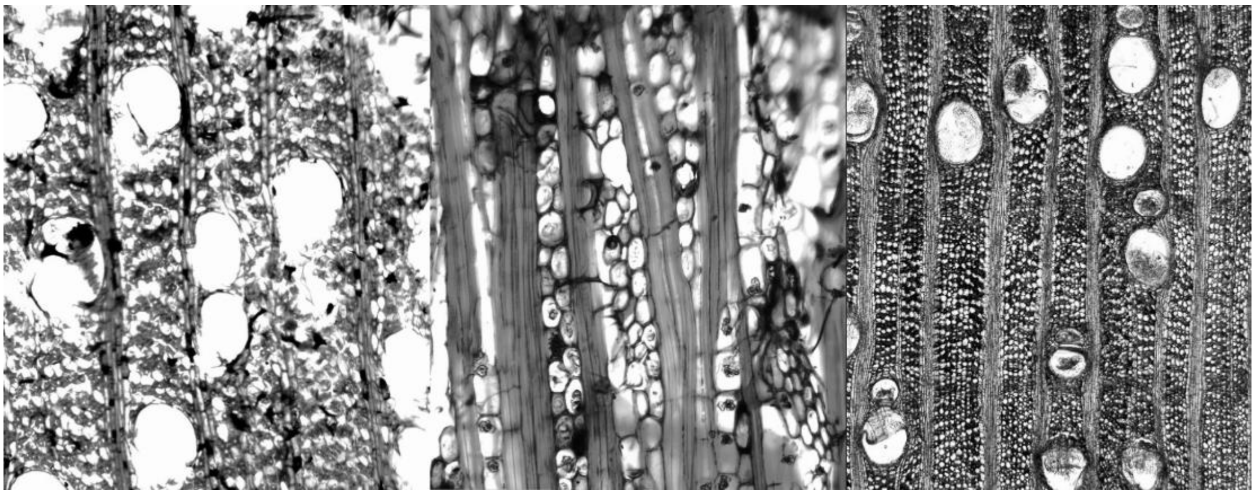
MALVACEAE BOMBACOIDEAE *Ochroma pyramidale* (balsa, balso)

- Vessels >200µm, <5 /mm^2
- Rays 4 to 10 seriate, <=4/mm
- Parenchyma diffuse in aggregates, scanty



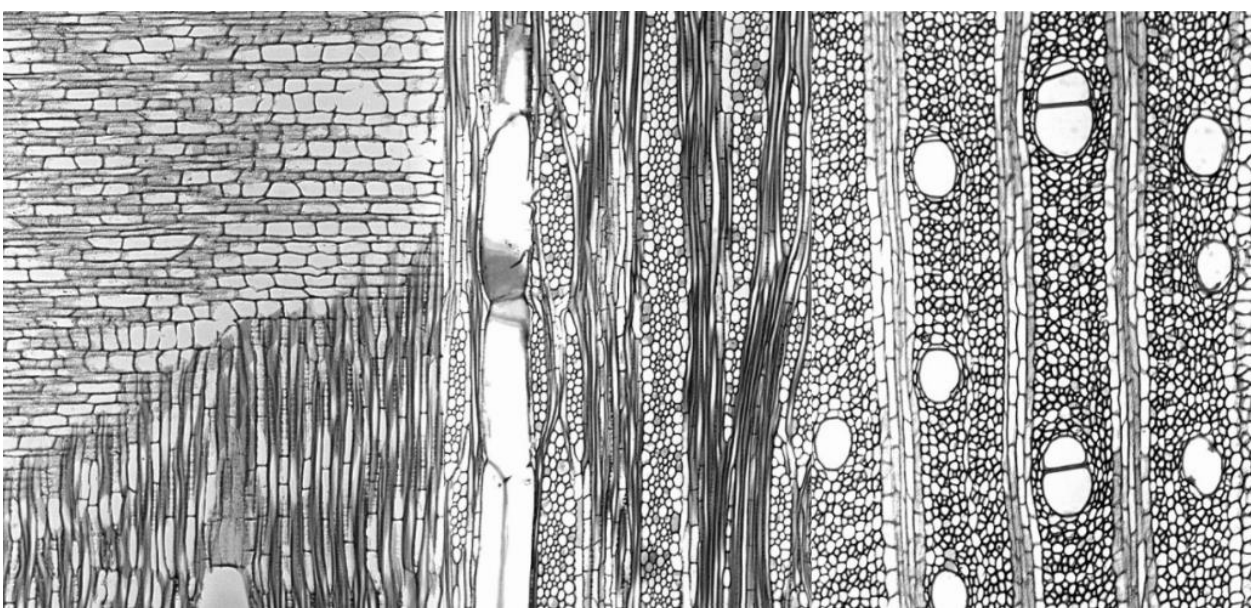
MALVACEAE BOMBACOIDEAE *Pachira aquatica* (sapote, coco de agua, guiana chestnut)
P. aquatica, caerulea, pustulifera, quinata, sessilis (yuco de monte, ceibo)

- Vessels >200µm, 5-20 /mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse in aggregates, narrow bands



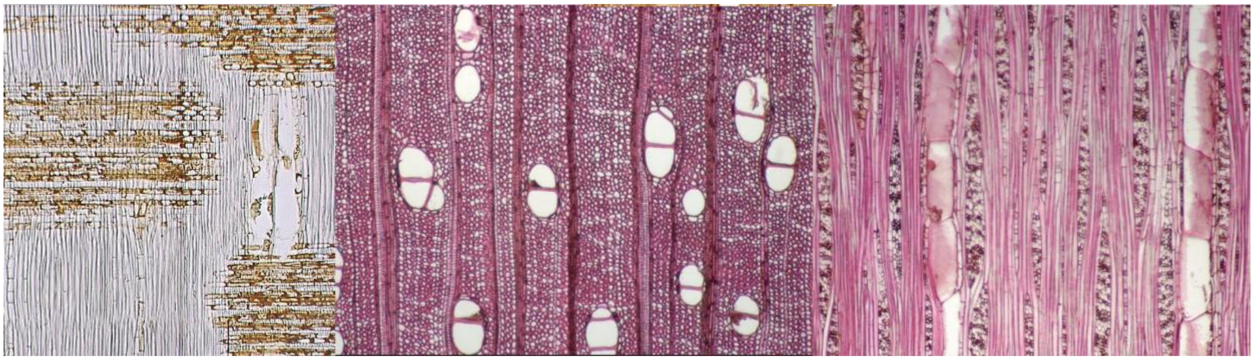
MALVACEAE BOMBACOIDEAE *Quararibea asterolepis* (guayabillo)
Q. funebris, yunckeri, ochrocalyx, oblliquifolia, costaricensis, stenophylla, platyphylla, parvifolia

- Vessels 100-200µm, <5-20/mm^2
- Rays 4 to 10, 4-12/mm
- Parenchyma diffuse, vasicentric, bands

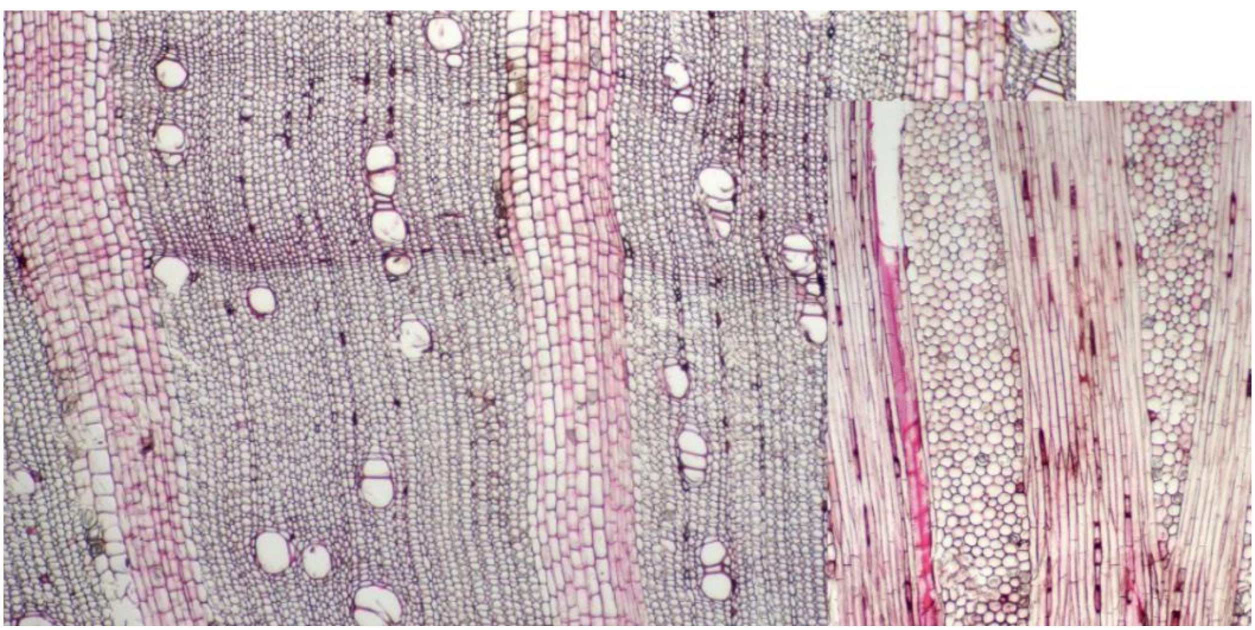


MALVACEAE BYTTNERIOIDEAE *Guazuma ulmifolia,* *invira* (guácimo)

- Vessels 50-200µm, 5-20/mm^2
- Rays 4-10 seriate, 4-12/mm
- Parenchyma diffuse in aggregates, scanty , narrow bands, marginal bands

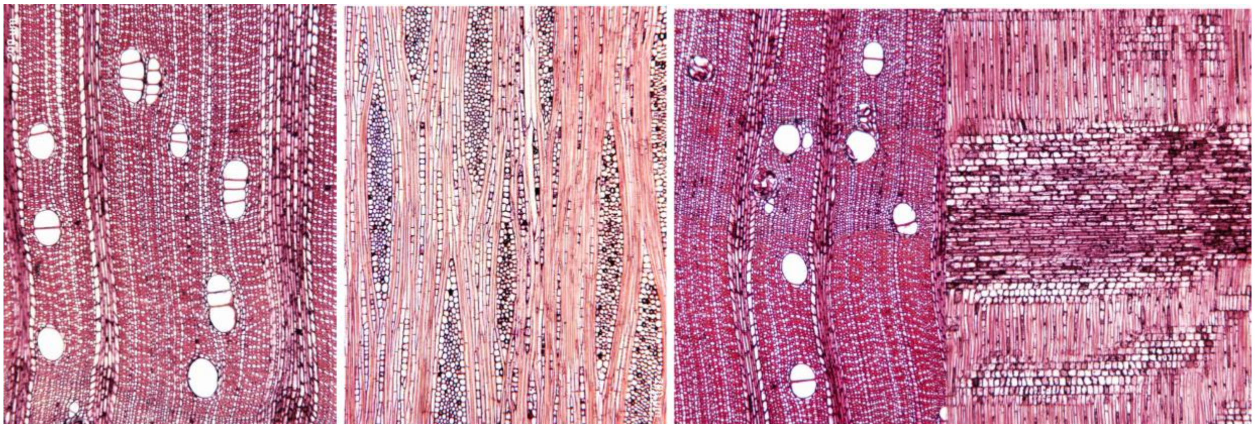


MALVACEAE BYTTNERIOIDEAE *Herrania* *purpurea*, image of *H. kanukensis* (cacao de monte)



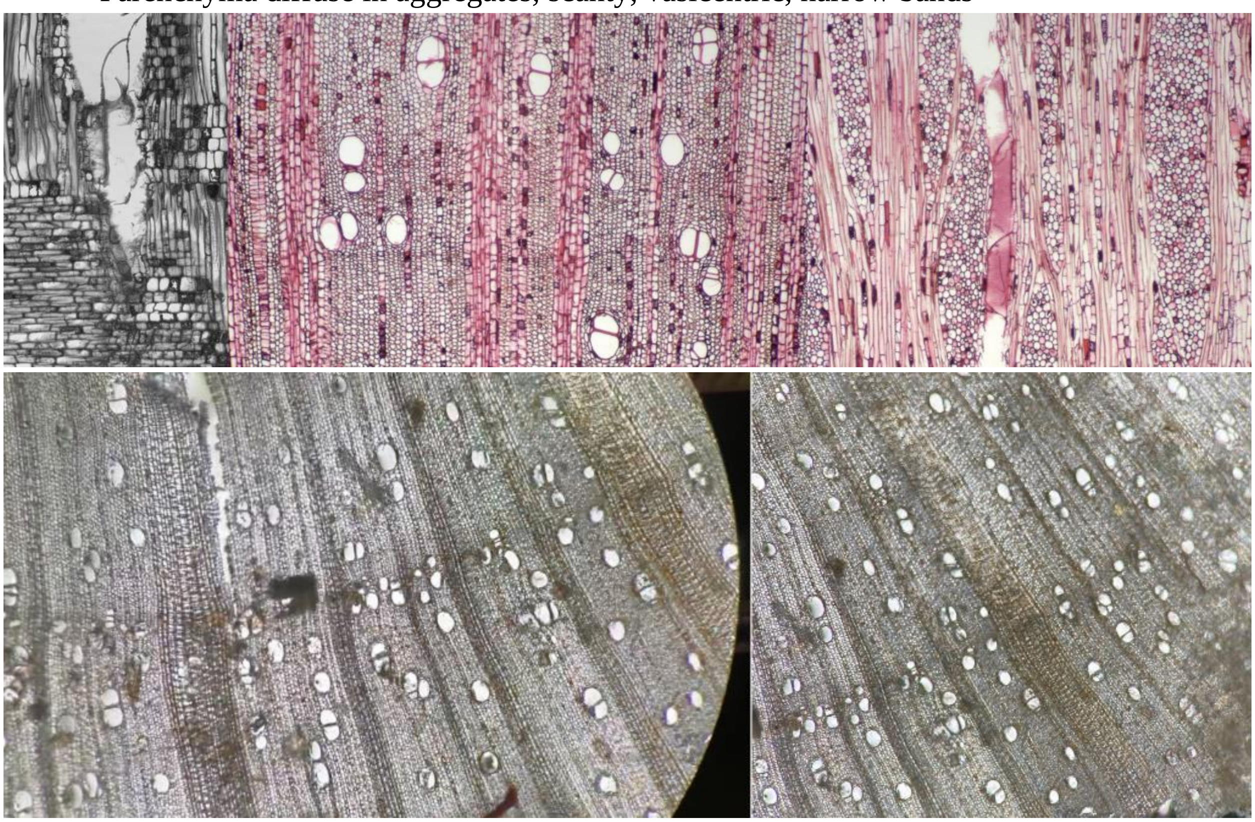
MALVACEAE BYTTNERIOIDEAE *Theobroma bernoullii,*
angustifloium, cacao, bicolor, mammosum, simiarum (synonym of *T. cacao)*

- Vessels 100-200µm, <5-20/mm^2
- Rays of two distinct sizes, 4-12/mm
- Parenchyma diffuse in aggregates, scanty, narrow bands



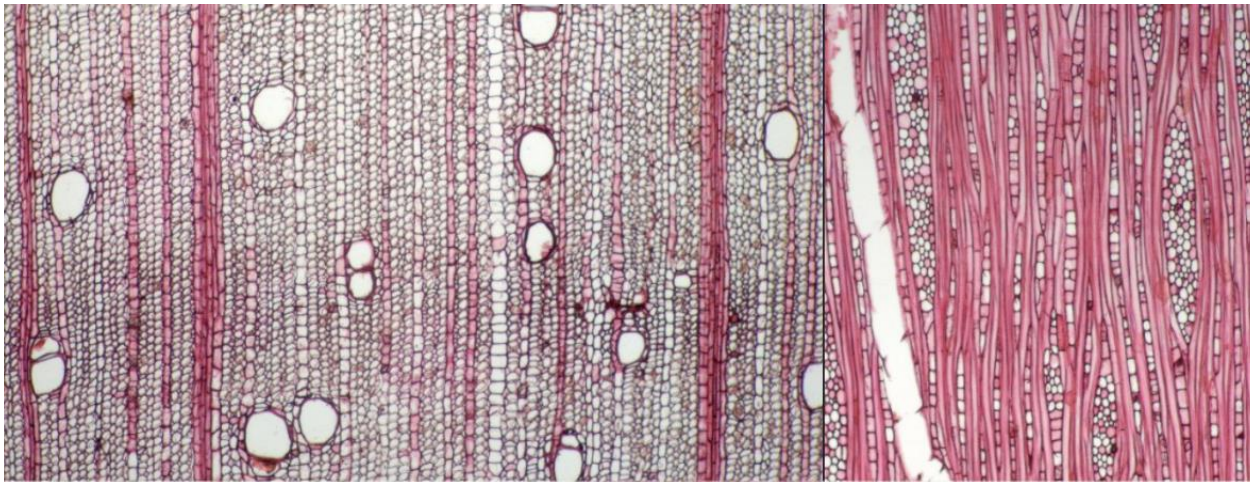
MALVACEAE BYTTNERIOIDEAE
Theobroma cacao, *angustifloium, bernoullii, bicolor, mammosum, simiarum* (cacao)

- Vessels 50-100µm, 5-20/mm^2
- Rays of two distinct sizes, 4-12/mm
- Parenchyma diffuse in aggregates, scanty, vasicentric, narrow bands



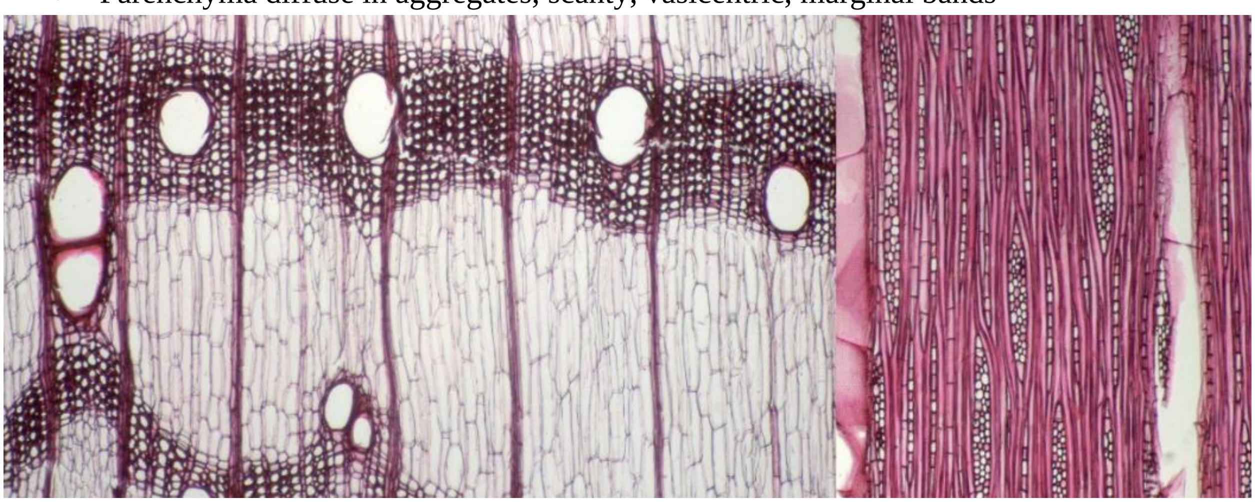
MALVACEAE GREWIOIDEAE *Apeiba membranacea,* *tibourbou* **(**peine de mono, peinecillo, cortezo, monkeys comb**)**

- Vessels 100-200µm, <5-20 /mm^2
- Rays of two distinct sizes, 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse in aggregates, scanty, vasicentric, marginal bands
- Tyloses common



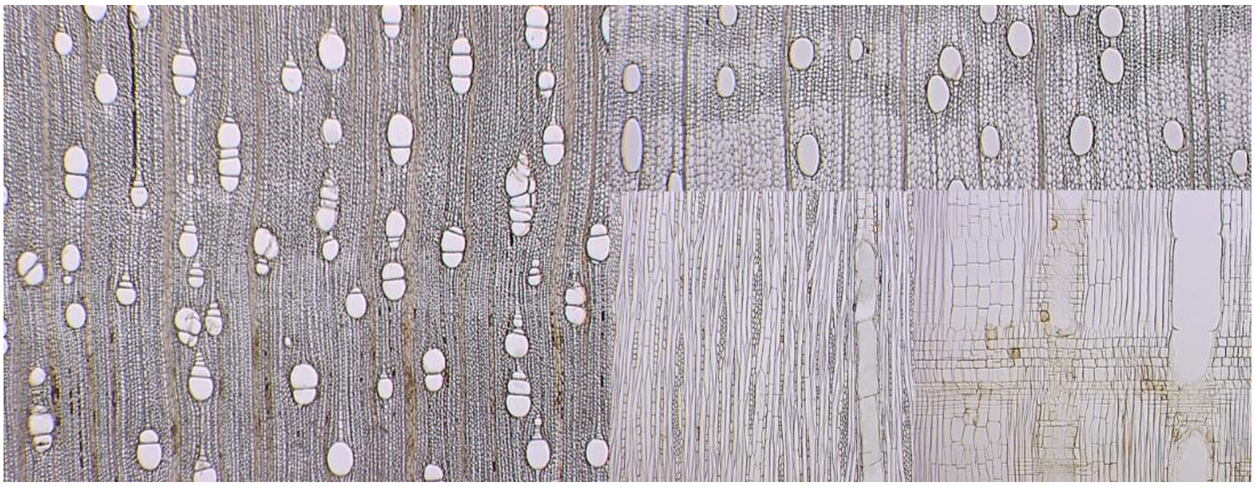
MALVACEAE GREWIOIDEAE *Apeiba tibourbou*
(peine de mono, peinecillo, cortezo, monkeys comb)

- Vessels 100-200µm, <5-20 /mm^2
- Rays Of two distinct sizes, 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse in aggregates, scanty, vasicentric, marginal bands



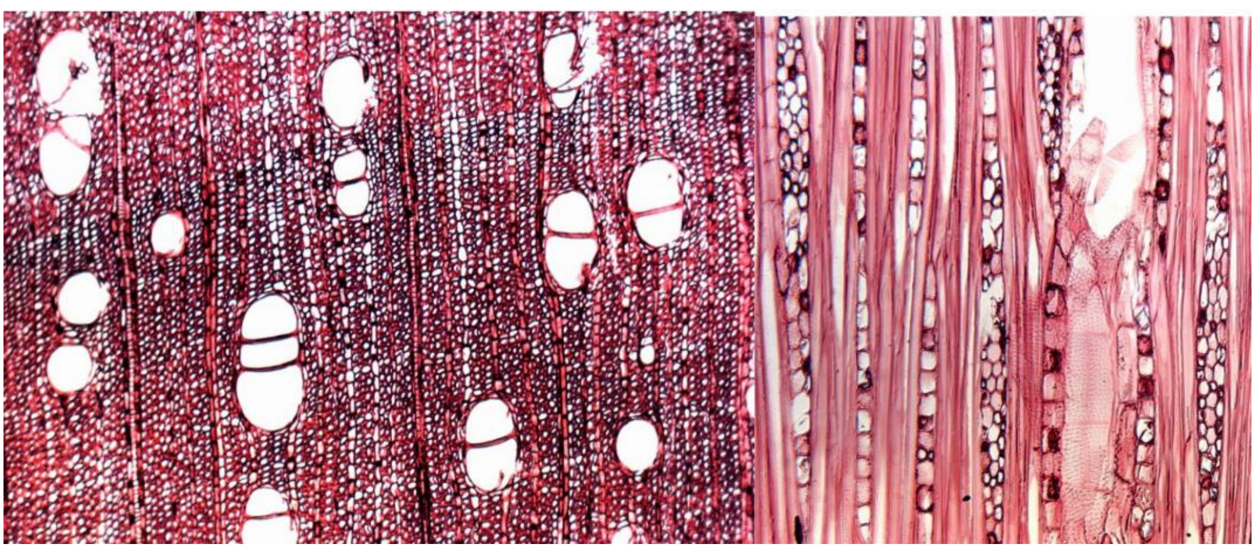
MALVACEAE GREWIOIDEAE *Heliocarpus americanus* (majaguillo/majagua) *H. appendiculatus, americanus, excelsor, mexicanus*

- Vessels 100-200µm, <5-20 /mm^2
- Rays 4 to 10 seriate, 4-12/mm, of two distinct sizes
- Parenchyma diffuse in aggregates, scanty, thick bands



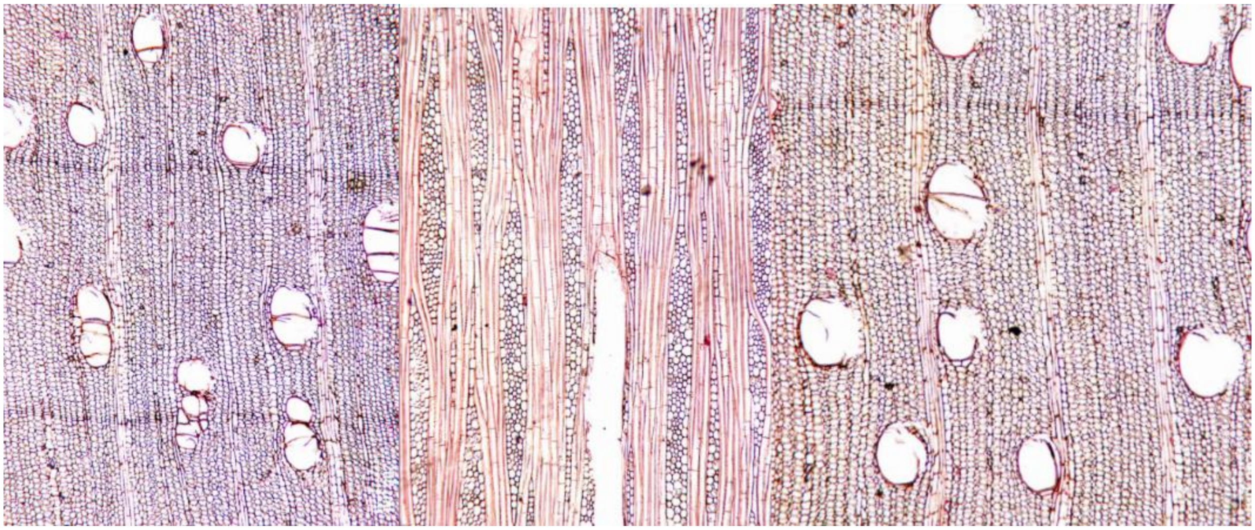
MALVACEAE GREWIOIDEAE *Luehea speciosa,* *seemannii*
(guácimo molenillo, guácimo blanco, guácimo borcico, guácimo tortugo)

- Vessels 50-100µm, 5-20 /mm^2
- Rays 4 to 10 seriate, 4-12/mm, all rays storied
- Parenchyma diffuse in aggregates, scanty, vasicentric



MALVACEAE TILLIOIDEAE *Mortoniodendron anisophyllum,* *abelianum, apetalum, cauliforum, costarricense, moralesii, guatemaensis, palaciosii*
(cuero de vieja)

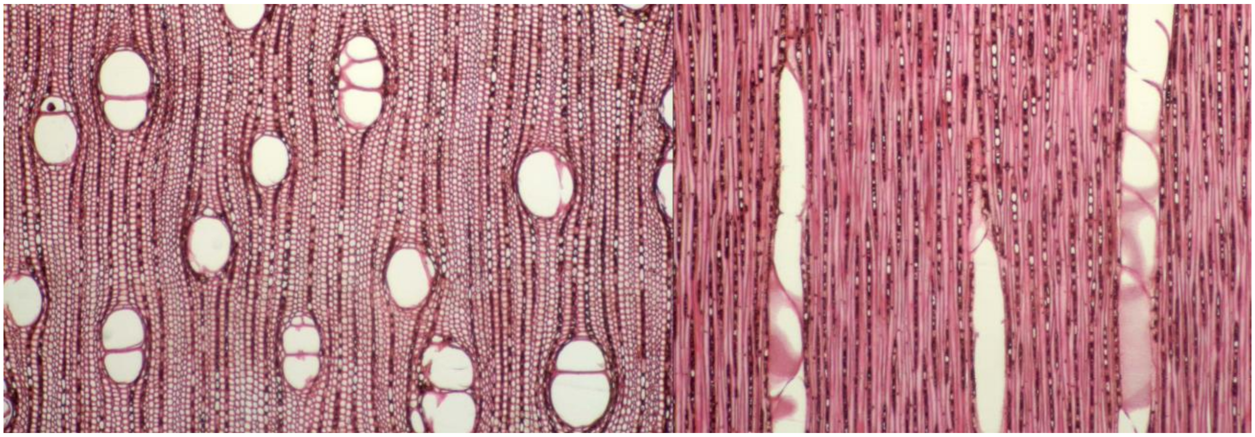
- Vessels 100-200µm, 5-20 /mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse in aggregates, scanty



MELASTOMATACEAE *Bellucia pentamera* *(coronillo), mespiloides, grossularioides*

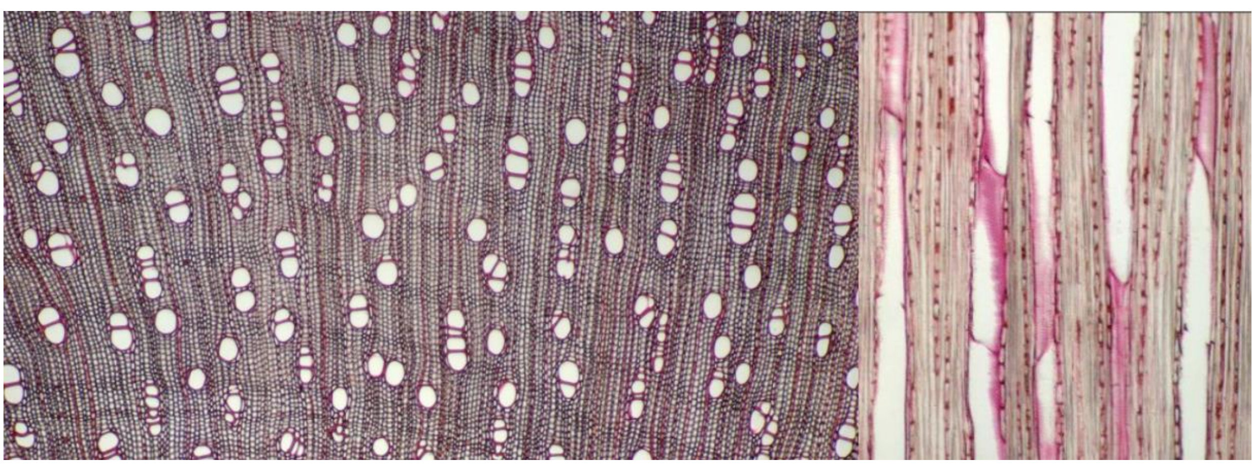
MELASTOMATACEAE *Bellucia grossularioides,* *pentamera, mespiloides* (coronillo)

- Vessels 50-200µm, 5-20/mm^2, tyloses common
- Rays exclusively uniseriate, 12+/mm
- Parenchyma rare, scanty



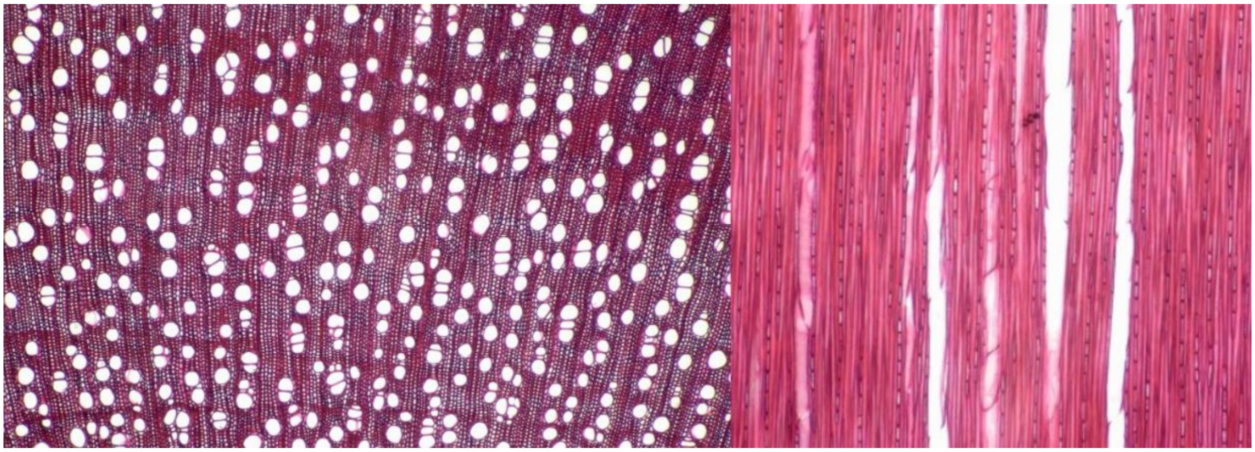
MELASTOMATACEAE *Clidemia capitellata,* *dentata, sericea, octona*
(soapbush, canillo)

- Vessels <50-100µm, 40-100+/mm^2
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma diffuse, scanty



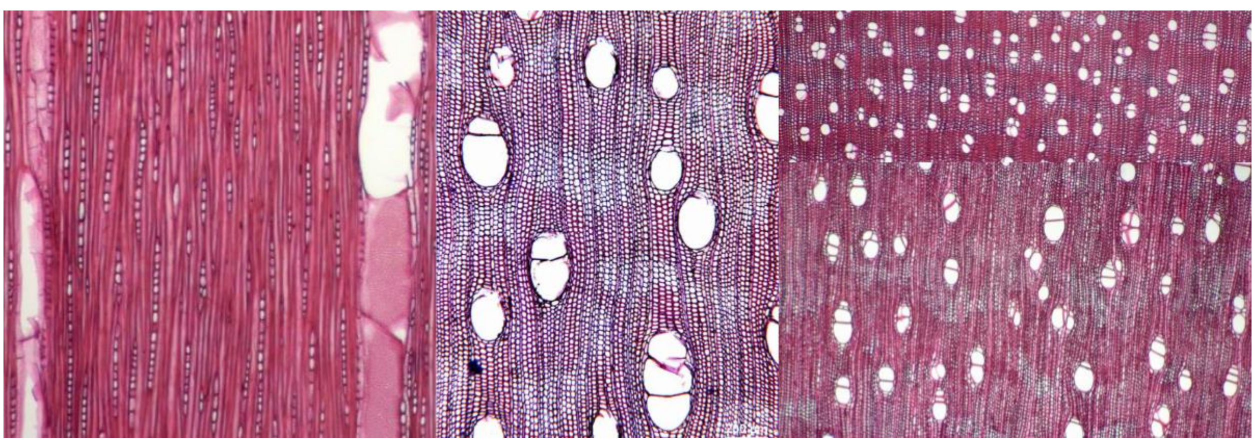
MELASTOMATACEAE *Clidemia dentata,* *capitellata, sericea, octona*
(soapbush, canillo)

- Vessels <50-100µm, 40-100+/mm^2
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma diffuse, scanty

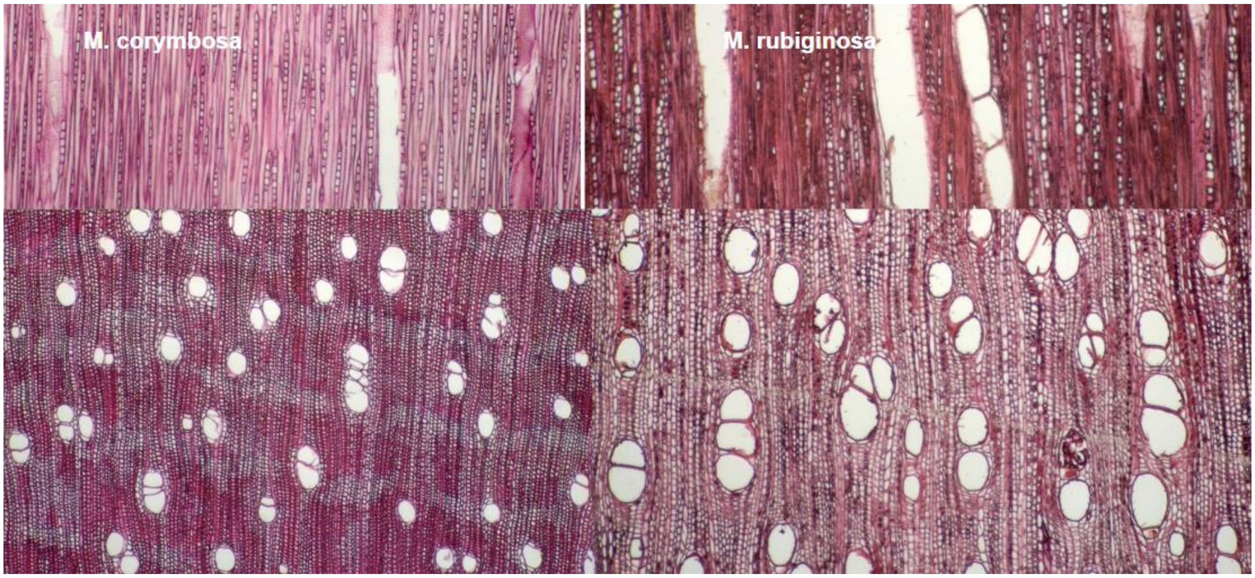


MELASTOMATACEAE *Conostegia rufescens,* (canillo, dos caras, papelillo, raspa lengua, quita manteca) *bracteata, cinnamomea, speciosa, xalapensis*

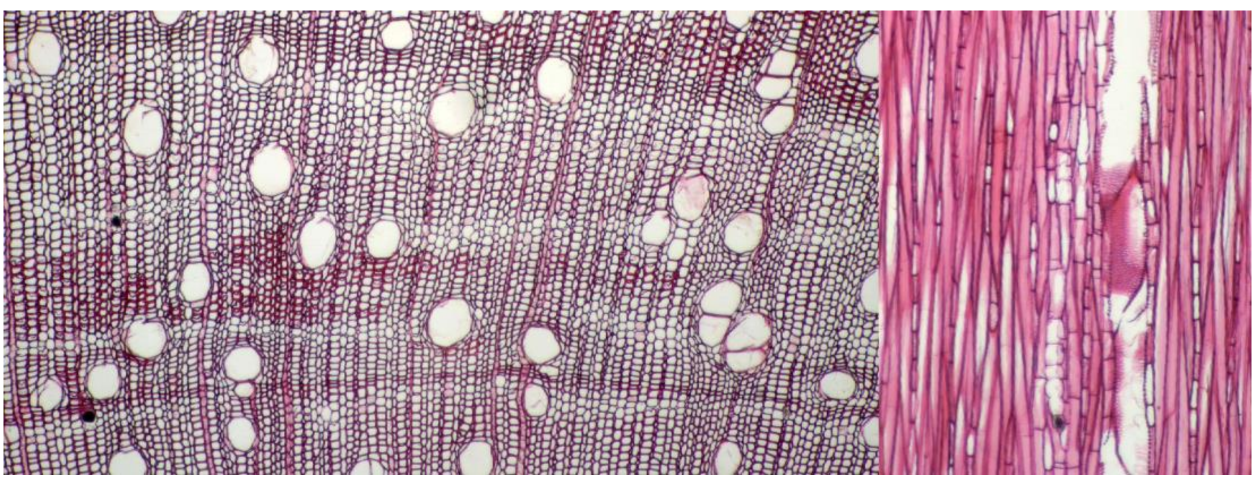
- Vessels 100-200µm, <5-20/mm^2
- Rays exclusively uniseriate, >12/mm
- Parenchyma scanty, banded more than 3 cells wide



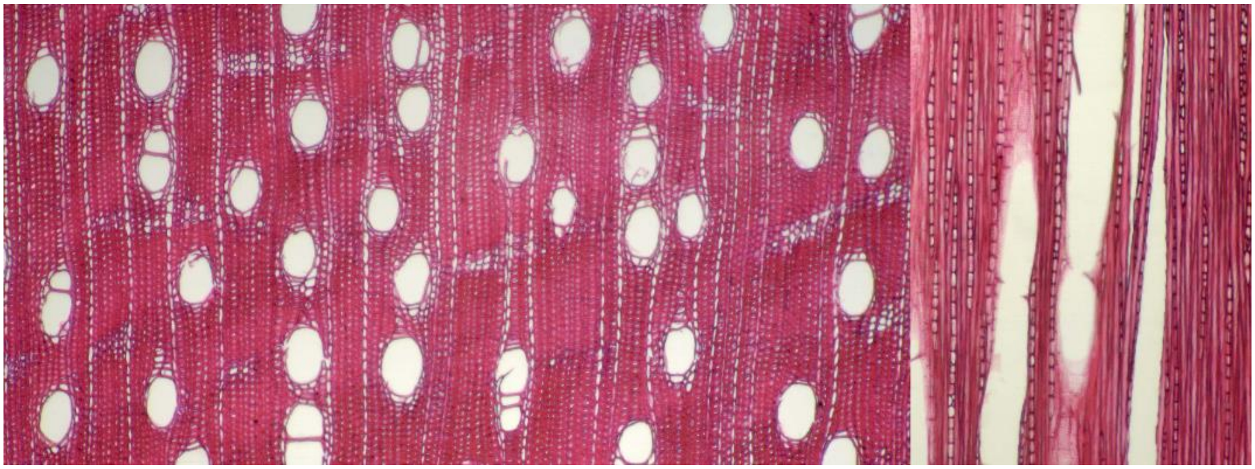
MELASTOMATACEAE *Miconia* (canillo, dos caras, papelillo) *affinis, argentea, elata, hondurensis, impetiolaris* (oreja de mula), *nervosa, oinochrophylla, trinervia*



MELASTOMATACEAE *Tibouchina bipenicillata,* *ciliaris, inopinata, lepidota, longifolia, urvilleana* (glory bush, lasiandra)

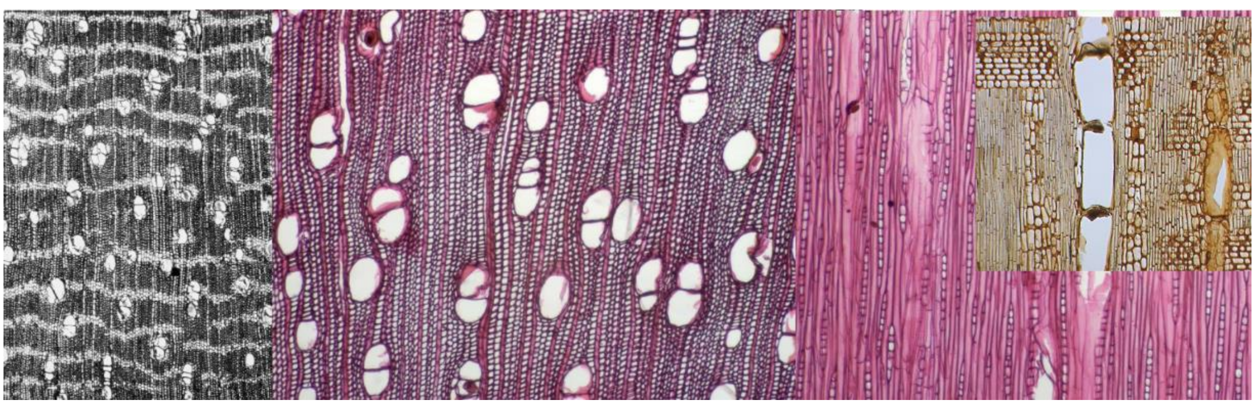


MELASTOMATACEAE ***Tibouchina ciliaris,*** *bipenicillata, inopinata, lepidota, longifolia, urvilleana* (glory bush, lasiandra)



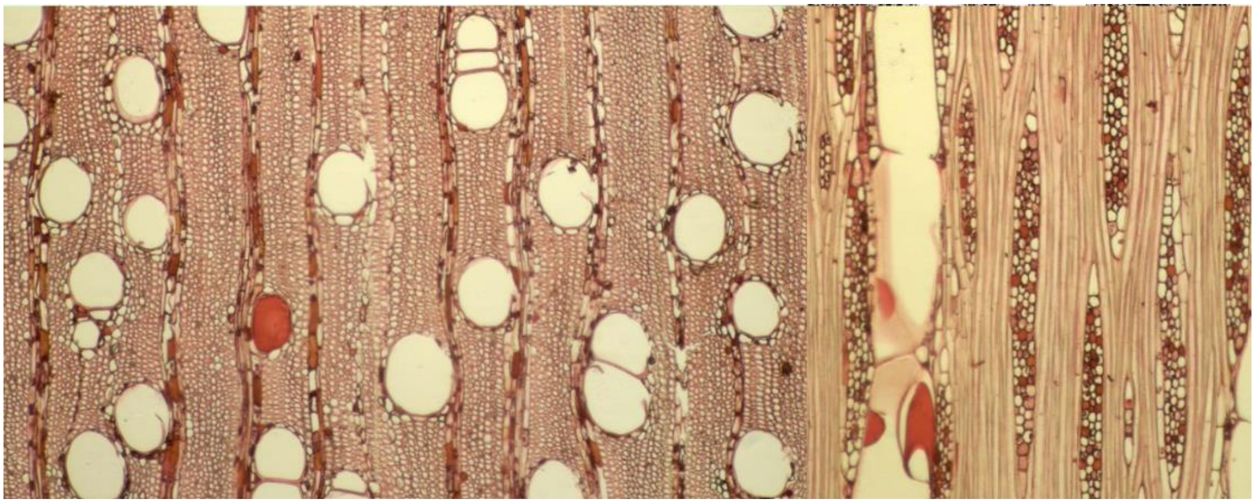
MELIACEAE ***Cabralea canjerana*** *(*canjerana)

- Vessels 100-200µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma confluent, thick bands
- Gums in heartwood vessels



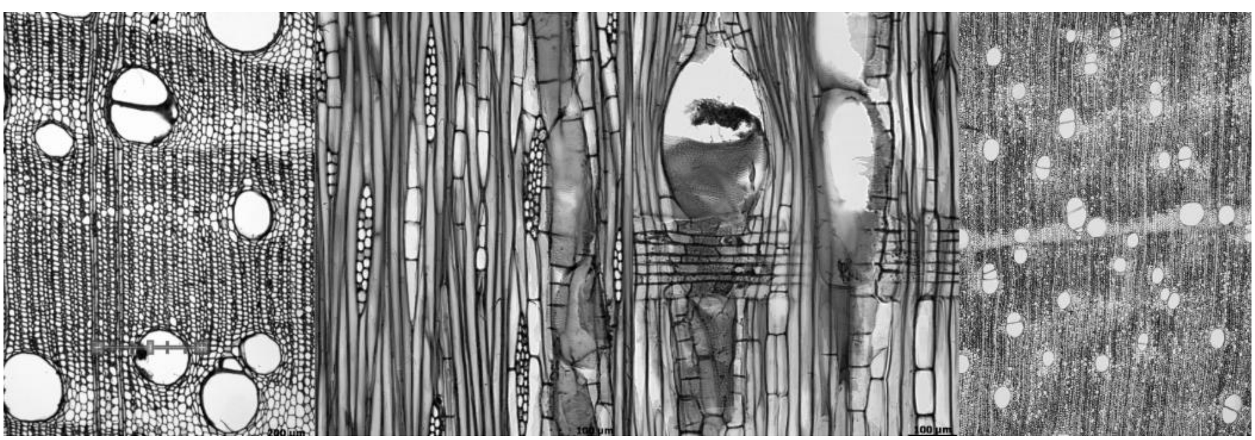
MELIACEAE *Carapa guianensis,* *nicaraguensis* (tangaré, cedro bateo)

- Vessels 100-200+µm, <5-20/mm^2
- Gums in heartwood vessels
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, vasicentric, marginal bands



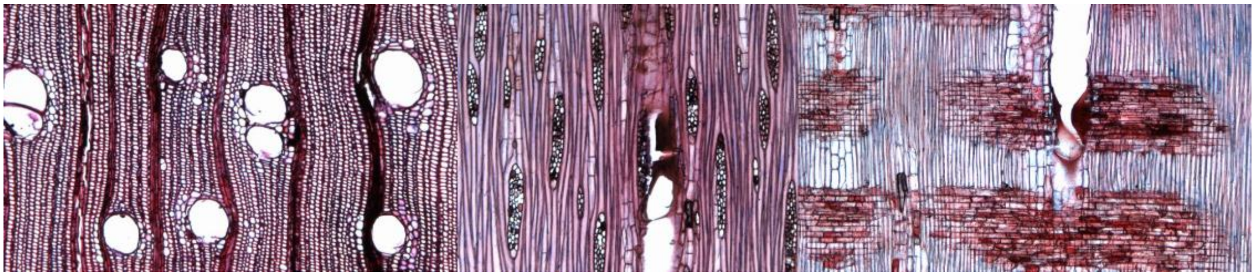
MELIACEAE *Cedrela fissilis* (cedro real) *Cedrela tonduzii, odorata, salvadorensis, fissilis*

- Vessels <5-20/mm^2, 100-200µm
- Rays 1to3, 4 to 10, 4-12/mm
- Parenchyma diffuse, vasicentric, marginal bands
- Gums in heartwood vessels



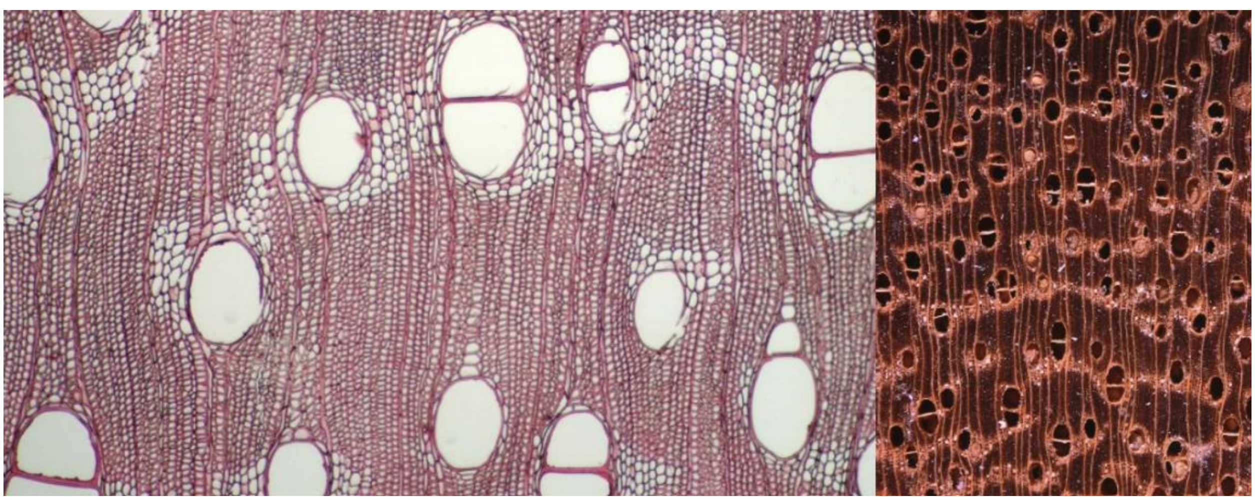
MELIACEAE *Cedrela odorata* (cedro) *Cedrela tonduzii*, *odorata*, *salvadorensis*, *fissilis*

- Vessels <5-20/mm^2, 100-200µm
- Rays 1to3, 4 to 10, 4-12/mm
- Parenchyma diffuse, vasicentric, marginal bands
- Gums in heartwood vessels



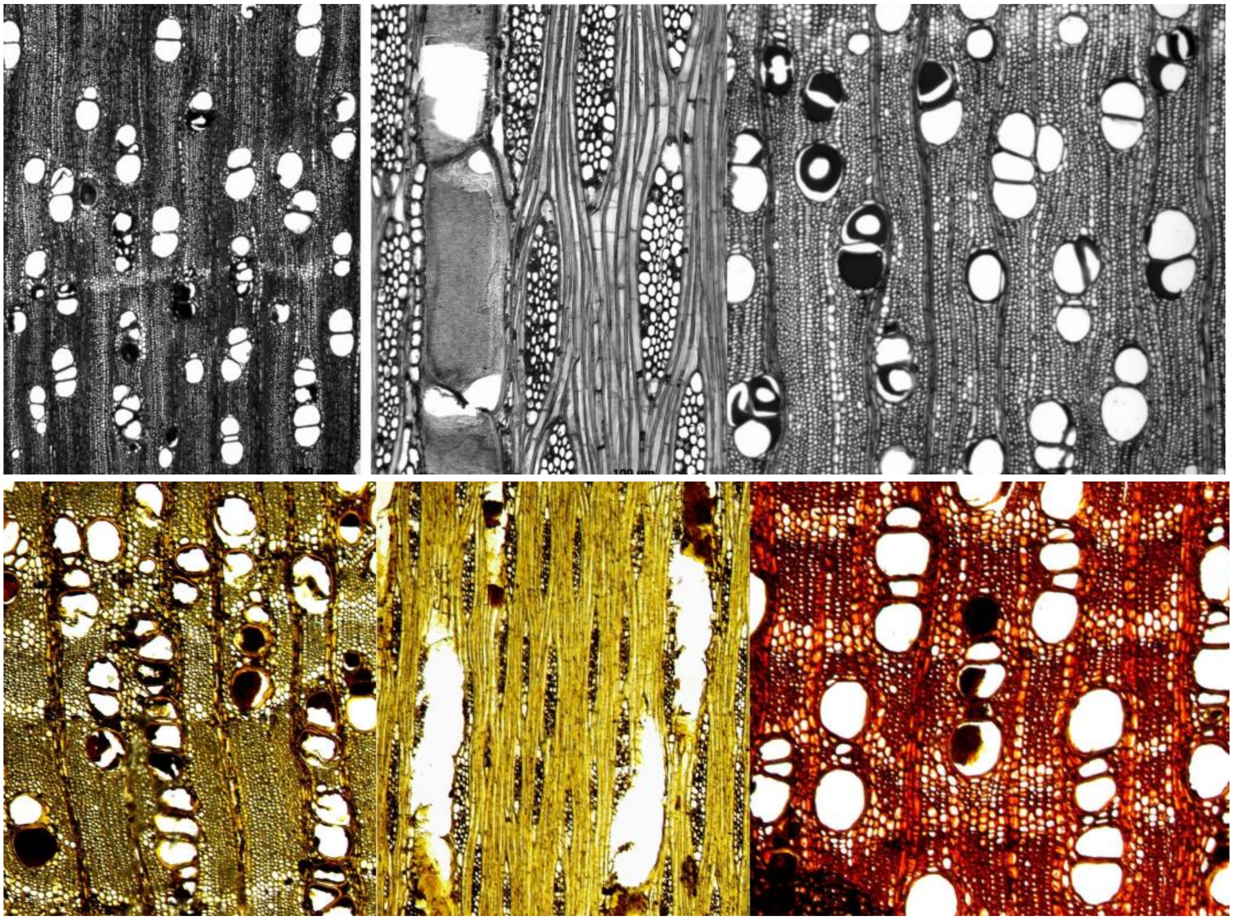
MELIACEAE *Guarea guidonia,* *grandifolia*, *pterorhachis* (chuchupate, cedro macho)

- Vessels <5-20/mm^2, >200µm, Gums in heartwood vessels
- Rays 1 to 3, 4-12/mm
- Parenchyma aliform, confluent, bands more than 3 cells wide



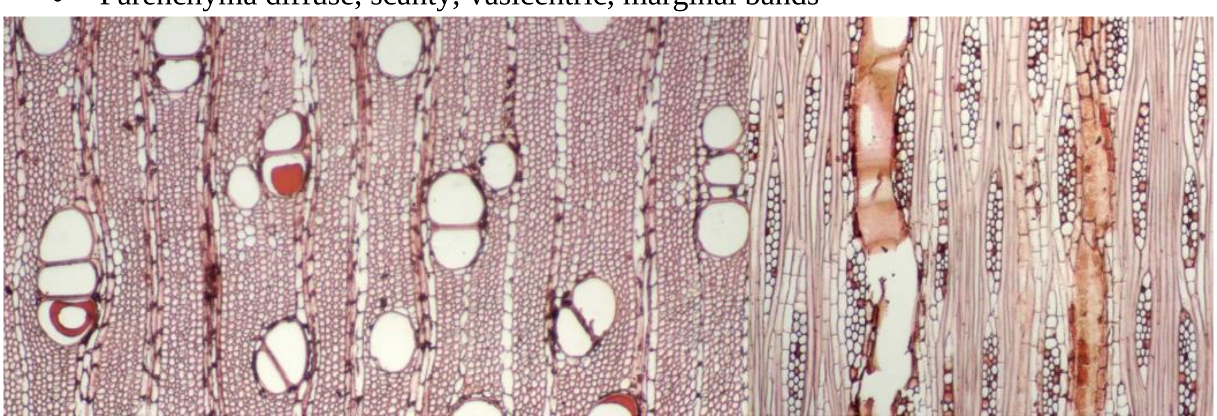
MELIACEAE *Swietenia humilis,* *macrophylla* (mahogany)

- Vessels <5-20/mm^2, 100-200µm, Gums in heartwood vessels
- Rays 1 to 3, 4 to 10, 4-12/mm, all storied
- Parenchyma diffuse, scanty, vasicentric, marginal bands



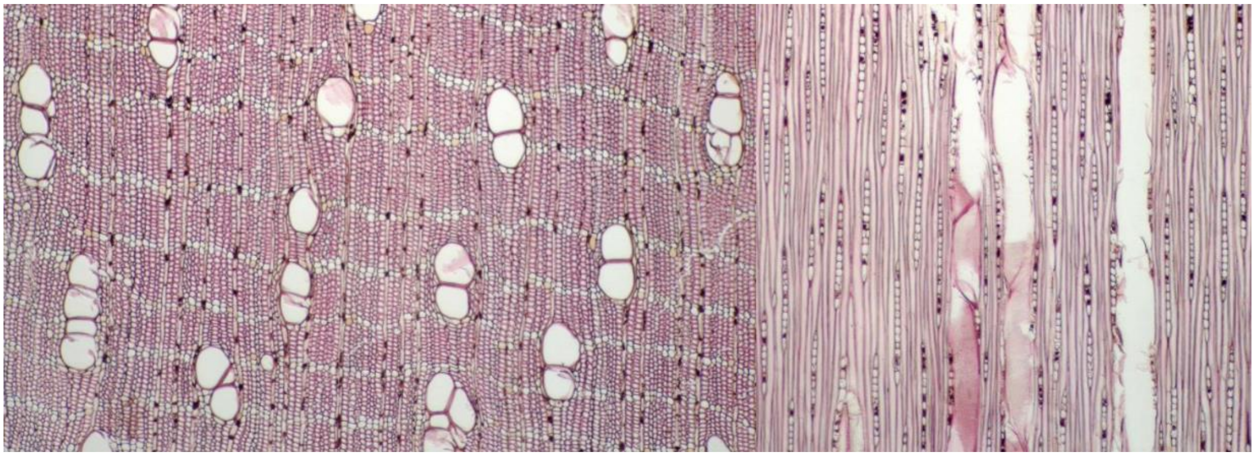
MELIACEAE *Swietenia macrophylla,* *humilis* (caoba, mahogany)

- Vessels <5-20/mm^2, 100-200µm, Gum in heartwood vessels
- Rays 1 to 3, 4 to 10, 4-12/mm, all storied
- Parenchyma diffuse, scanty, vasicentric, marginal bands



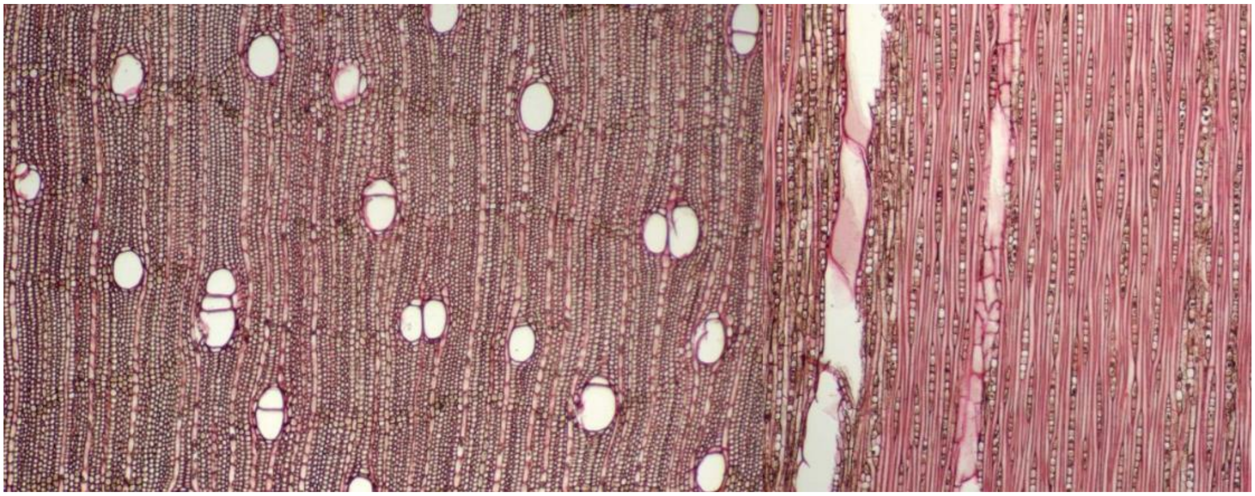
MELIACEAE ***Trichilia martiana,*** *hirta, pallida, pleeana, tuberculata*
(conejo colorado, mata piojo)

- Vessels 100-200µm, 5-20/mm^2, Gums in heartwood vessels (cacahuillo)
- Rays 1 to 3 cells, 4 to 10, 4-12/mm
- Parenchyma scanty, reticulate, narrow bands



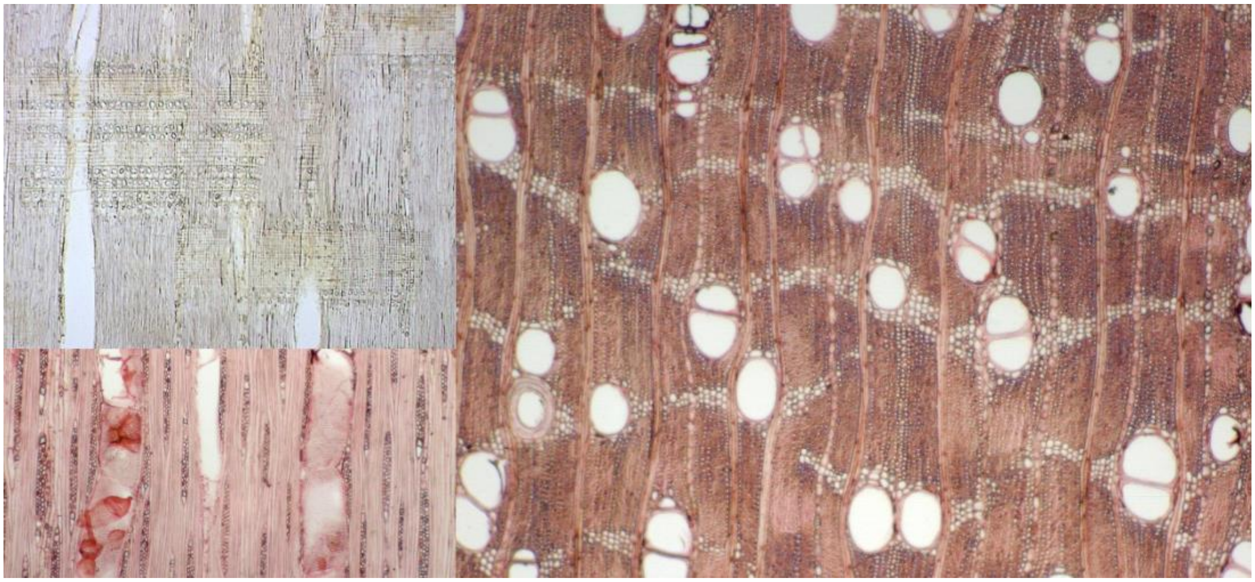
MELIACEAE ***Trichilia pallida,*** *hirta, martiana, pleeana, tuberculata* (terciopelo, conejito colorado)

- Vessels 50-100µm, 5-40/mm^2, Gums in heartwood vessels
- Rays exclusively uniseriate, >=12/mm
- Parenchyma aliform, winged, confluent, narrow bands



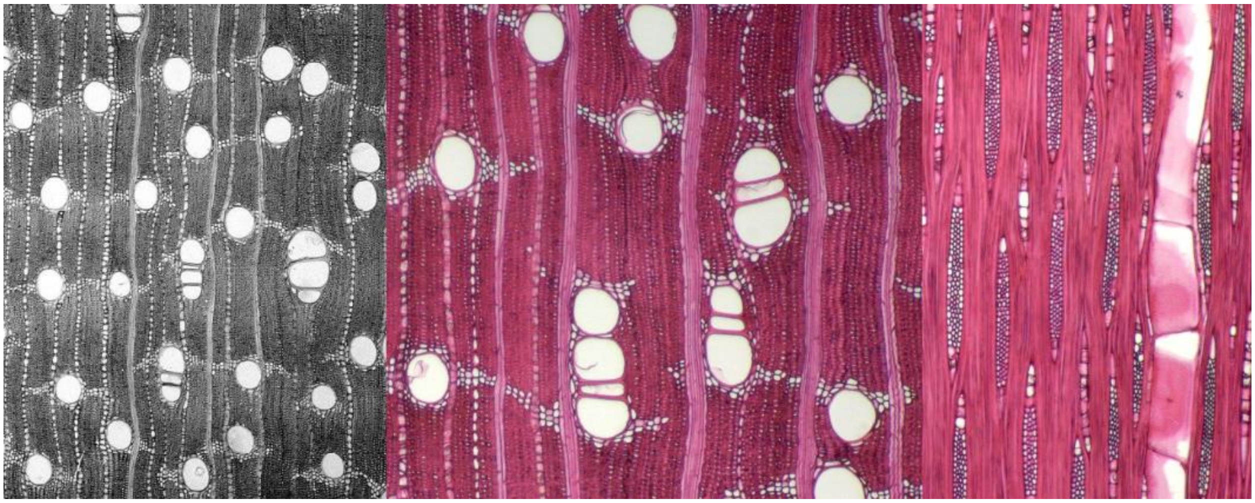
MORACEAE *Brosimum alicastrum,* *costaricanum, guianense, utile* (breadnut, ramon, berbá, cacique)

- Vessels 50-200 µm, 5-20 /mm^2, tyloses common, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, winged, confluent, unilateral



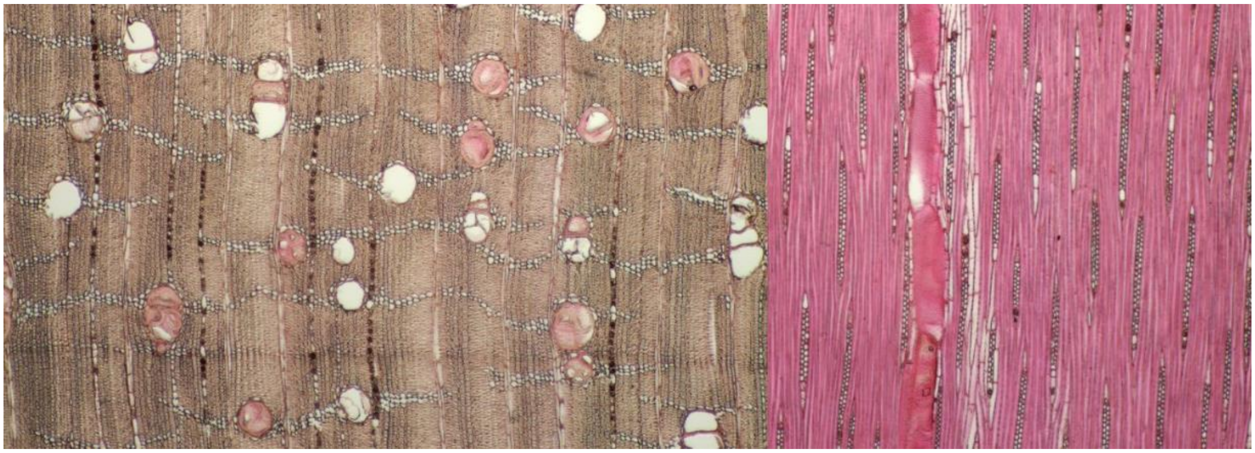
MORACEAE *Brosimum costaricanum,* *alicastrum, guianense, utile*
(breadnut, ramon, berbá, cacique)

- Vessels 50-200 µm, 5-20 /mm^2, tyloses common, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, winged, confluent, unilateral



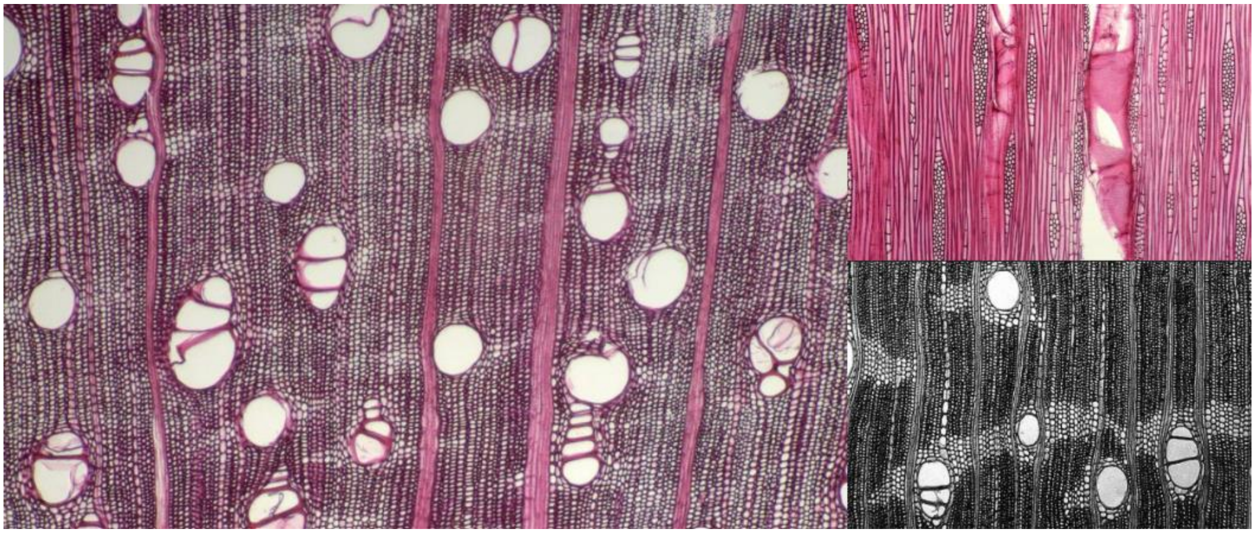
MORACEAE *Brosimum guianense*, *costaricanum, alicastrum, utile* (berbá, cacique)

- Vessels 50-200 µm, 5-20 /mm², tyloses common, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, winged, confluent, unilateral



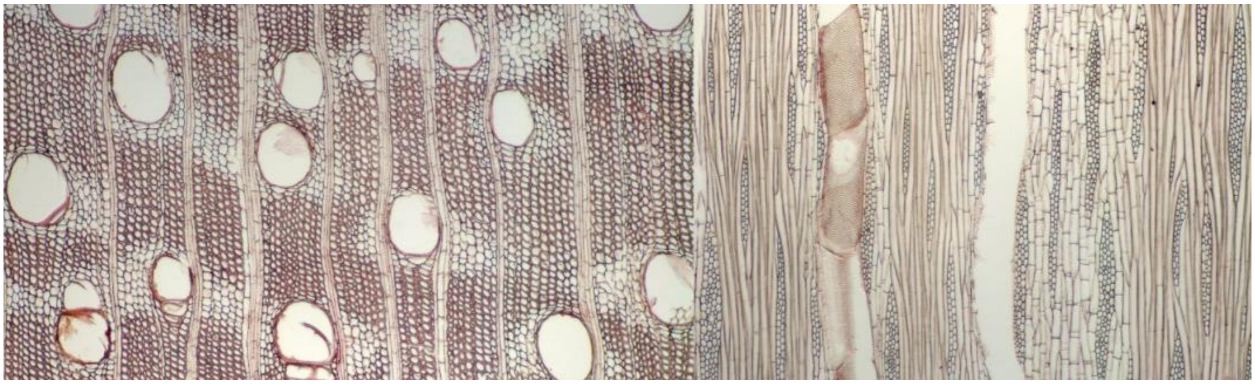
MORACEAE *Brosimum utile,* *costaricanum, alicastrum, guianense* (sande, mastate, breadnut)

- Vessels 50-200 µm, 5-20 /mm², tyloses common, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, winged, confluent, unilateral



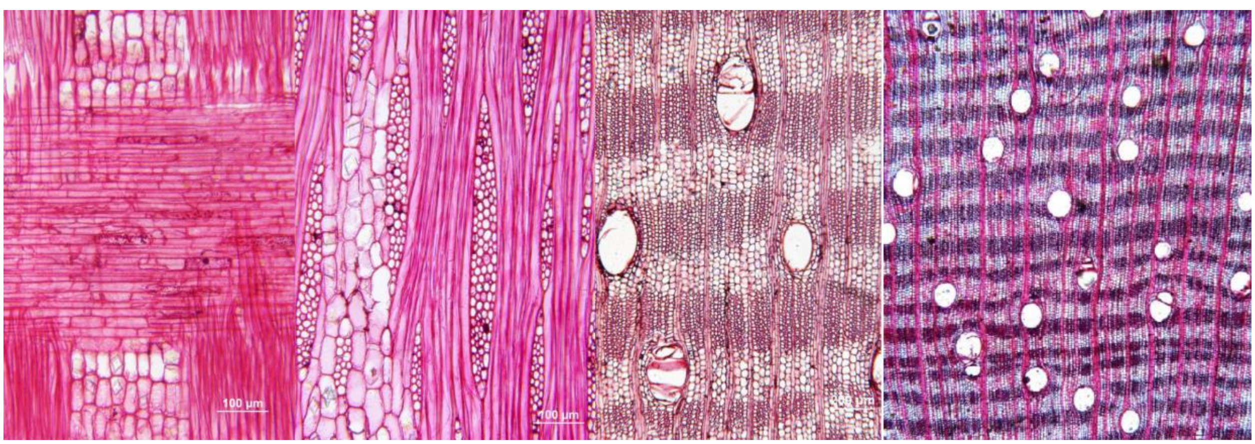
MORACEAE *Castilla elastica* (caucho, mastate blanco, hule, rubber tree)

- Vessels 100-200 µm, <5-20 /mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, bands more than 3 cells wide

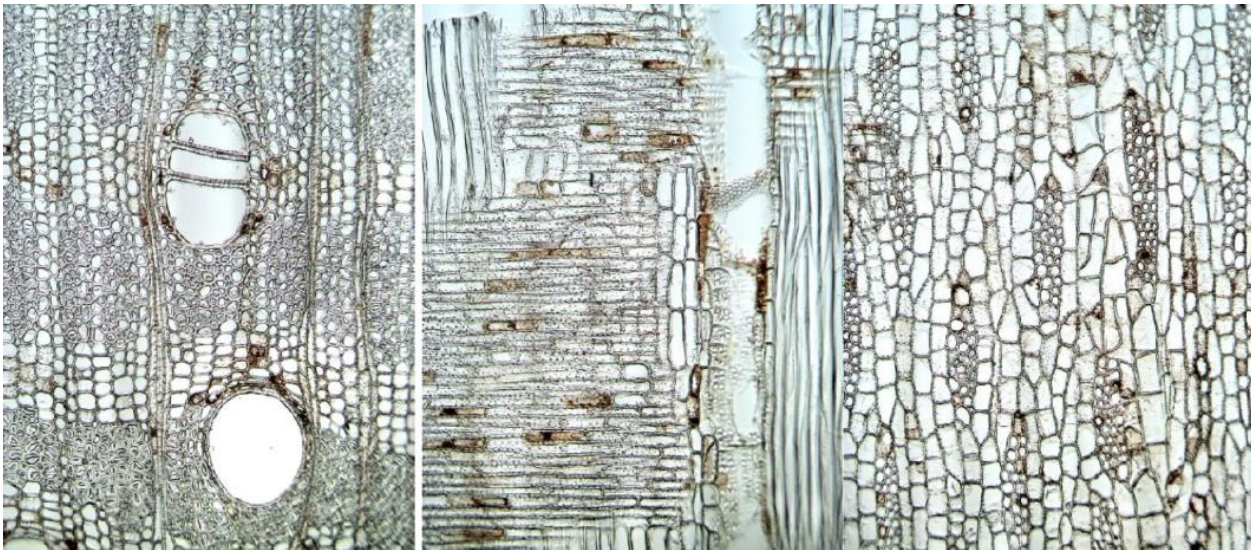


MORACEAE *Ficus citrifolia* (fig, higuerón) *F. americana, colubrinae, costaricana, citrifolia, cotinifolia, crassiuscula, davidsoniae, elastica, insipida, pertusa, maxima, morazaniana, obtusifolia, schippii, tonduzii, turrialbana, velutina, yopensis*

- Vessels 100-200+ µm, <5/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma thick bands
- Tyloses common

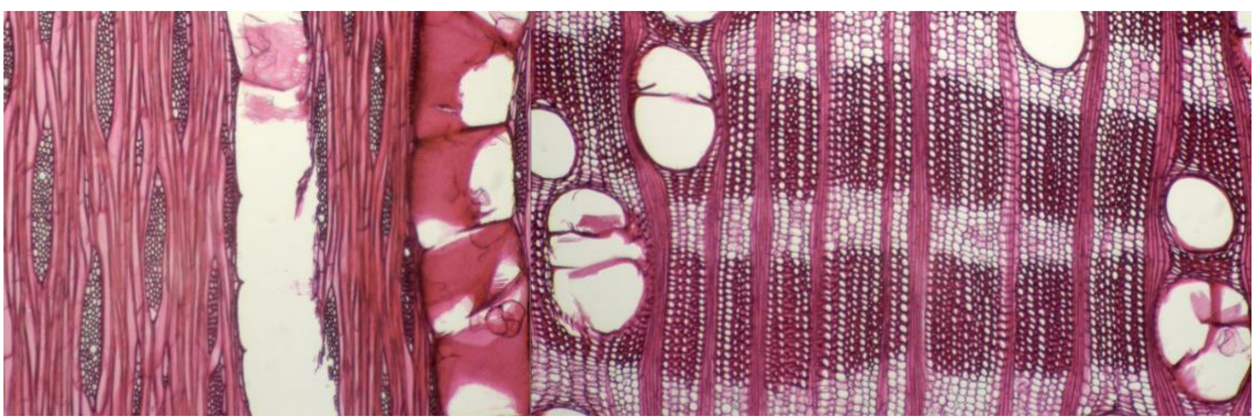


MORACEAE *Ficus elastica* (fig) *F. americana, colubrinae, costaricana, citrifolia, cotinifolia, crassiuscula, davidsoniae, elastica, insipida, pertusa, maxima, morazaniana, obtusifolia, schippii, tonduzii, turrialbana, velutina, yopensis*



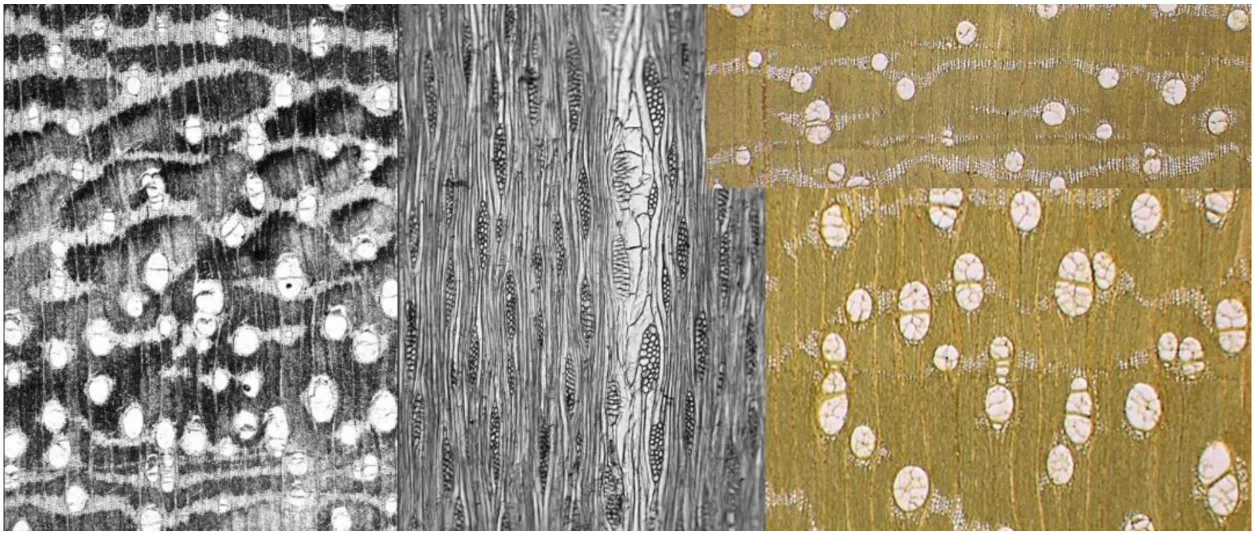
MORACEAE *Ficus insipida* (fig, higuerón) *F. americana, citrifolia, colubrinae, costaricana, cotinifolia, crassiuscula, davidsoniae, elastica, maxima, morazaniana, obtusifolia, pertusa, schippii, tonduzii, turrialbana, velutina, yopensis*

- Vessels 200+ µm, <5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma thick bands
- Tyloses common



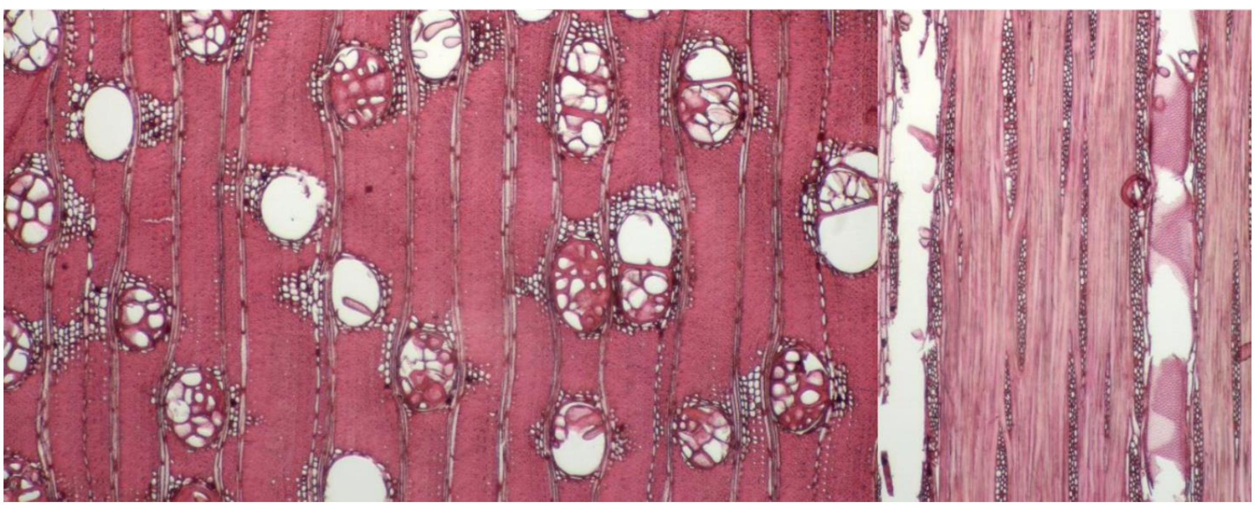
MORACEAE *Maclura tinctoria* (moro, mora, amarillo)
Only species in Costa Rica within this genus

- Vessels 100-200+ µm, <5-20/mm^2, Tyloses common
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma thick bands



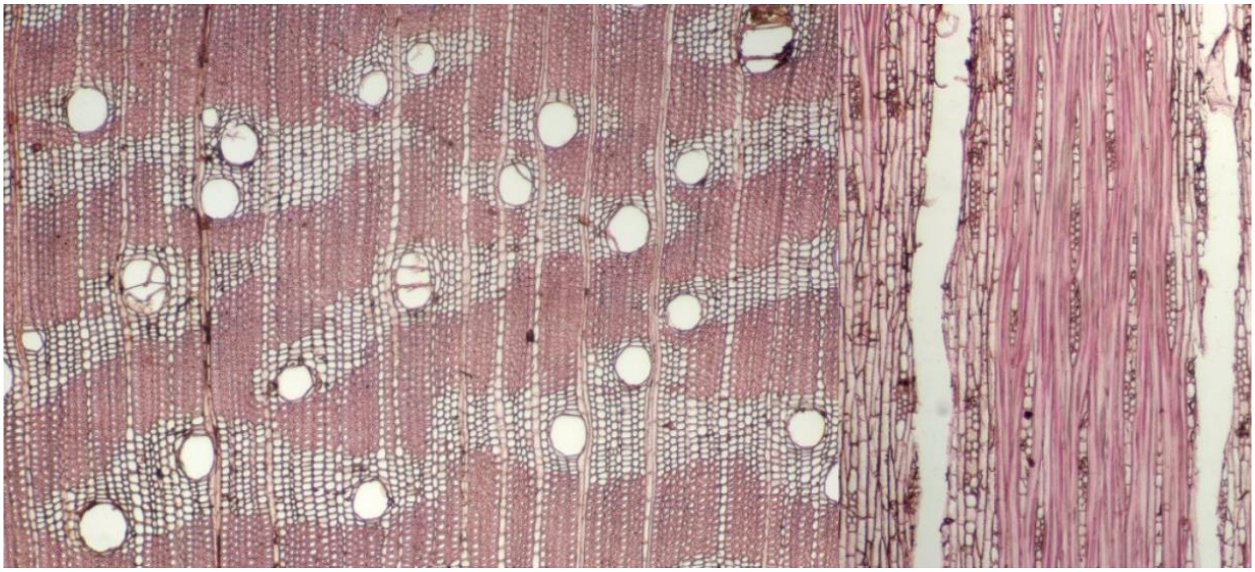
MORACEAE *Maquira guianensis,* *costaricana* (palo de pico)

- Vessels 100-200 µm, 5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, unilateral, banded

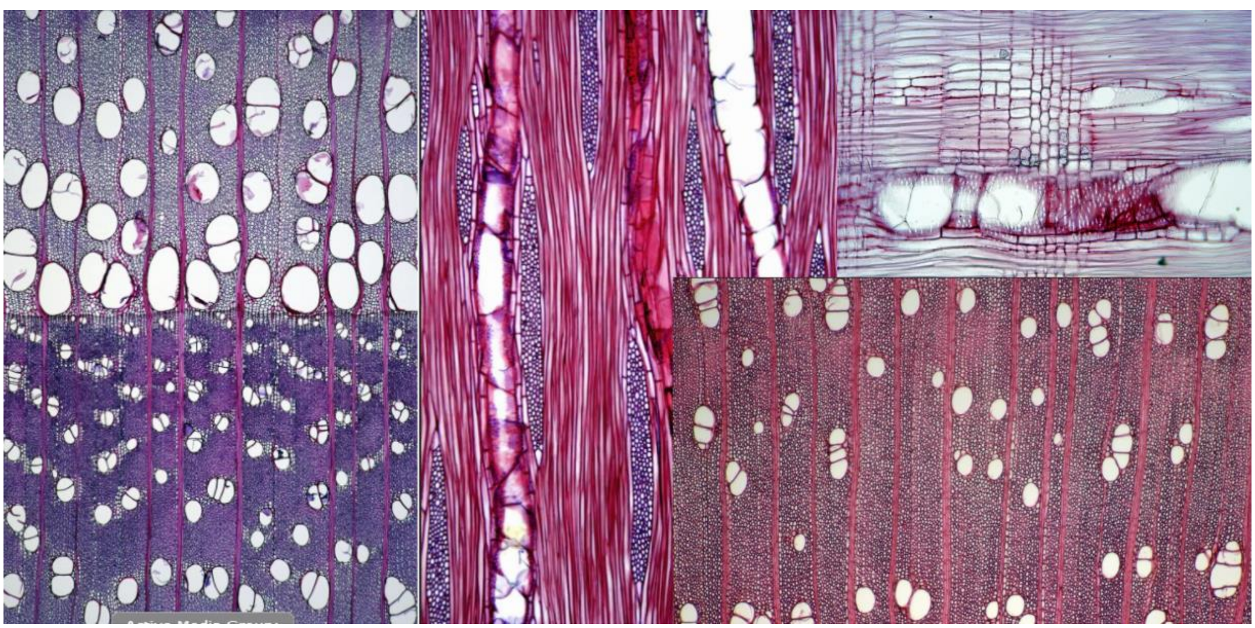


MORACEAE *Maquira costaricana,* *guianensis* (palo de pico)

- Vessels 100-200 µm, 5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, unilateral, banded



MORACEAE *Morus alba* *M. alba, celtidfolia, insignis, nigra* (mulberry)

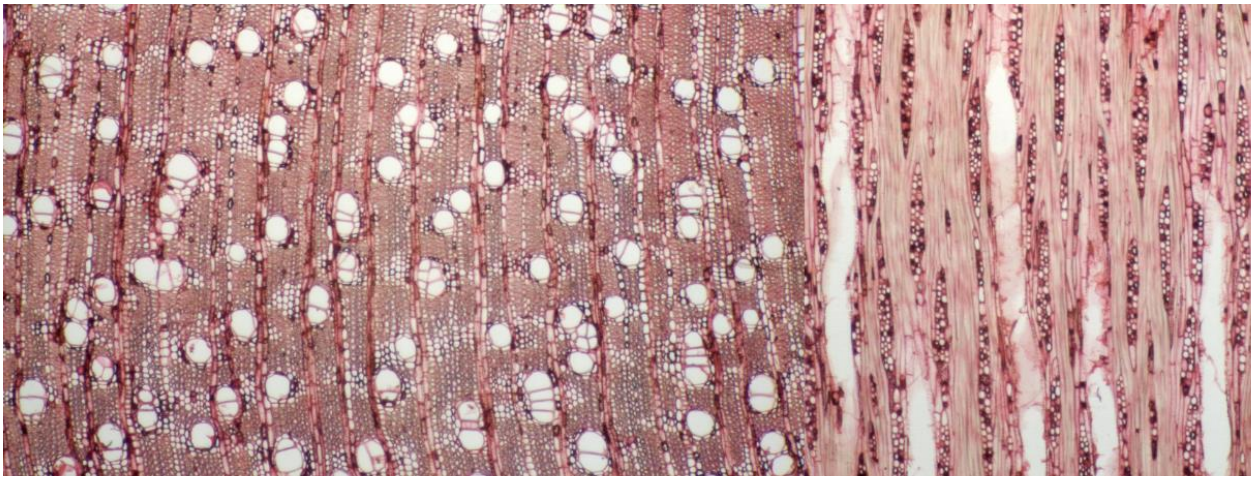


MORACEAE *Morus insignis* *M. alba, celtidfolia, insignis, nigra* (mulberry)

- Vessels 100-200µm
- Rays 4 to 10 seriate, >=4/mm
- Parenchyma vasicentric, confluent
- Tyloses common

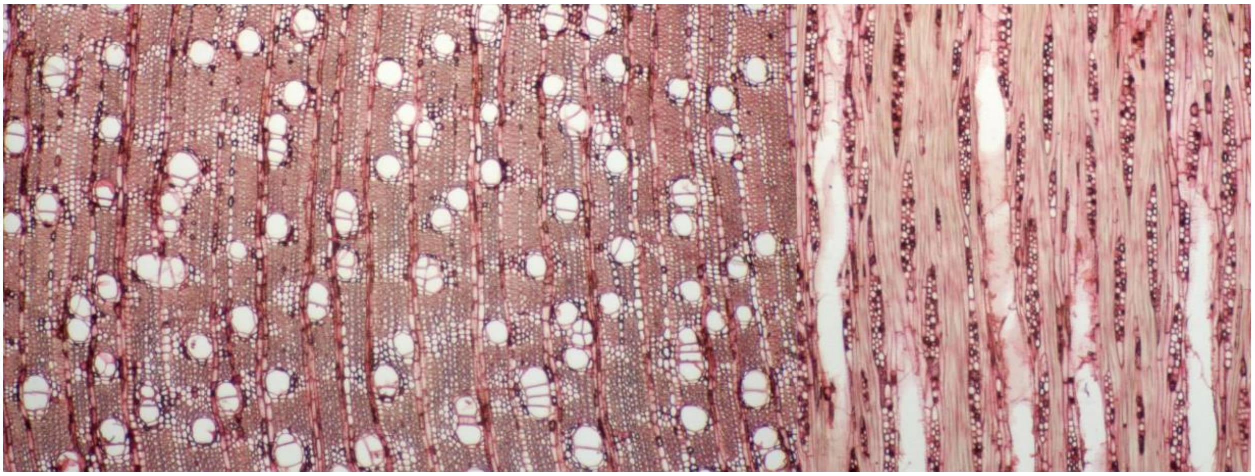
MORACEAE *Naucleopsis ulei,* *capirensis, naga* (palo de pico)

- Vessels 20-100 /mm^2, 50-100µm
- Rays 1 to 3, 4 to 10, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, unilateral, marginal bands



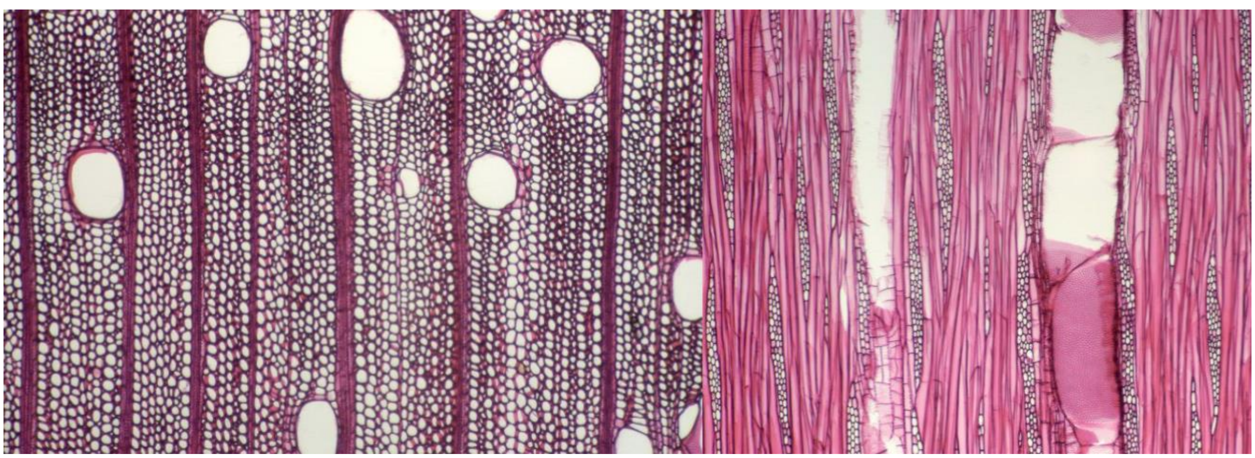
MORACEAE *Naucleopsis ulei,* *capirensis, naga* (palo de pico)

- Vessels 20-100 /mm^2, 50-100µm
- Rays 1 to 3, 4 to 10, 4-12/mm
- Parenchyma vasicentric, aliform, confluent, unilateral, marginal bands



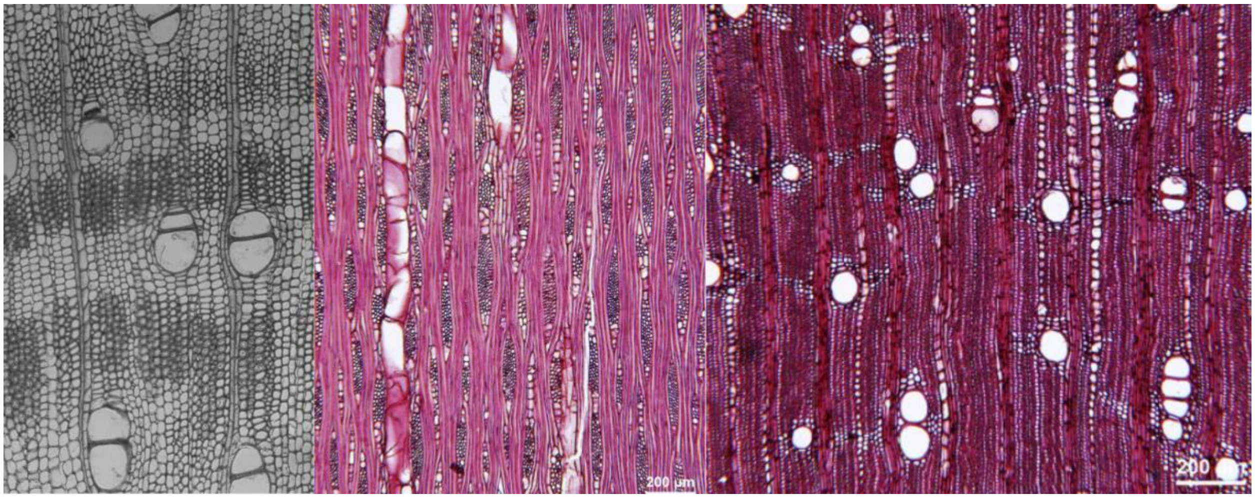
MORACEAE *Poulsenia armata* *(*chilamate, chanchama, cucua, mastate*)*
(Only species in Costa Rica within this genus)

- Vessels 100-200µm, <5-20/mm^2
- Rays<4-12/mm, 4 to 10 seriate
- Parenchyma scanty, aliform, confluent
- Tyloses common



MORACEAE *Trophis racemosa,* *caucana* (lija)

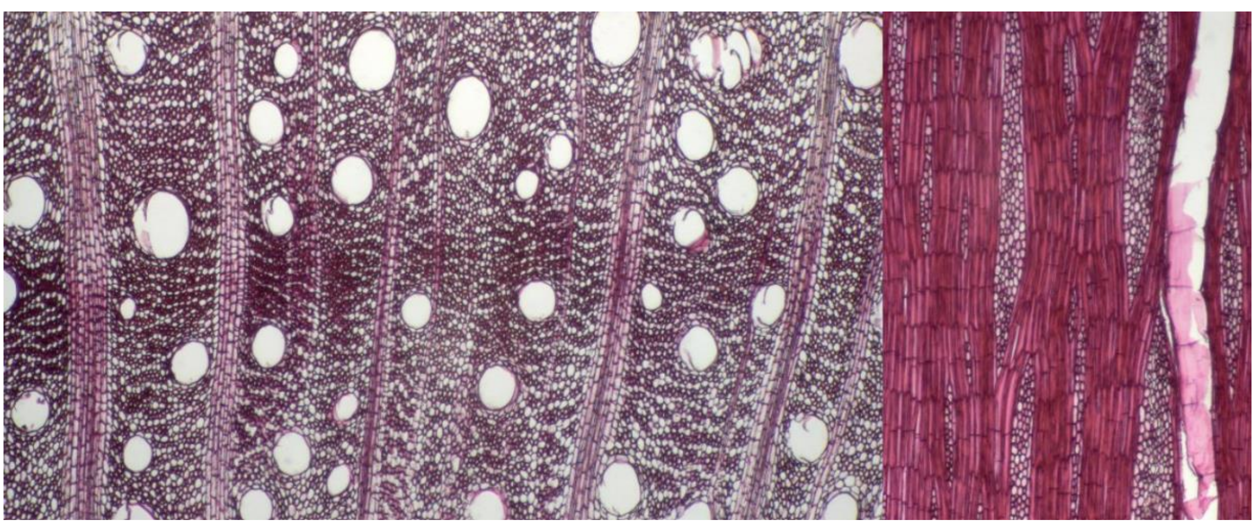
- Vessels 100-200µm, <5-20/mm^2, Tyloses common
- Rays 4-12/mm, 4 to 10 seriate
- Parenchyma vasicentric, confluent, thick marginal bands



MUNTINGIACEAE *Muntingia calabura* (capulin, jamaican cherry)

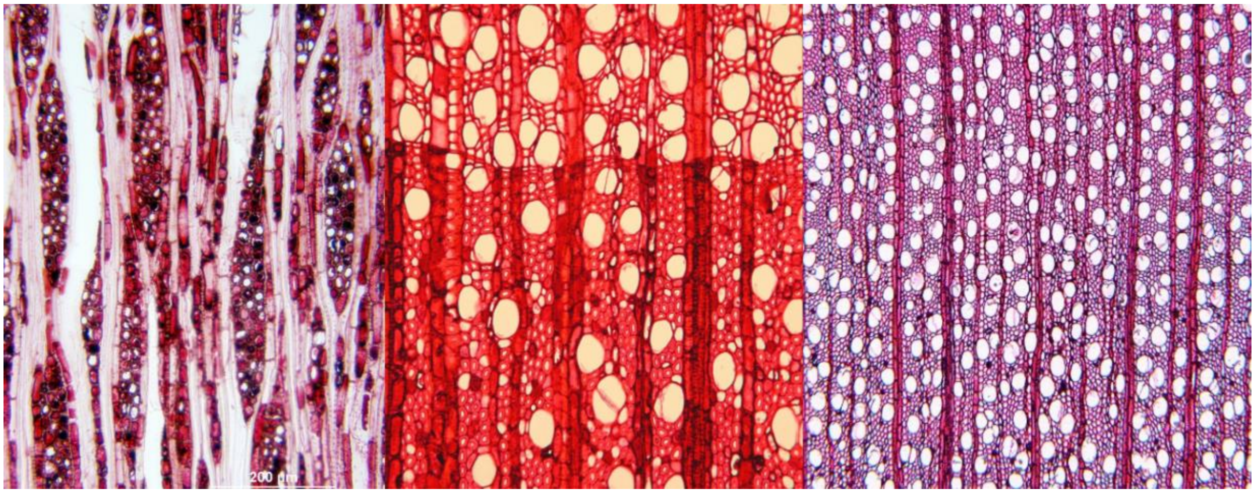
Only species in Costa Rica within this genus

- Vessels 100-200µm, 5-20/mm^2
- Rays 4-12/mm, 4 to 10 seriate
- Parenchyma diffuse in aggregates, narrow bands, scalariform



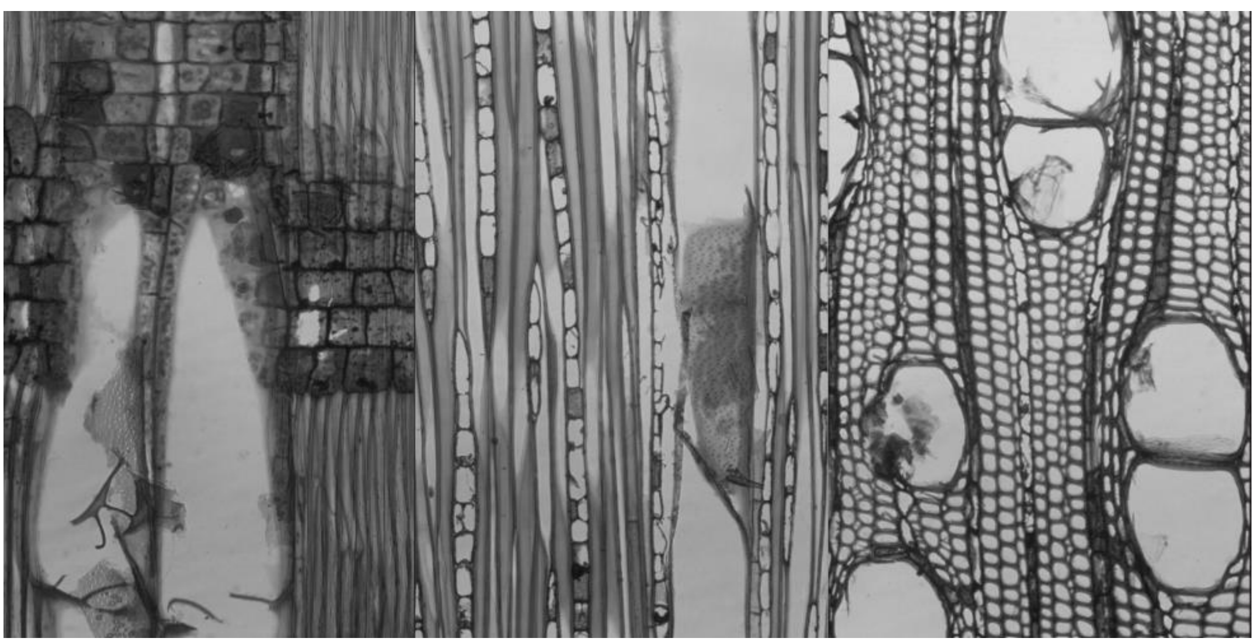
MYRICACEAE ***Morella cerifera,*** *parvifolia, phanerodonta, pubescens* (southern bayberry)

- Vessels <=50µm, >=100/mm^2
- Rays 4-12/mm, 1 to 3 cells, 4 to 10 seriate
- Parenchyma diffuse



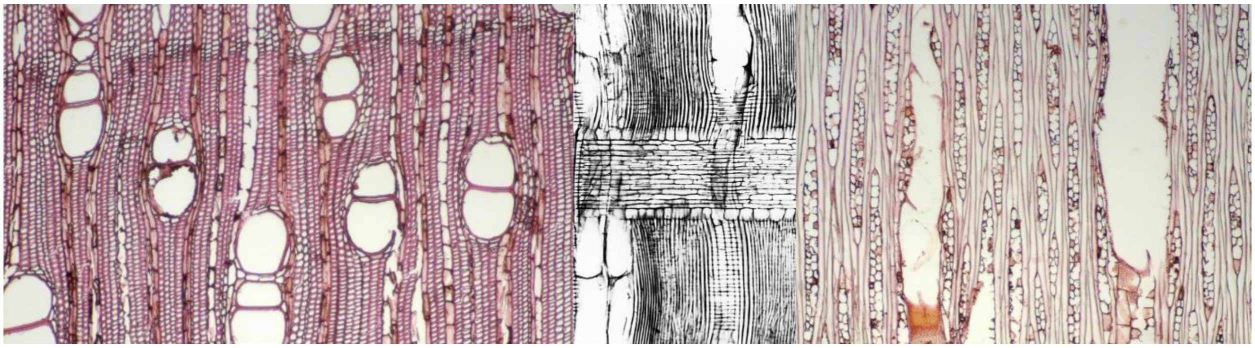
MYRISTICACEAE ***Otoba sp.*** (miguelario, velario, fruta dorada)

- Vessels 100-200µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty, vasicentric



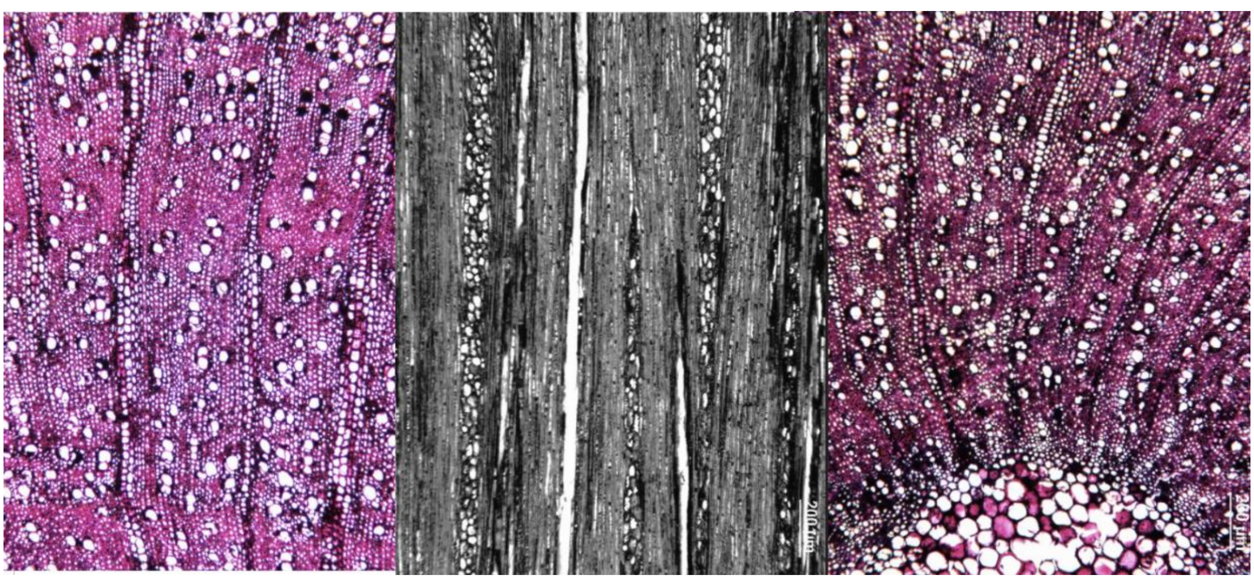
MYRISTICACEAE *Virola surinamensis,* laevigata, elongata, megacarpa (baboonwood, ucuhuba)

- Vessels 100-200 µm, <5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma rare, scanty, marginal bands
- Simple scalariform perforation plates



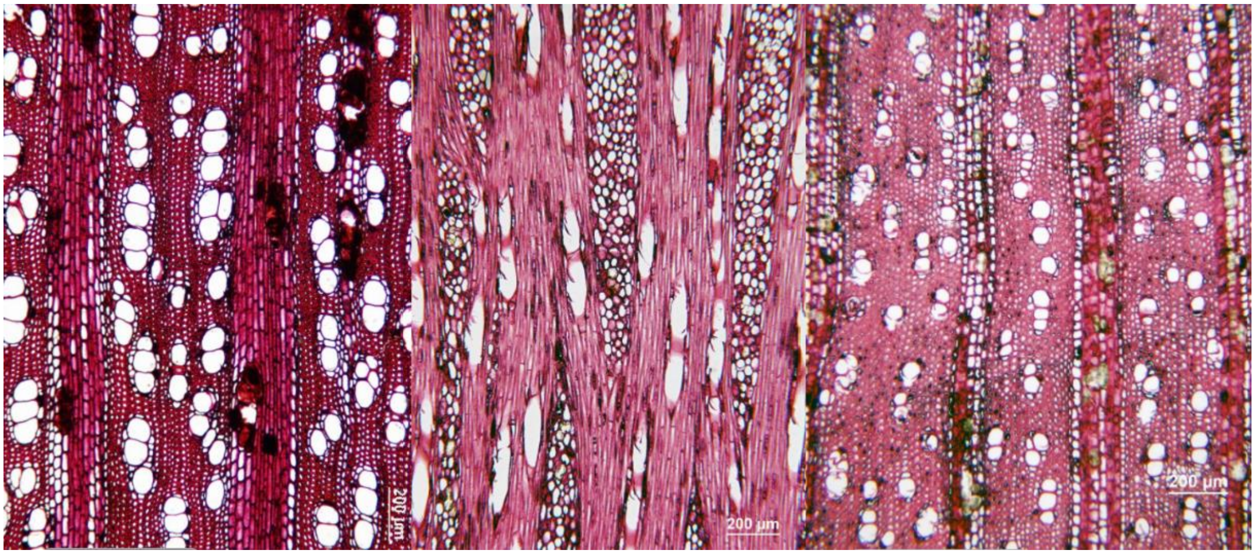
MYRSINACEAE *Ardisia compressa,* (coralberry) *revoluta, standleyana*

- Vessels 50-200 µm, 20-40/mm^2
- Rays 4 to 10 seriate, <=4/mm
- Parenchyma absent, rare, scanty



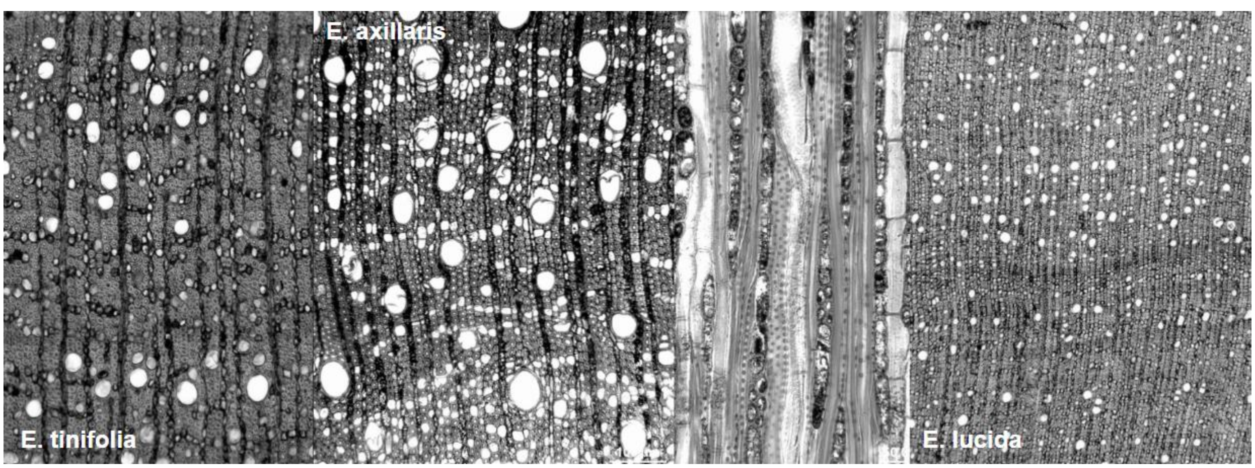
MYRSINACEAE *Myrsine* *coriacea, juergensenii* (mangle de montana, mangle de sabanas)

- Vessels <50-100 µm, 20-100+/mm^2
- Rays 4 to 10 seriate, <=4/mm
- Parenchyma scanty paratracheal



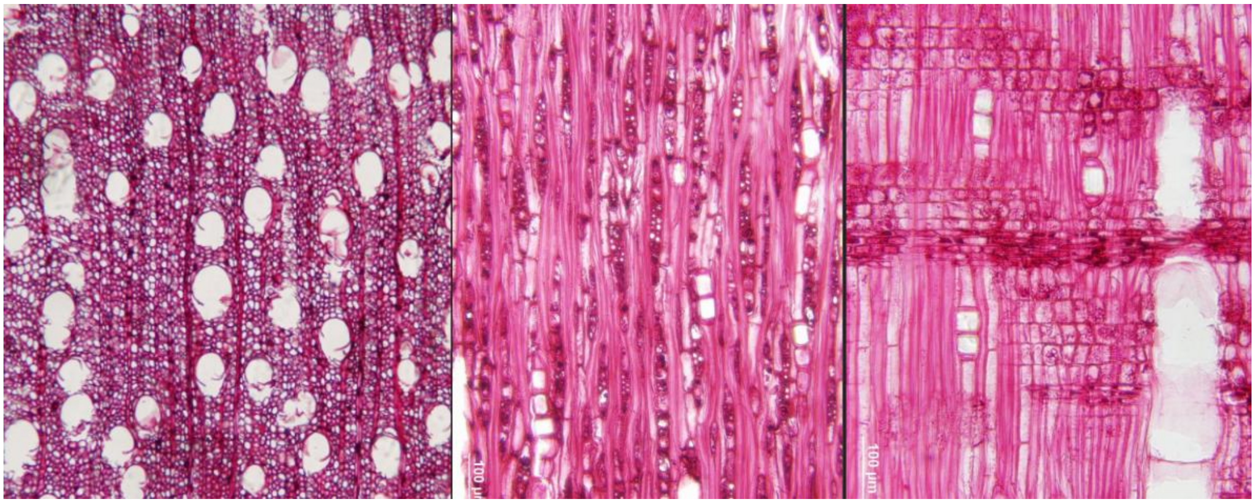
MYRTACEAE *Eugenia* *acapulcensis, austin-smithii, basilaris, biflora, costaricensis, gomezii, haberi, hypargyrea, lepidota, monteverdensis, monticola, moorei, octopleura, oerstediana, oligandra, principium, salamensis, siggersii, siltepecana, smithii, tomlinsonii, truncata, valerioi* (pitanga, guayabillo)

- Vessels can be exclusively solitary, 50-200µm, two sizes, 5-40 /mm^2
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma diffuse in



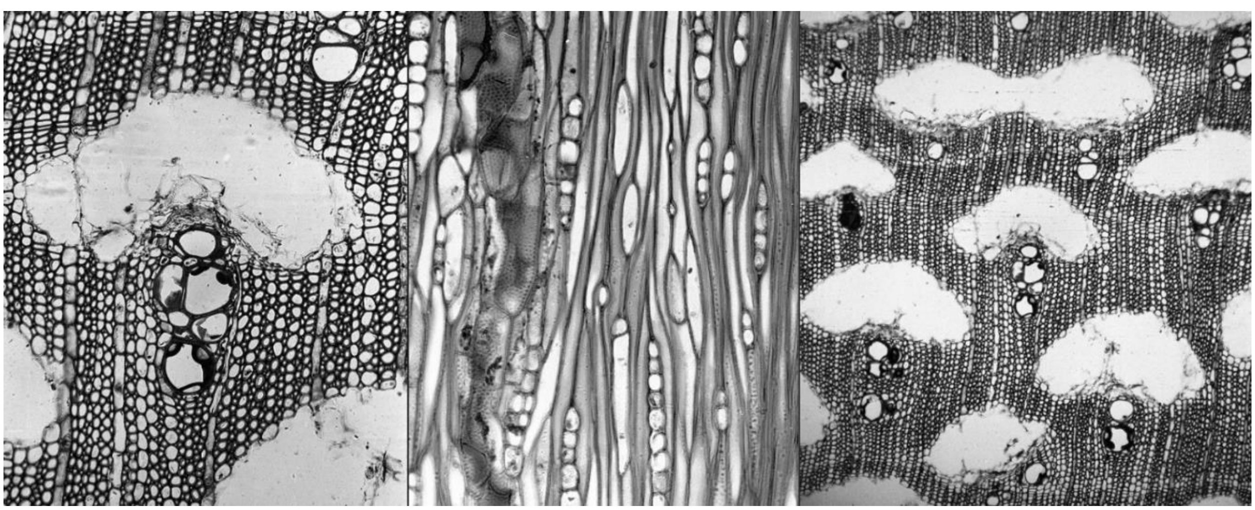
MYRTACEAE *Psidium guajava* (guava, guayaba) *P. guieense, cattleianum, friedrichsthalianum, salutare, sartorianum, savannarum, wrightii*

- Vessels 50-100µm, 20-100 /mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse in aggregates, narrow bands



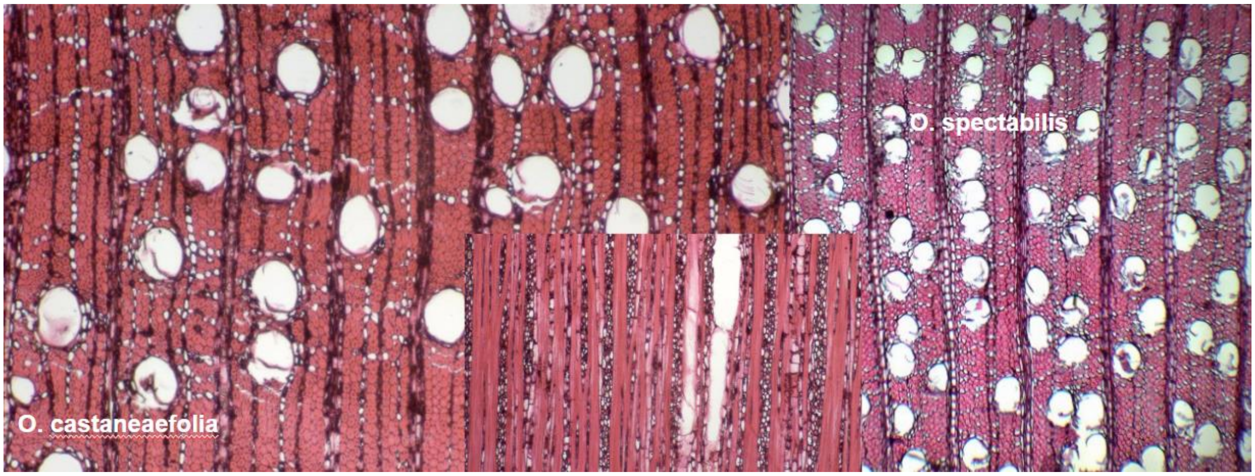
NYCTAGINACEAE Neea amplifolia, *delicatula, elegans, laetevirens, orosiana, pittieri, psychotrioides, urophylla* (canela, canelito)

- Vessels 50-100µm, <=5 /mm^2, gums in heartwood vessels
- Rays exclusively uniseriate, 4-12/mm
- Parenchyma vasicentric



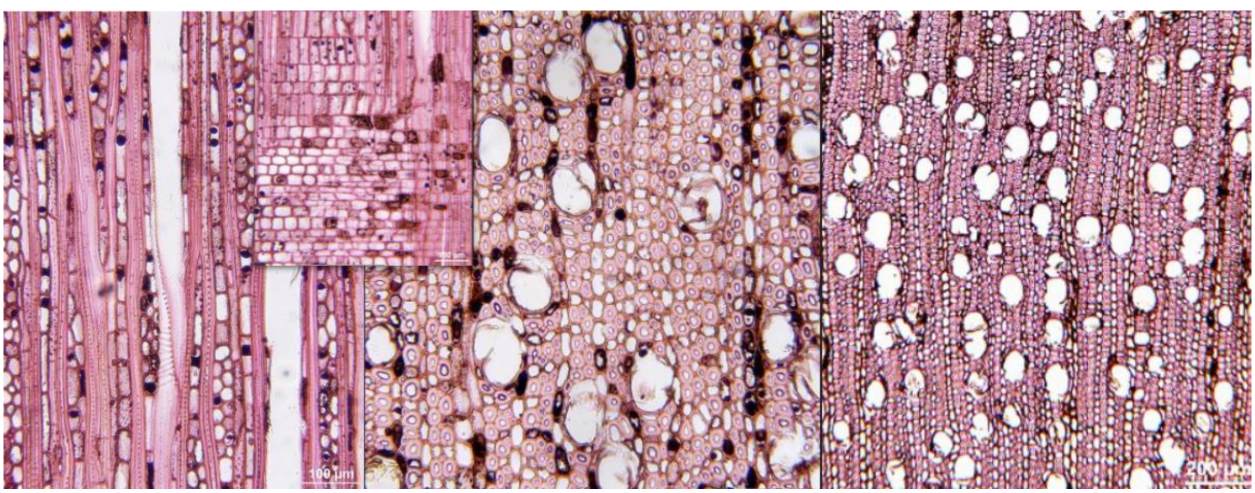
OCHNACEAE Ouratea *crassinervia, lucens, osaensis, prominens, rinconensis, valeroi* (unk common name)

- Vessels exclusively solitary, 100-200µm, 5-20 /mm^2
- Rays 1 to 3, 4 to 10 seriate, 2 distinct sizes, 4-12+/mm
- Parenchyma diffuse in aggregates, scanty paratracheal



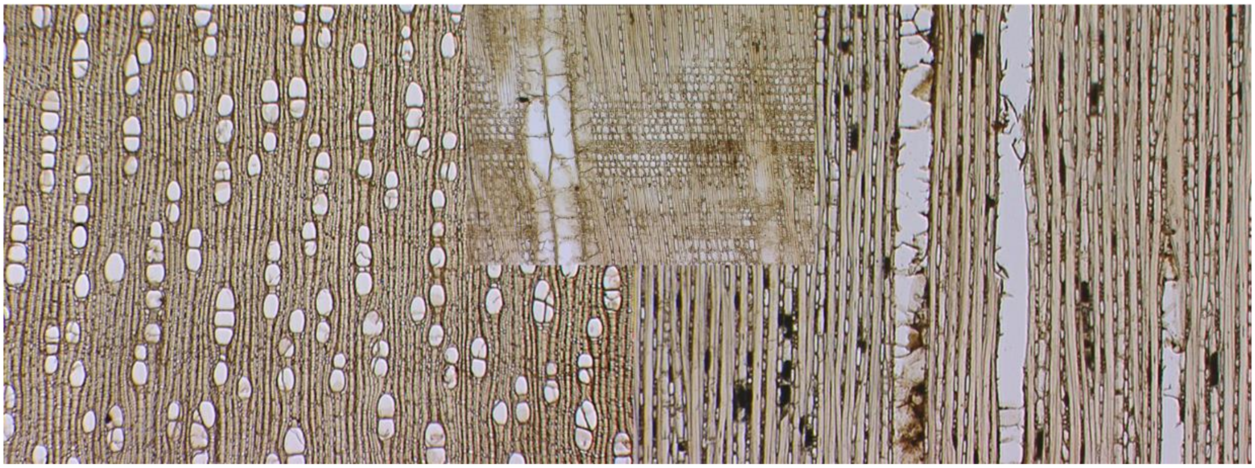
OLACACEAE *Heisteria macrophylla,* *acuminata, concinna, costaricensis, cyanocarpa, povedae, scandens* (sombrerito, ajicillo, chorola)

- Vessels exclusively solitary, <=50-100µm, 40-100/mm^2
- Rays 1 to 3 cells, >=12/mm
- Parenchyma diffuse



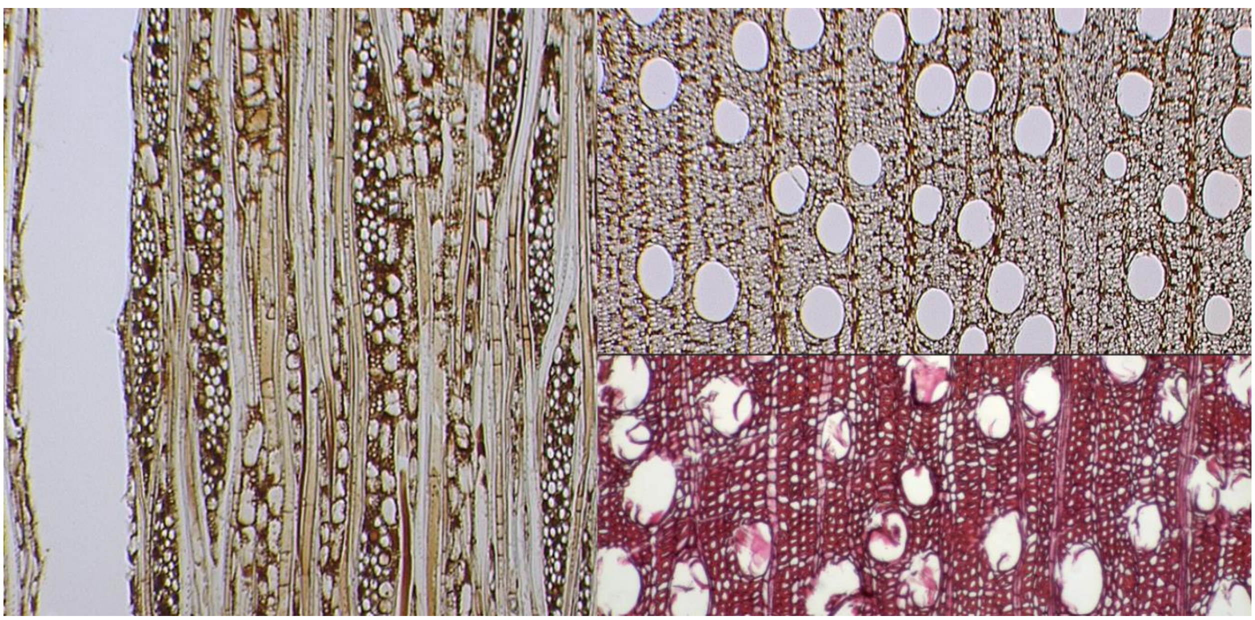
OLACACEAE *Minquartia guianensis* (cuajado, criollo, aratta, black manwood, huambula)

- Vessels is radials, 50-200+µm, 5-40 /mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse, scanty



PHYLLANTHACEAE *Hieronyma alchorneoides,* *oblonga*
(zapatero, pilón, palo chancho, piedro)

- Vessels 100-200+ µm, <=5-20/mm^2
- Rays 4 to 10, 4-12/mm
- Parenchyma diffuse in aggregates, narrow bands



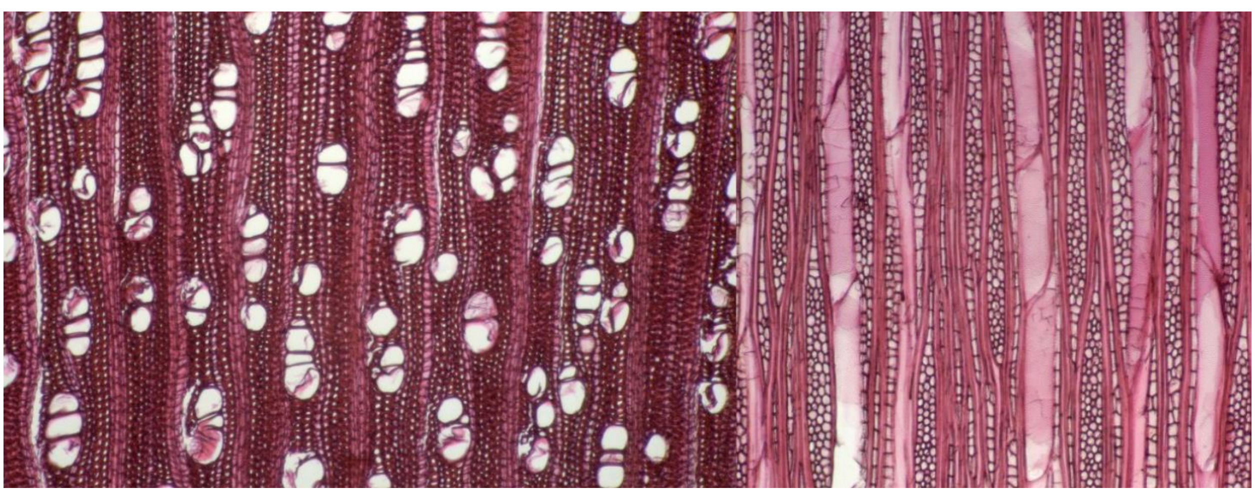
PHYLLANTHACEAE *Hieronyma oblonga,* *alchorneoides* (trompito)

- Vessels exclusively solitary, 50-100 µm, 20-40/mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10, >12/mm
- Parenchyma diffuse in aggregates

PHYLLANTHACEAE *Margaritaria nobilis* *(clavito)*

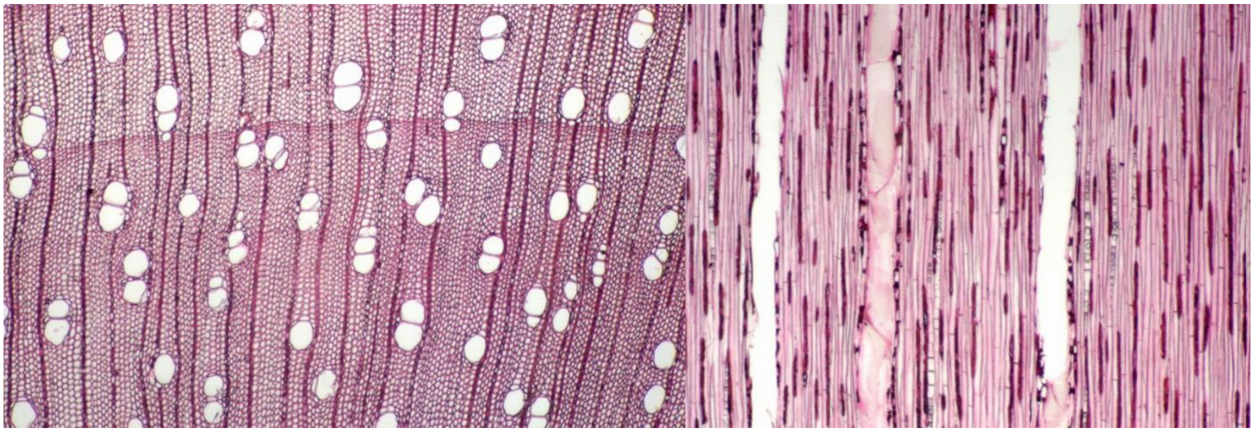
Only species in Costa Rica within this genus

- Vessels 100-200 µm, 5-20/mm^2, tyloses common
- Rays 1 to 3, 4 to 10, 4-12+/mm
- Parenchyma absent or rare



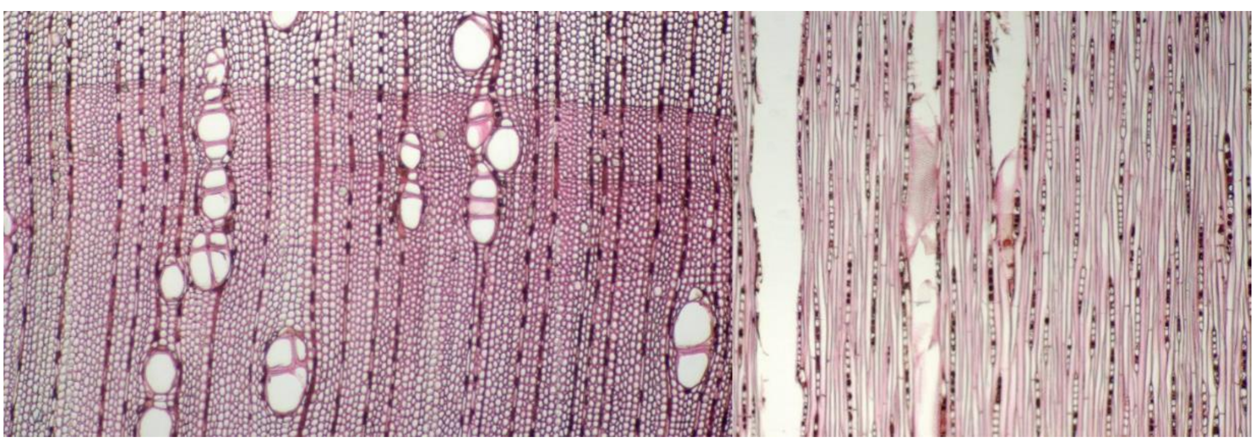
POLYGONACEAE *Coccoloba acuminata,* (uvito, sea grape, uvero) *ascendens, caracasana, escuintlensis, guanacastensis, liportizii, mollis, obovata, padiformis, parimensis, porphyrostachys, tuerckheimii, uvifera, venosa*

- Vessels 50-100µm, 20-100 $/mm^2$
- Rays exclusively uniseriate, >12/mm
- Parenchyma absent or rare



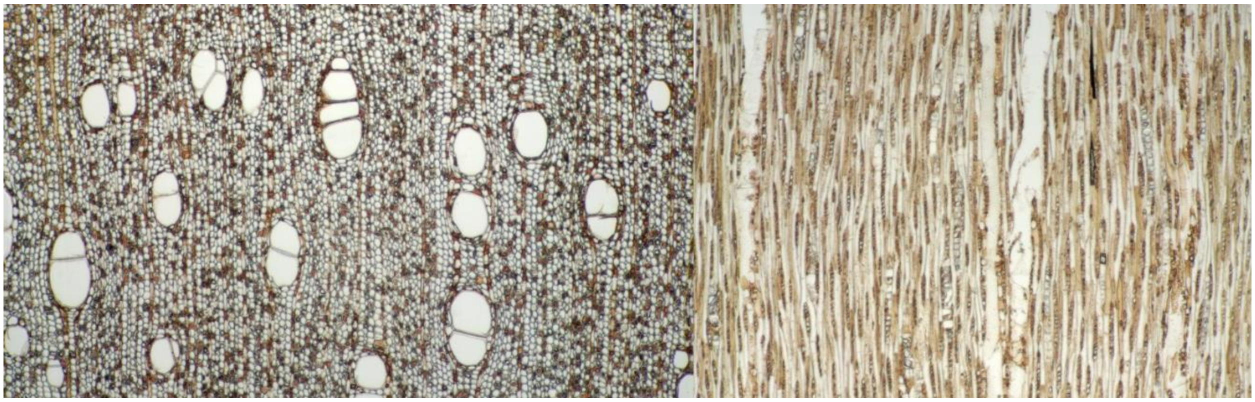
POLYGONACEAE *Coccoloba mollis,* (uvito, sea grape, uvero) *acuminata, ascendens, caracasana, escuintlensis, guanacastensis, liportizii, obovata, padiformis, parimensis, porphyrostachys, tuerckheimii, uvifera, venosa*

- Vessels 50-100µm, 20-100 $/mm^2$
- Rays exclusively uniseriate, >12/mm
- Parenchyma absent or rare



POLYGONACEAE *Coccoloba uvifera* (uvito, sea grape, uvero) *acuminata, ascendens, caracasana, escuintlensis, guanacastensis, liportizii, mollis, obovata, padiformis, parimensis, porphyrostachys, tuerckheimii, uvifera, venosa*

- Vessels 50-100µm, <5-20 /mm^2
- Rays exclusively uniseriate, >12/mm
- Parenchyma diffuse in aggregates, scanty

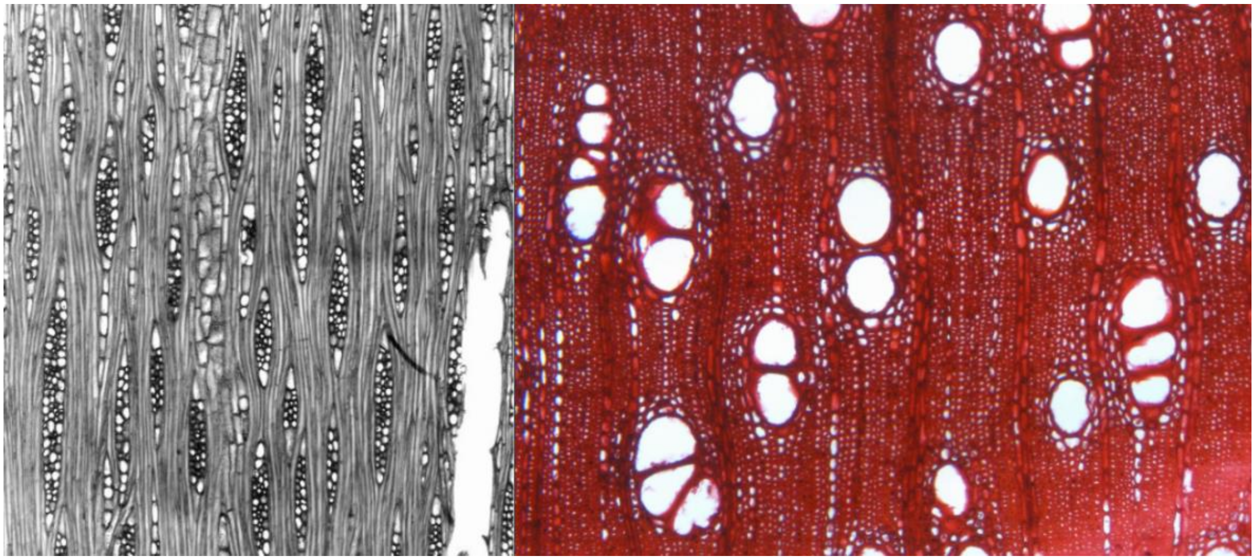


PROTEACEAE *Roupala montana,* *glaberrima* (carne asada, ratón, árbol carne)

- Vessels 100-200µm, 5-20 /mm^2
- Rays of two sizes, <4/mm
- Parenchyma in narrow bands

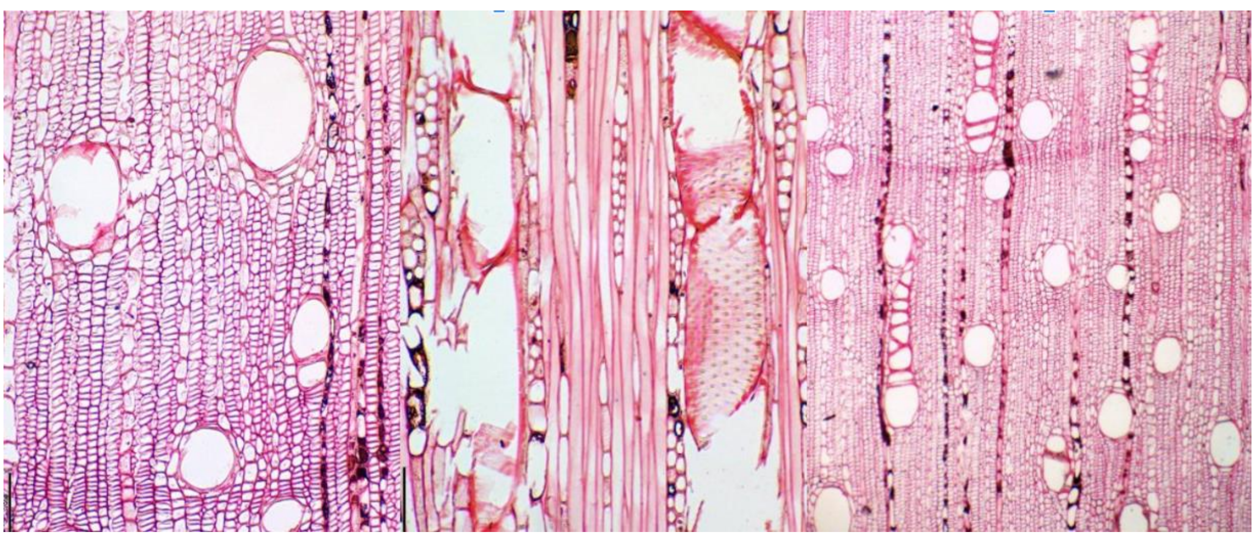
RHAMNACEAE *Colubrina glandulosa,* *heteroneura, spinosa* (carbonero, frio)

- Vessels 100-200µm, 5-20 /mm^2, two distinct diameter classes
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric



RHAMNACEAE *Colubrina spinosa,* *glandulosa, heteroneura* (espino del diablo)

- Vessels 50-100µm, 5-20 /mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma vasicentric, scanty

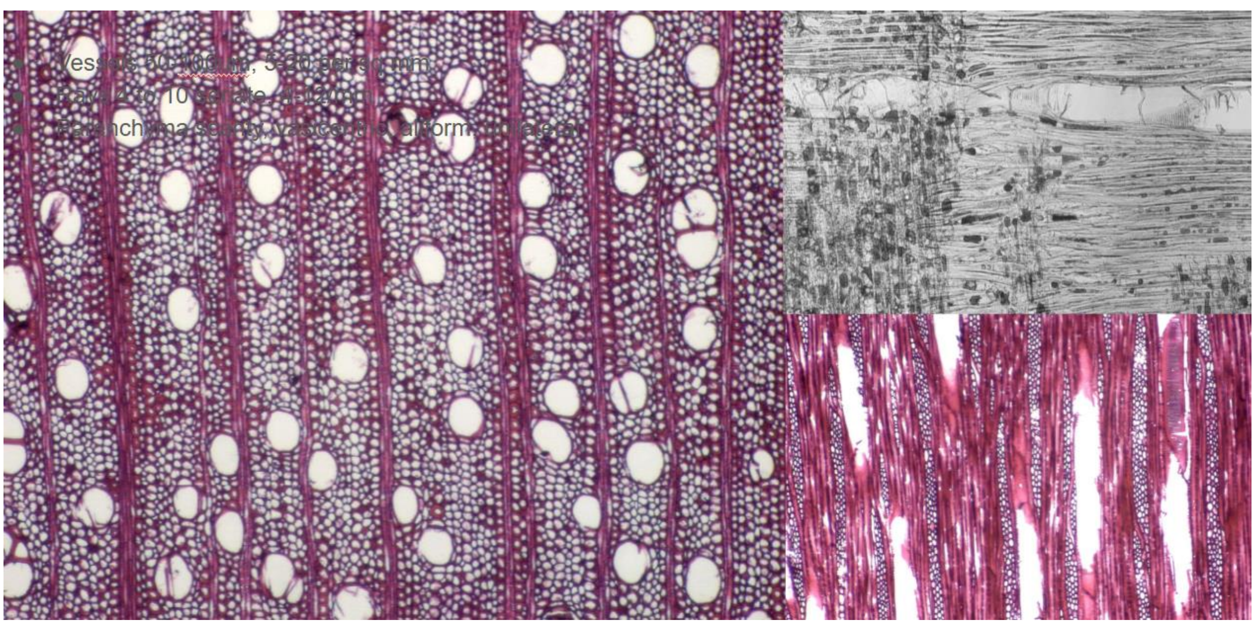


RHAMNACEAE *Rhamnus cathartica,* *oreodendron, sharpii* (common buckthorn)

- Vessels <50-100µm, 100+ /mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent, rare

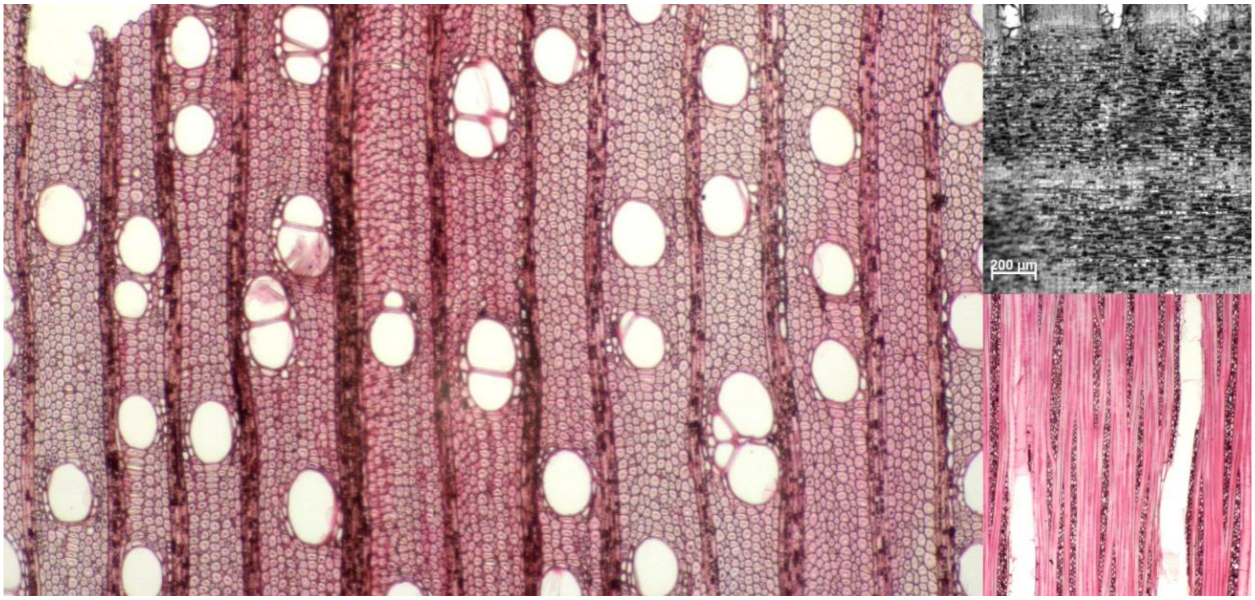
RHIZOPHORACEAE Rhizophora mangle, *harrisonii, racemosa*
(mangle rojo, mangle colorado, red mangrove)

- Vessels 50-100µm, 5-20 /mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, vasicentric, aliform, unilateral



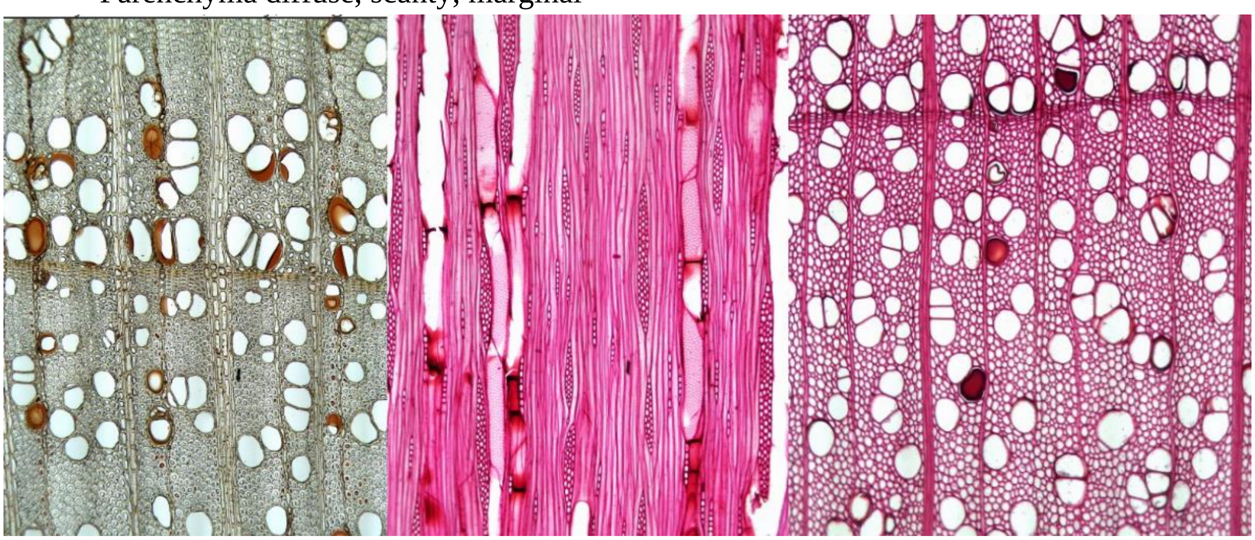
RHIZOPHORACEAE Rhizophora racemosa, *harrisonii, mangle*
(mangle rojo, mangle colorado, red mangrove)

- Vessels 50-200µm, 5-40 /mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, rare, unilateral



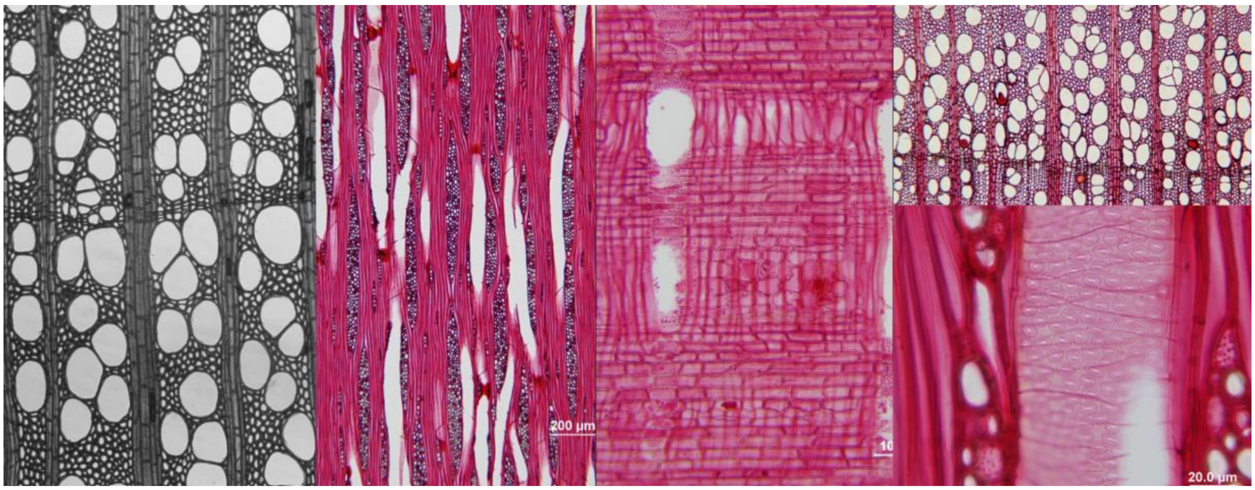
ROSACEAE *Prunus padus,* (cherry) *annularis, brachybotrya, cornifolia, fortunensis, guatemalensis, myrtifolia, occidentalis, rhamnoides, serotina, skutchii, subcorymbosa, virginiana*

- Vessels >50-100µm, 40-100+ /mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse, scanty, marginal



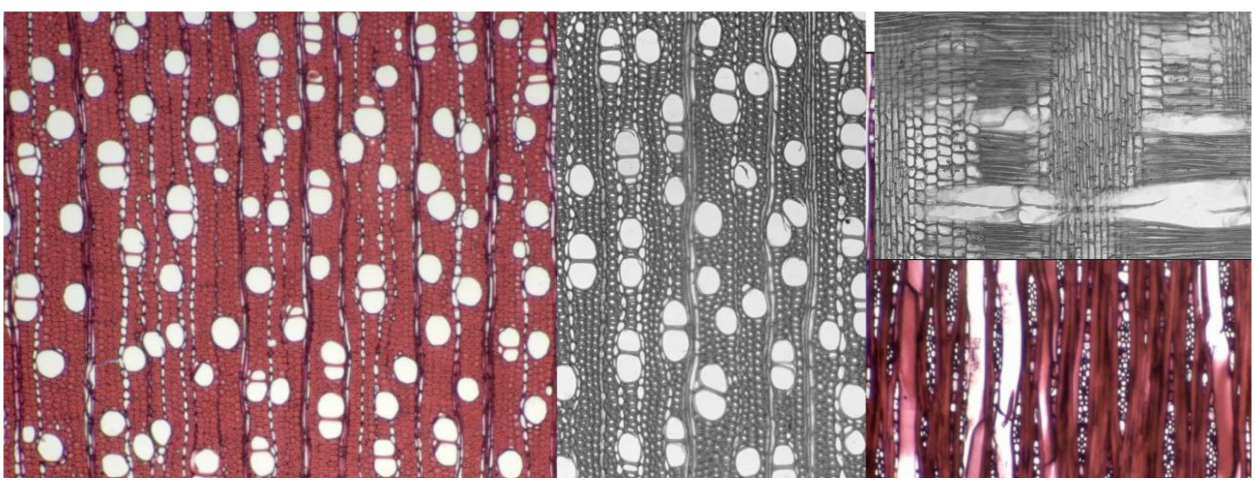
ROSACEAE *Prunus serotina,* (cherry) *annularis, brachybotrya, cornifolia, fortunensis, guatemalensis, myrtifolia, occidentalis, padus, rhamnoides, skutchii, subcorymbosa, virginiana*

- Vessels 50-100µm, 40-100+ /mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma absent, diffuse



RUBIACEAE *Calycophyllum candidissimum* *Only species in Costa Rica within this genus* (madroño, alazano, lluvia de plato, degame, lemonwood)

- Vessels in radial multiples, <50-100µm, 100+/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, of two distinct sizes, 4-12+/mm
- Parenchyma rare, scanty



RUBIACEAE

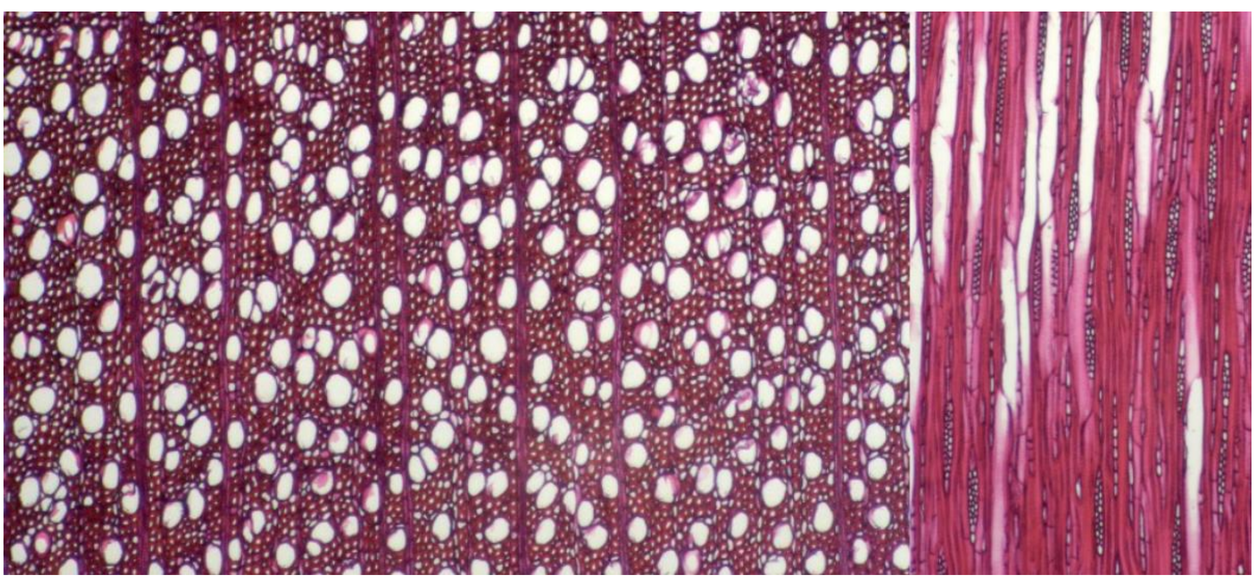
Cosmibuena grandiflora, *macrocarpa, valeroi* (tabaquillo)

- Vessels 50-100µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma thick confluent bands

RUBIACEAE *Coutarea hexandra* (azulejo, quina)

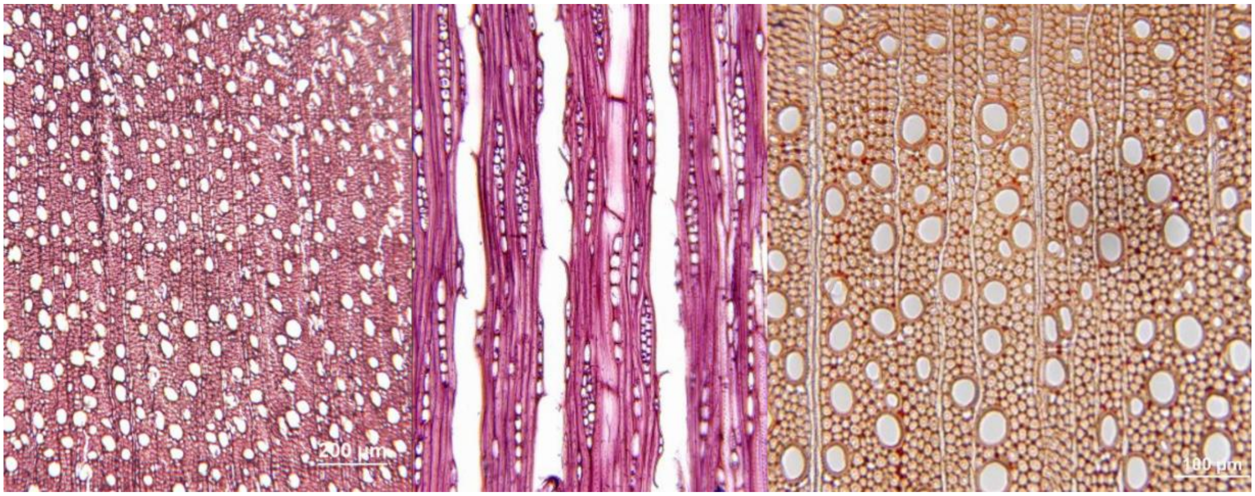
Only species in Costa Rica within this genus

- Vessels exclusively solitary, <50-100µm, 40-100/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse



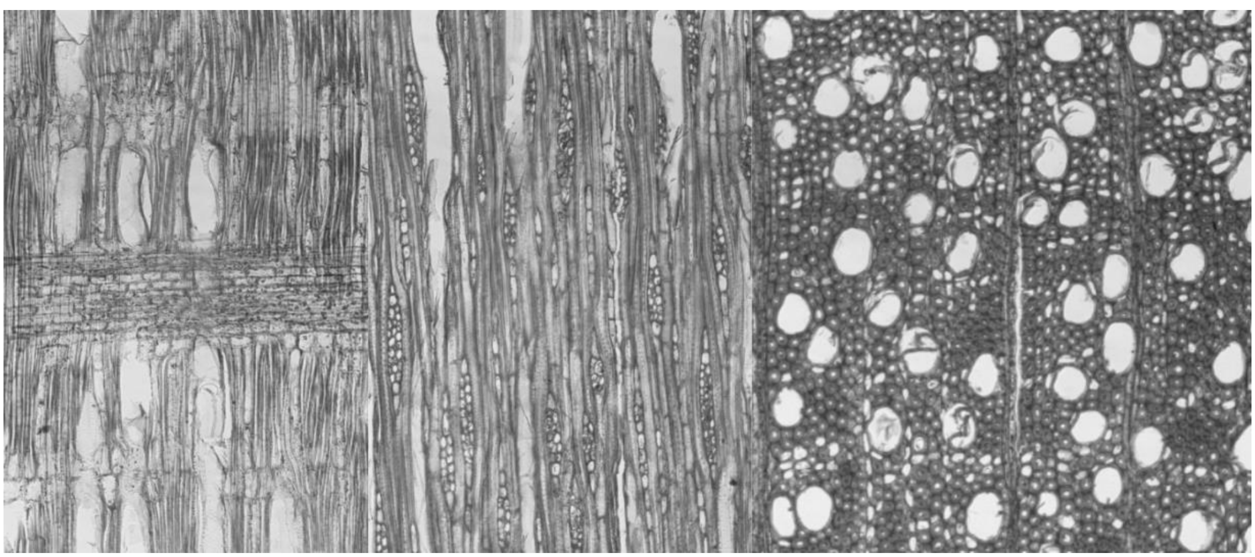
RUBIACEAE *Exostema caribaeum,* *mexicanum* (azulejo, quina)

- Vessels exclusively solitary, <50-100µm, 40-100+/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse, scanty



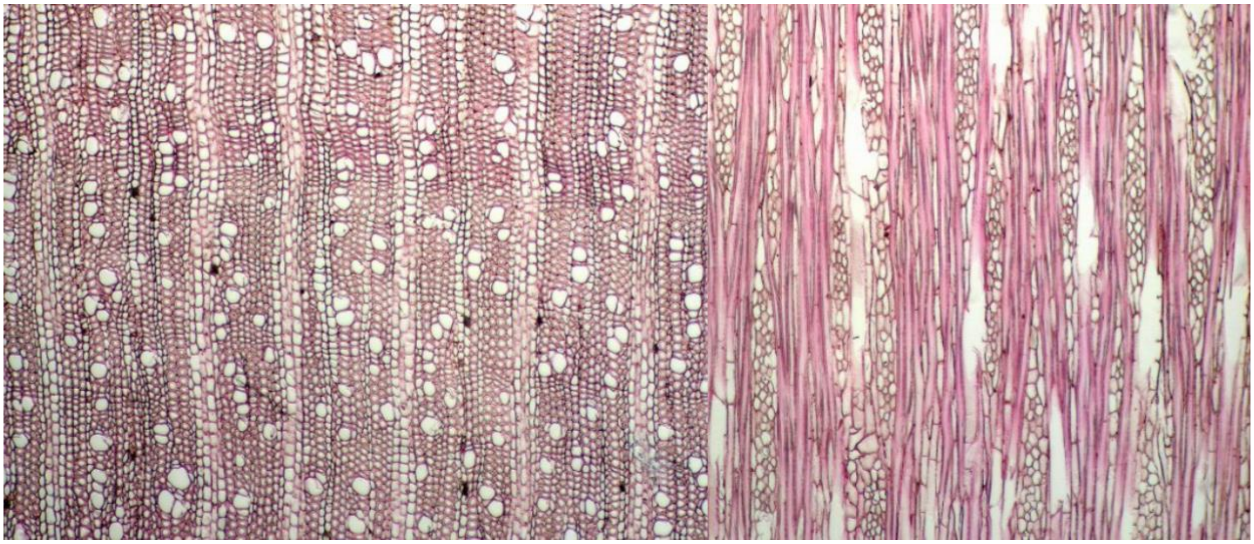
RUBIACEAE *Exostema mexicanum,* *caribaeum* (azulejo, quina)

- Vessels exclusively solitary, <50-100µm, 100+/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma diffuse



RUBIACEAE *Faramea occidentalis,* *luteovirens* (huesito, benjamín, garrotillo, jazmín)

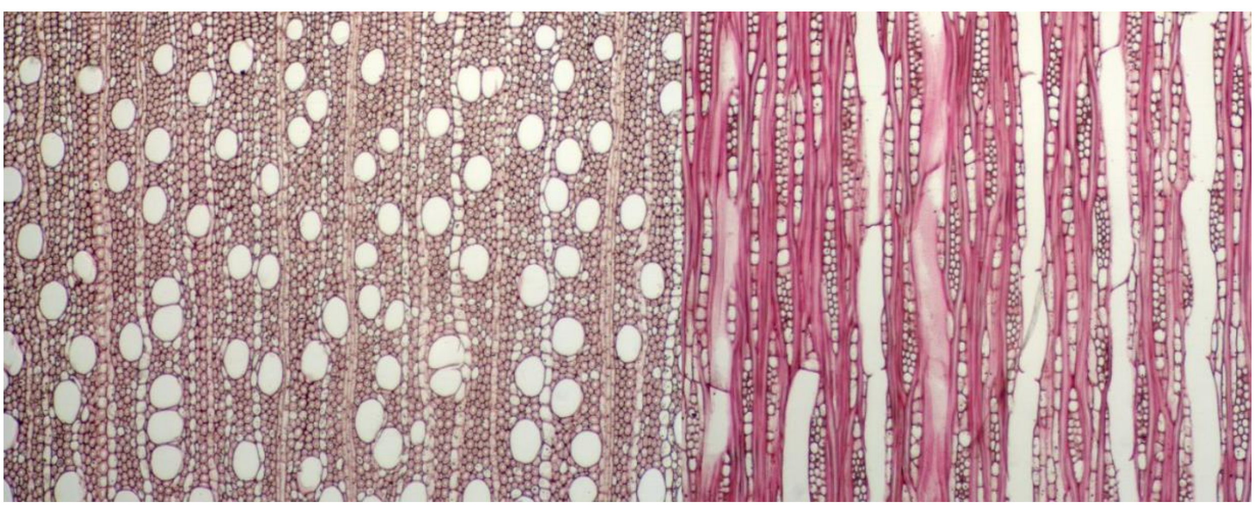
- Vessels <50-100µm, 40-100/mm^2
- Rays 4 to 10 seriate, <4-12/mm
- Parenchyma rare, diffuse



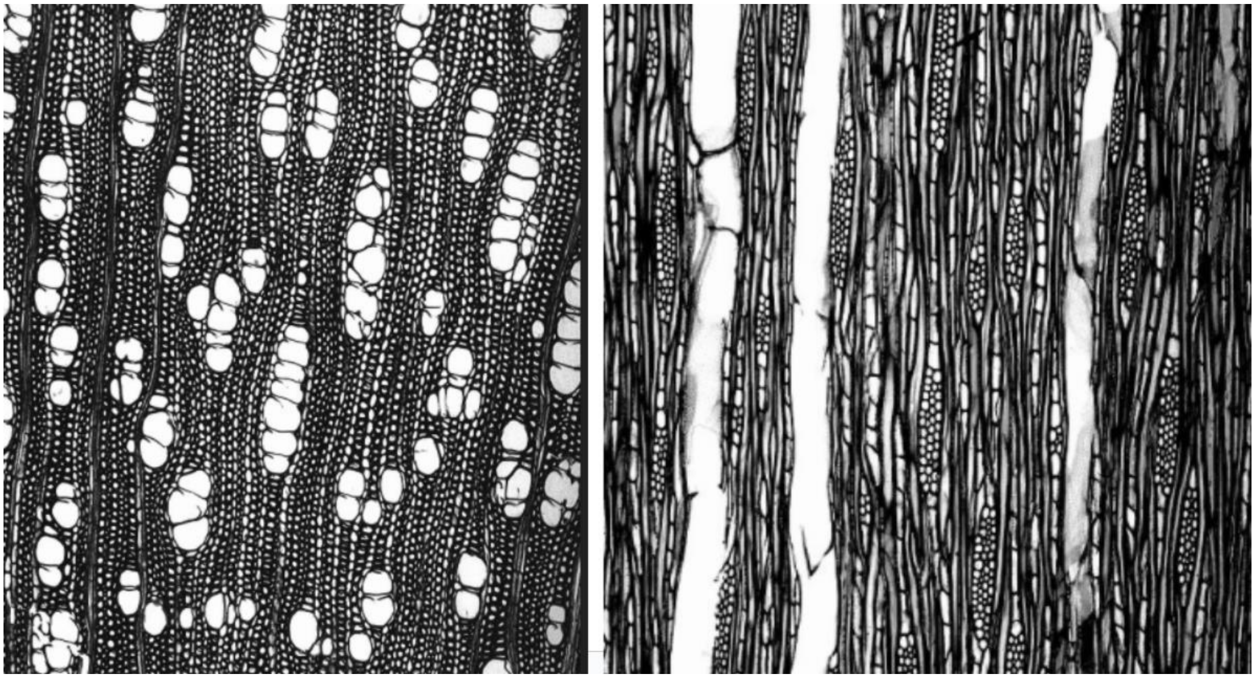
RUBIACEAE *Genipa americana* (jagua)

Only species in Costa Rica within this genus

- Vessels exclusively solitary, 50-100µm, 20-100/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12+/mm
- Parenchyma diffuse, scanty

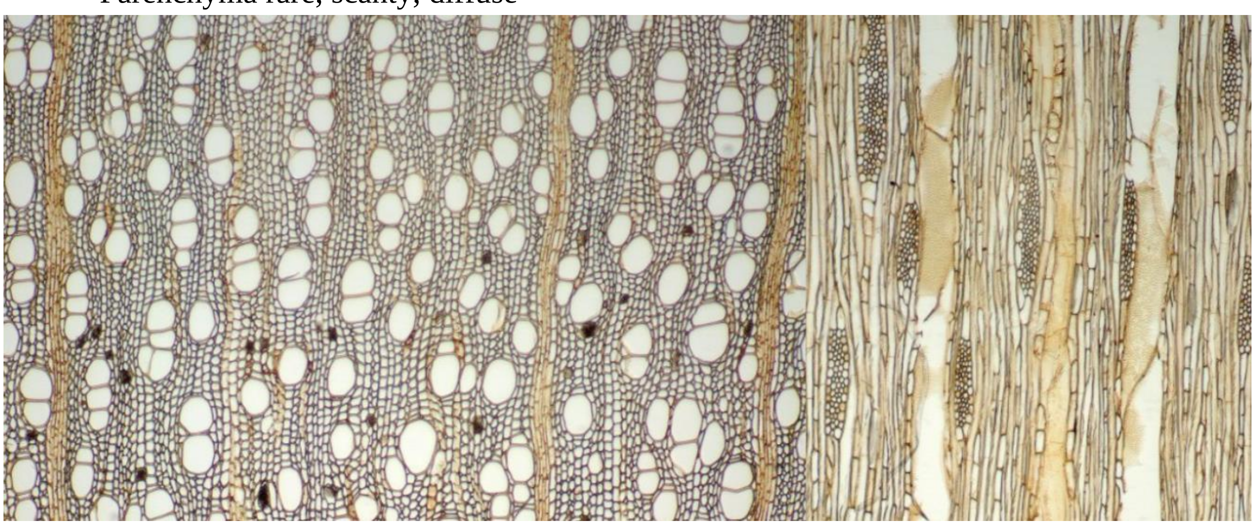


RUBIACEAE *Guettarda crispiflora* (salvia de montaña)***,*** *foliacea* (guayabo de monte, espino amarillo)



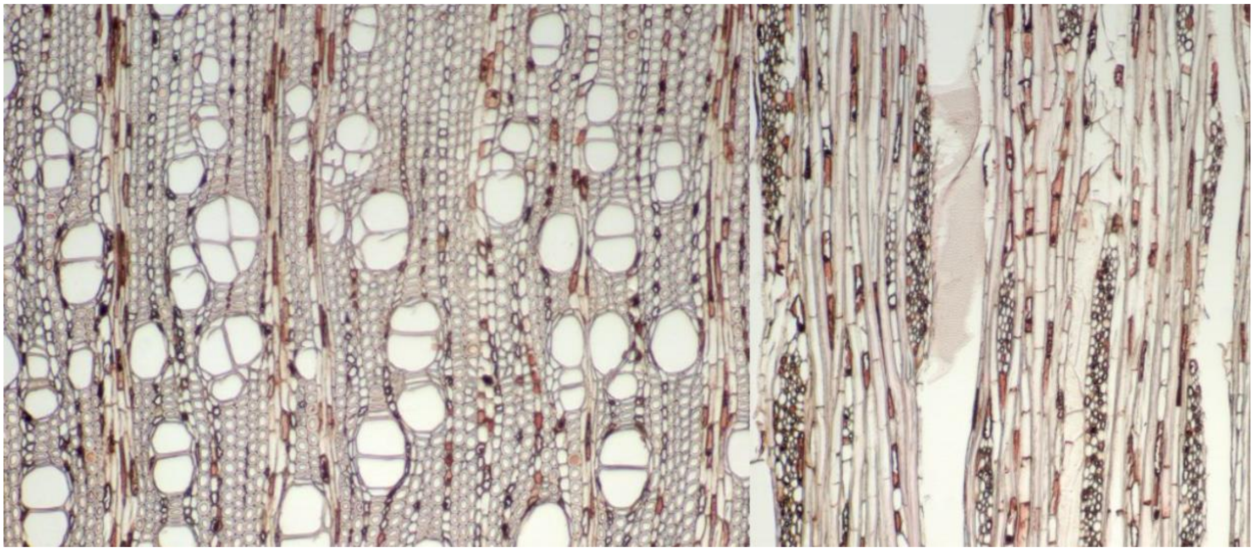
RUBIACEAE *Hamelia patens,* *axilaris, macrantha, magnifolia, rovirosae, xerocarpa* (guayabo negro, canelito)

- Vessels 50-100µm, 20-100/mm^2
- Rays 4 to 10 seriate, <=4-12/mm
- Parenchyma rare, scanty, diffuse



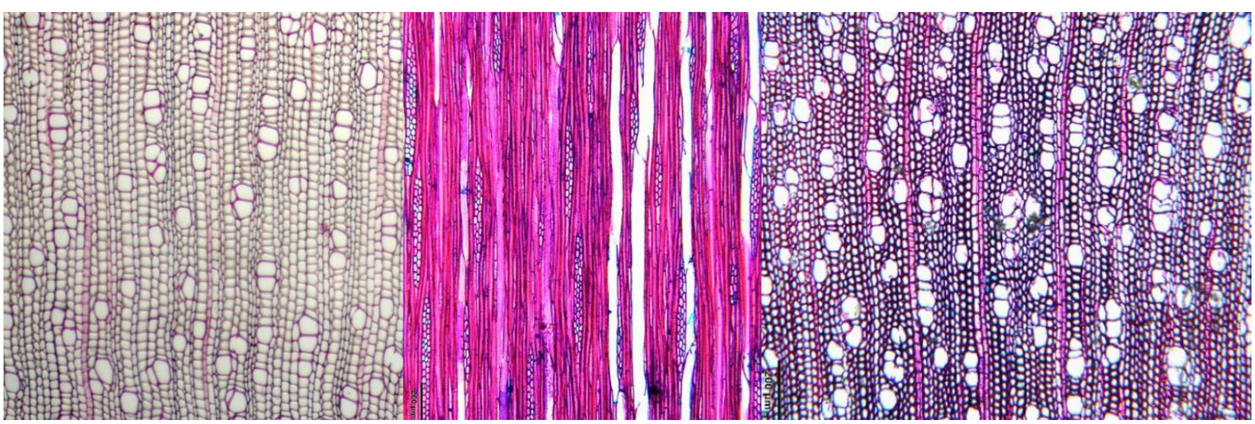
RUBIACEAE *Macrocnemum roseum* (palo cuadrado, madroño, canaleto)
Only species in Costa Rica within this genus

- Vessels 100-200µm, 20-40/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma rare, absent



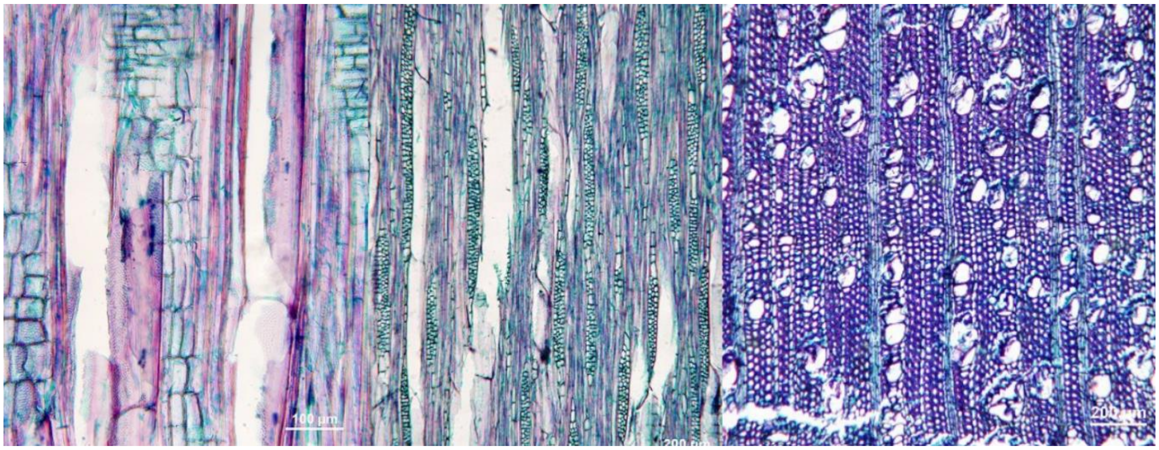
RUBIACEAE *Palicourea crocea* (recadito) *acuminata, adusta, angustifolia, brachiata, crocea, elata, hazenii, hondensis, luxurians, microbotrys, padifolia, pilosa, pubescens, romensis, salicifolia, tomentosa, torresiana, triphylla, winkleri*

- Vessels <50-100µm, 20-40/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma rare, absent



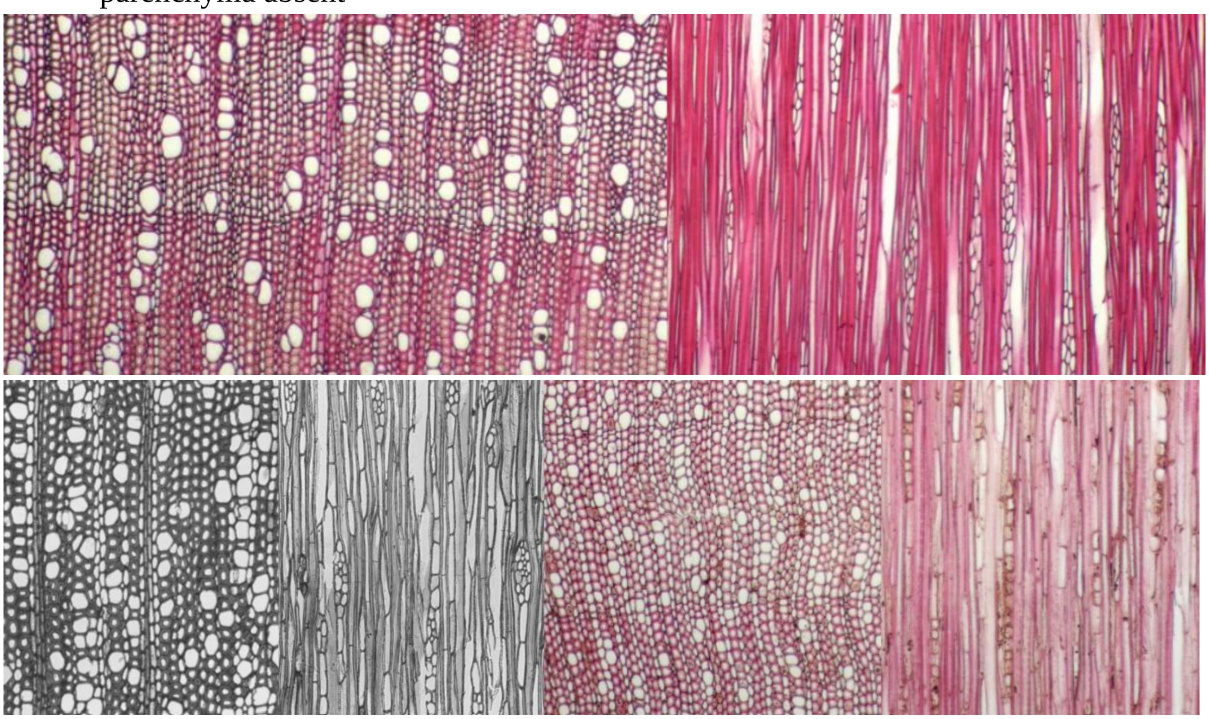
RUBIACEAE ***Palicourea guianensis*** (recadito) *acuminata, adusta, angustifolia, brachiata, crocea, elata, hazenii, hondensis, luxurians, microbotrys, padifolia, pilosa, pubescens, romensis, salicifolia, tomentosa, torresiana, triphylla, winkleri*

- Vessels <50-100µm, 20-40/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma rare, absent



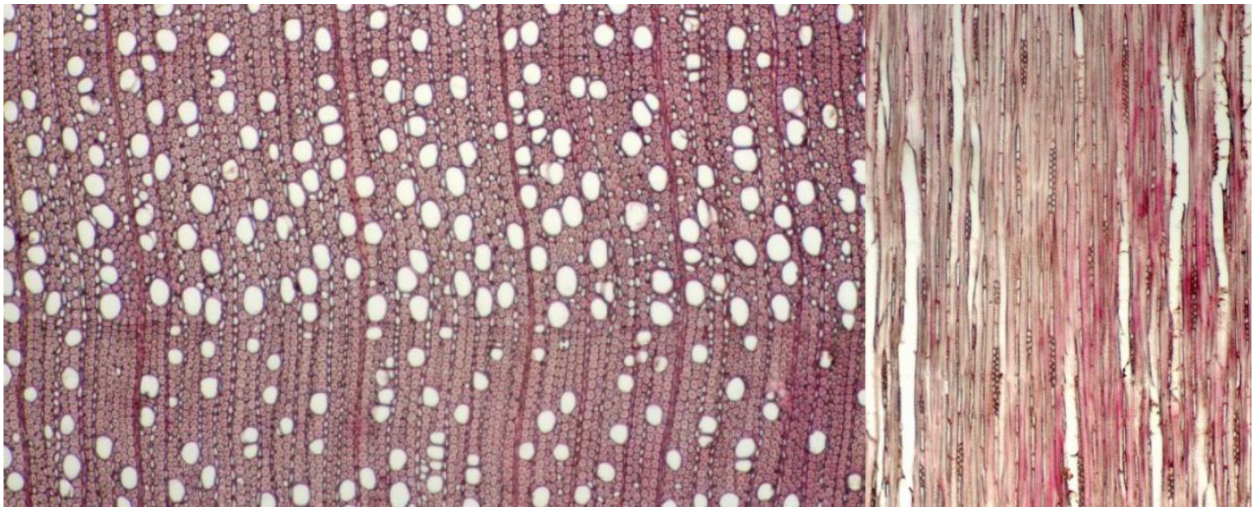
RUBIACEAE ***Psychotria*** *carthagenensis, convergens, elata, grandis, horizontalis, luxurians, marginata, poeppigiana*
(cafecillo, hot lips, sombrerito de diablo)

- Vessels 50-100µm, 20-100+/mm^2, tyloses common
- Rays 1 to 3 cells, 4 to 10 seriate, 12+/mm
- parenchyma absent



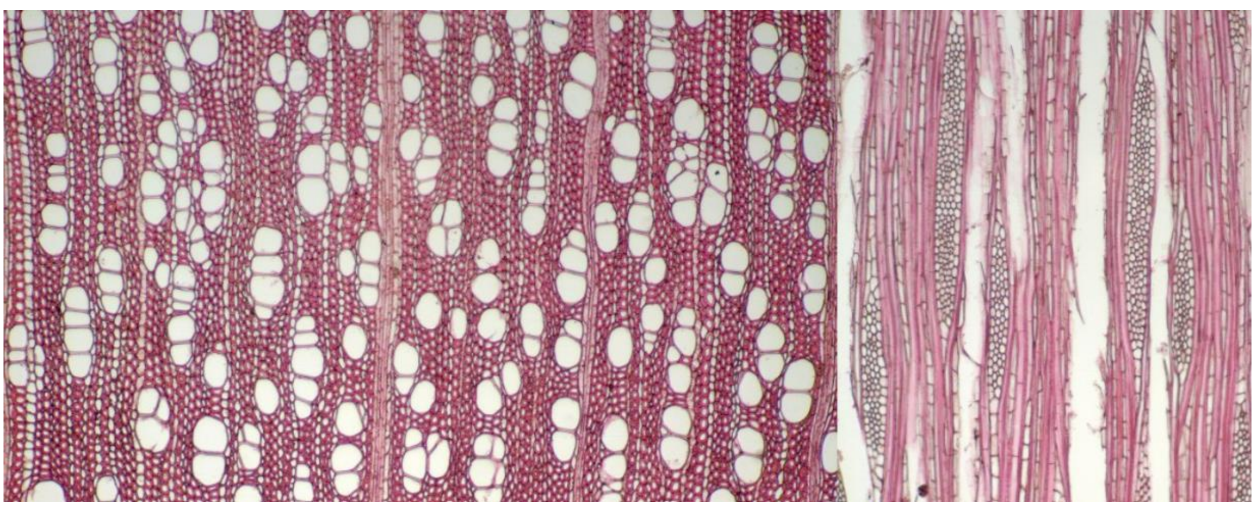
RUBIACEAE Randia armata,
aculeata, *brenesii*, *monantha*, *grandifolia*, *genipoides*, *altiscandens* (rosetillo, jagua macho, mostrenco, tres chucitos)

- Vessels exclusively solitary, <50-100µm, 40-100+/mm^2
- Rays 1 to 3 cells, 12+/mm
- Parenchyma diffuse



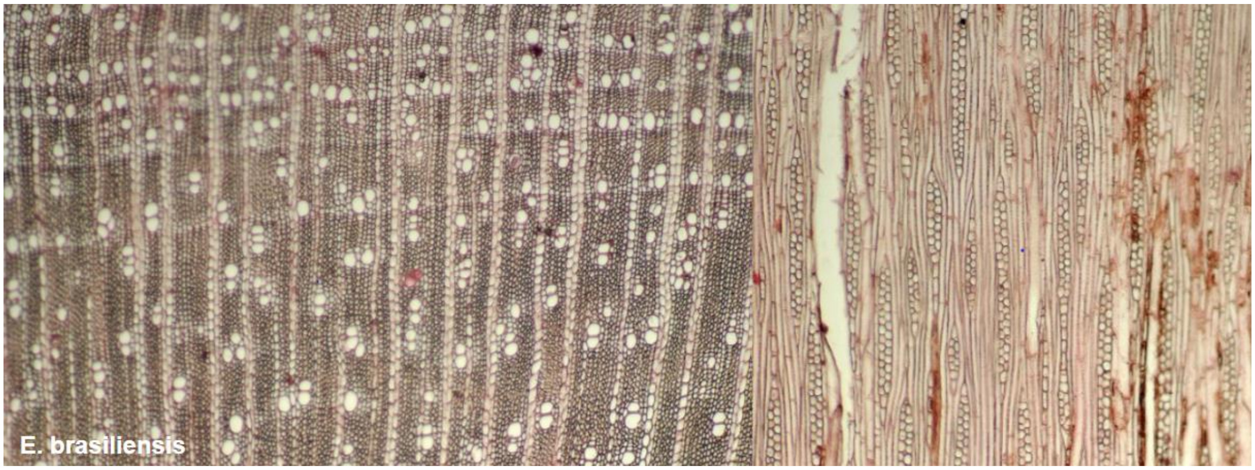
RUBIACEAE Warszewiczia coccinea, uxpanapensis (wakamy, sanguinaria, cresta de gallo, orinera)

- Vessels 50-100µm, 40-100/mm^2
- Rays 4 to 10 seriate, of two distinct sizes, 12+/mm
- Parenchyma rare, absent

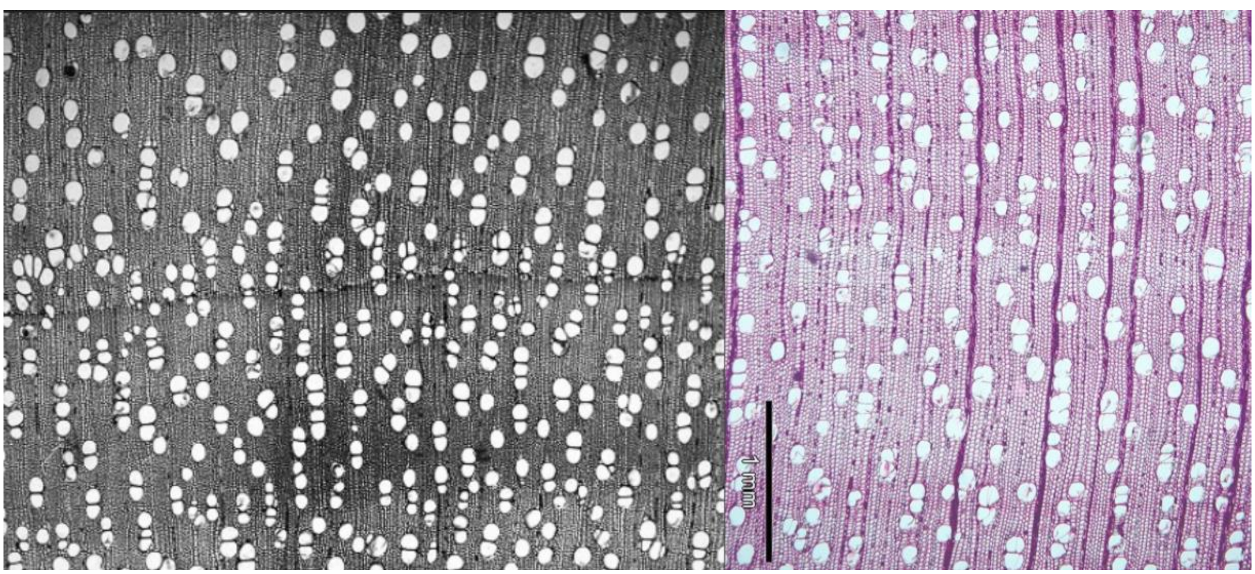


RUTACEAE *Erythrochiton* *gymnanthus* (common name unknown)

- Vessels <50µm, 40-100/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma vasicentric, confluent, marginal bands

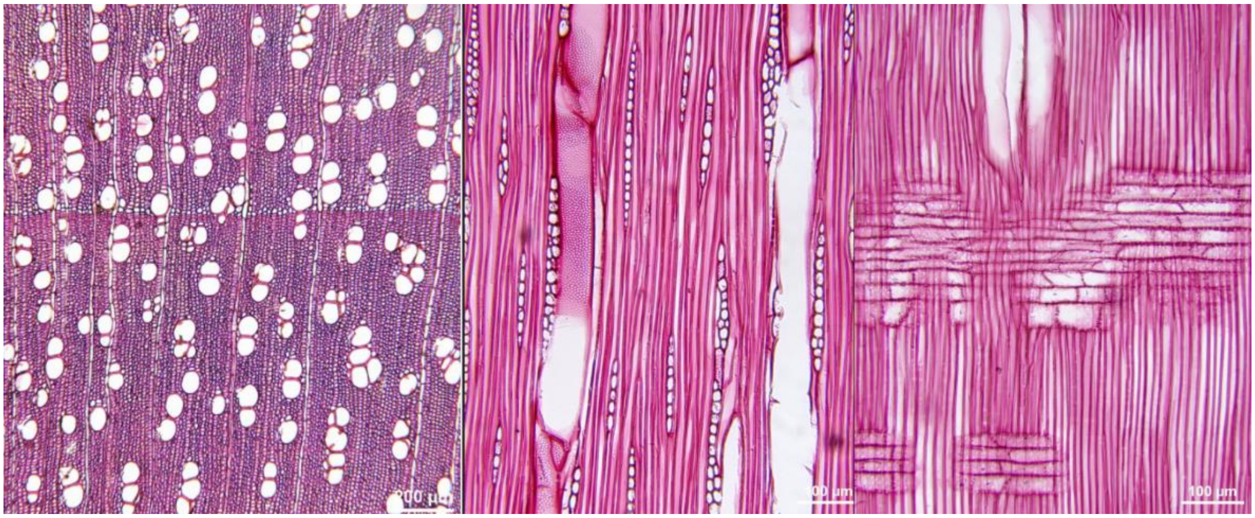


RUTACEAE *Zanthoxylum acuminatum,* *(*arcabú, tachuelo, pricklyash*) caribaeum, ekmanii, fagara, juniperinum, limoncello, melanostictum, mollissimum, panamense, procerum, rhoifolium, ridelianum, setulosum*



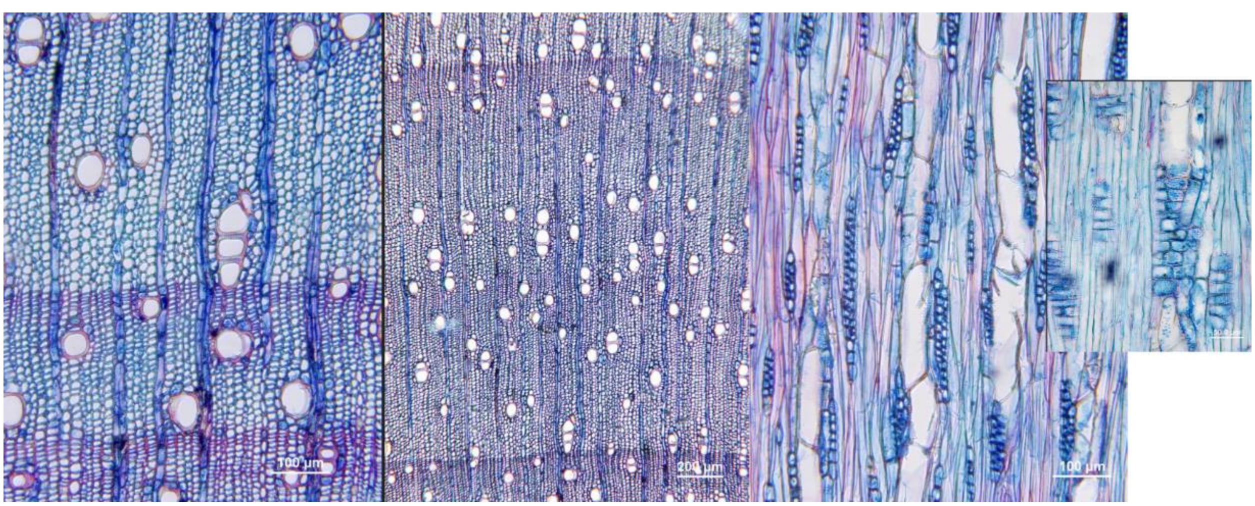
RUTACEAE *Zanthoxylum caribaeum,* *(*arcabú, tachuelo, pricklyash*) acuminatum, ekmanii, fagara, juniperinum, limoncello, melanostictum, mollissimum, panamense, procerum, rhoifolium, ridelianum, setulosum*

- Vessels 50-100µm, 20-40/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse, scanty, marginal bands



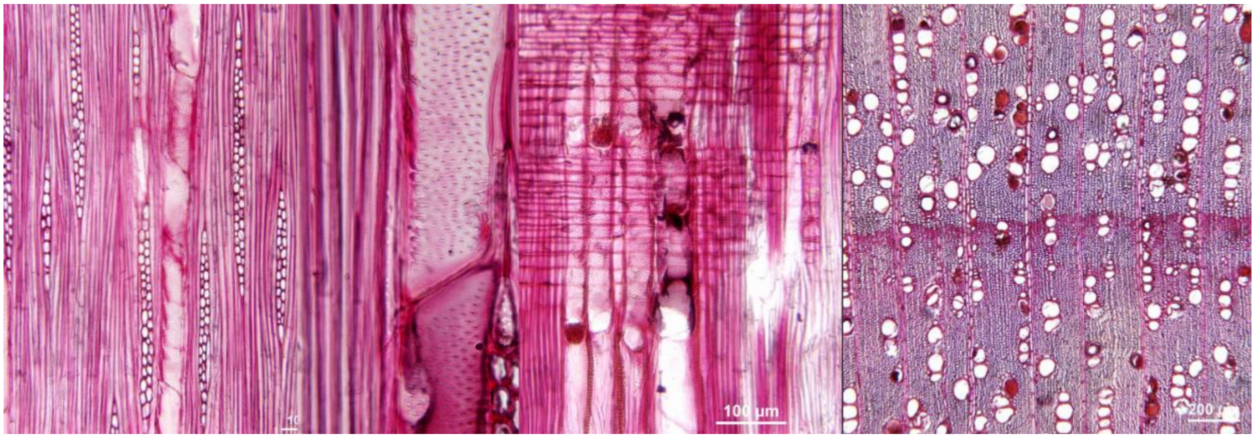
RUTACEAE *Zanthoxylum fagara,* *(*arcabú, tachuelo, pricklyash*) acuminatum, caribaeum, ekmanii, juniperinum, limoncello, melanostictum, mollissimum, panamense, procerum, rhoifolium, ridelianum, setulosum*

- Vessels <50-100µm, 20-100/mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm
- Parenchyma scanty, vasicentric, marginal bands



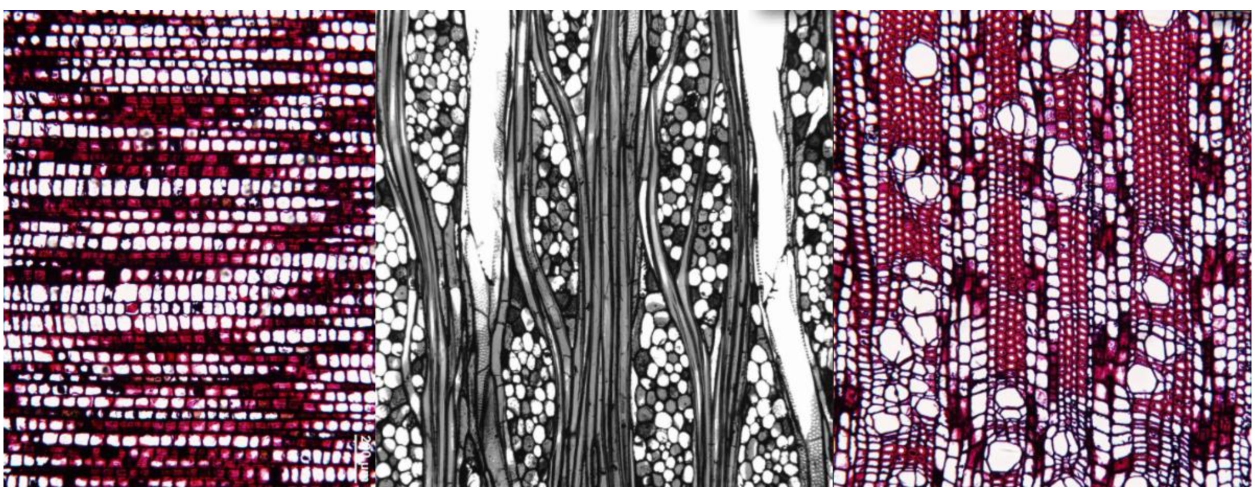
RUTACEAE *Zanthoxylum mollissimum,* *acuminatum, caribaeum, ekmanii, fagara, juniperinum, limoncello, melanostictum, panamense, procerum, rhoifolium, ridelianum, setulosum (*arcabú, tachuelo, pricklyash*)*

- Vessels <=50-100µm, 20-100/mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, <=4-12/mm
- Parenchyma scanty, marginal bands



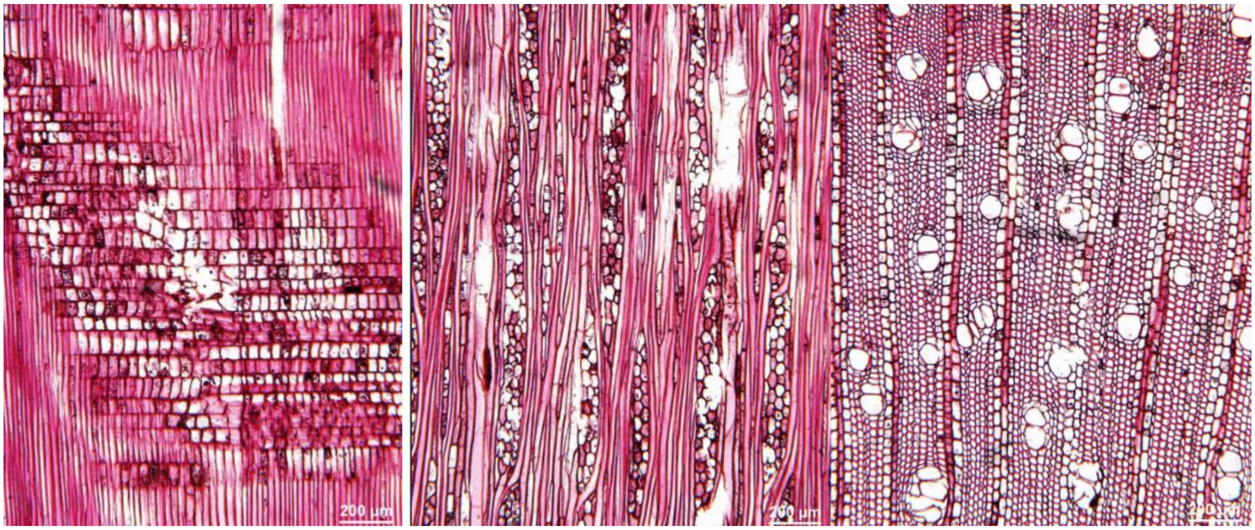
SABIACEAE *Meliosma allenii,* (worm head tree) *brenesii, clandestina, depressiva, donnellsmithii, glabrata, grandiflora, idiopoda, isthmensis, irazuensis, subcordata, vernicosa*

- Vessel clusters common, 100-200µm, 5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma scanty



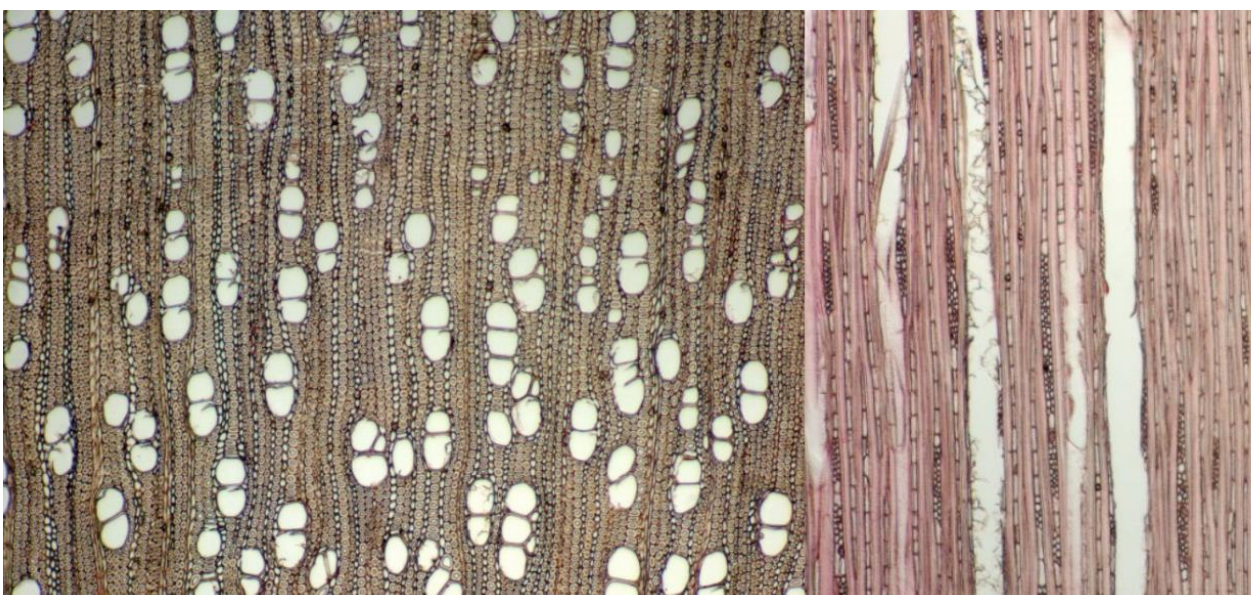
SABIACEAE *Meliosma glabrata,* (worm head tree) *allenii, brenesii, clandestina, depressiva, donnellsmithii, grandiflora, idiopoda, isthmensis, irazuensis, subcordata, vernicosa*

- Vessel clusters common, 50-100µm, 5-20/mm^2
- Rays 1 to 3 cells,, >=4/mm
- Parenchyma scanty



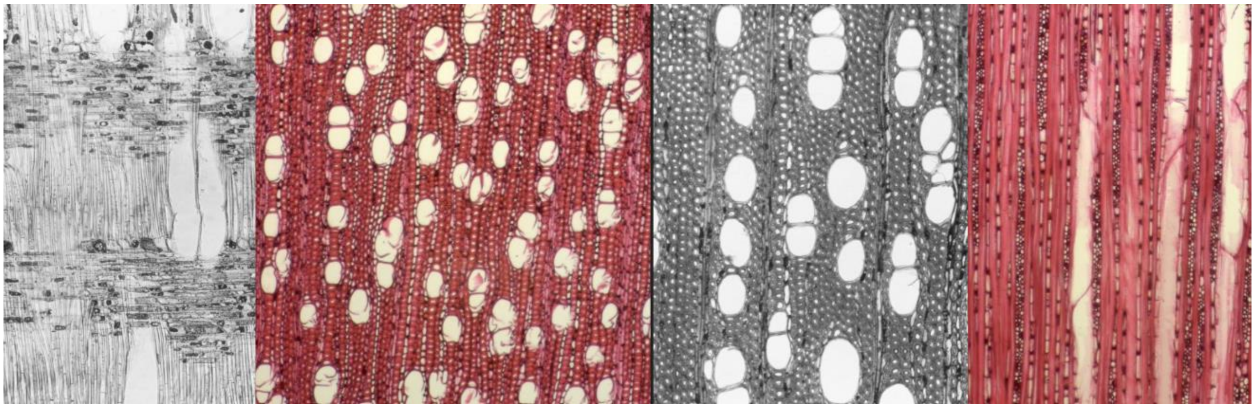
SALICACEAE *Banara guianensis* (corta lengua, pica lengua)

- Vessels 50-100µm, 5-20/mm^2, tyloses common
- Rays 1 o 3 cells, of two sizes, 4-12+/mm
- Parenchyma absent or rare



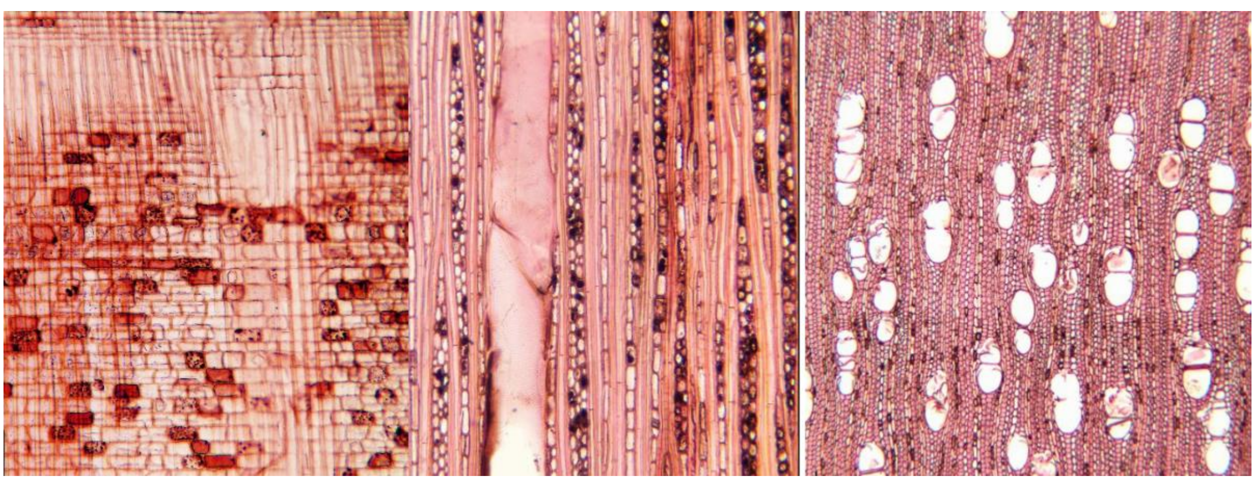
SALICACEAE *Casearia arborea,* (corta lengua, pica lengua, manga larga, mauro) *arguta, commersoniana, coronata, corymbosa, stanleyana, stjohnii, sylvestris, tacanensis*

- Vessels 50-100µm, 5-20/mm^2, tyloses common
- Rays of two sizes, >=12/mm
- Parenchyma absent or rare



SALICACEAE *Casearia corymbosa,* (corta lengua, pica lengua) *arborea, arguta, commersoniana, coronata, standleyana, stjohnii, sylvestris, tacanensis*

- Vessels <50-100µm, 20-40/mm^2
- Rays 1 to 3 cells, >=12/mm
- Parenchyma absent or rare

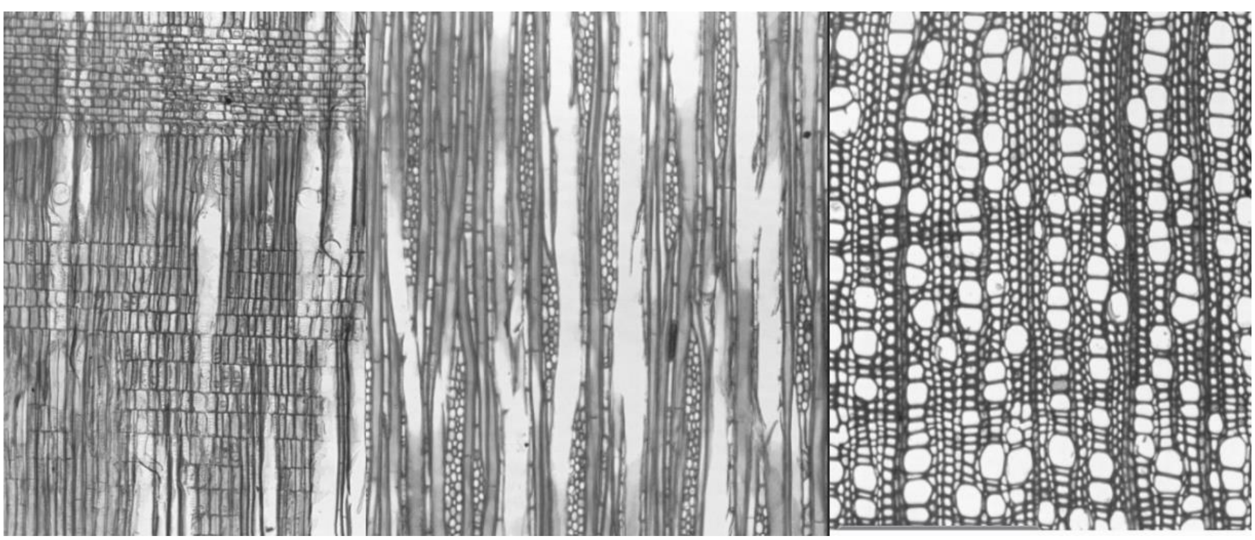


SALICACEAE *Casearia sylvestris,* (corta lengua, pica lengua) *arborea, arguta, commersoniana, coronata, corymbosa, standleyana, stjohnii, tacanensis*

- Vessels 50-100µm, 40-100+/mm^2
- Rays 1 to 3 cells, >=12/mm
- Parenchyma absent or rare

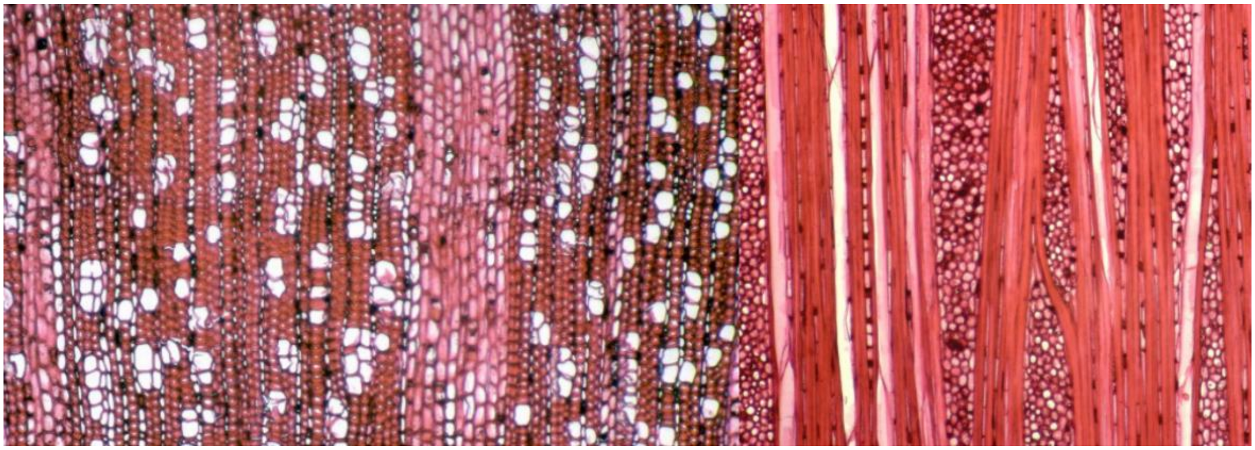
SALICACEAE *Hasseltia floribunda* *allenii, guatemalensis*
(parimontón, corta lengua, raspa lengua)

- Rays 1 to 3 cells, 4 to 10 seriate, 2 distinct sizes, >=12/mm
- Vessels 50-100µm, 20-40/mm^2
- Parenchyma absent or rare



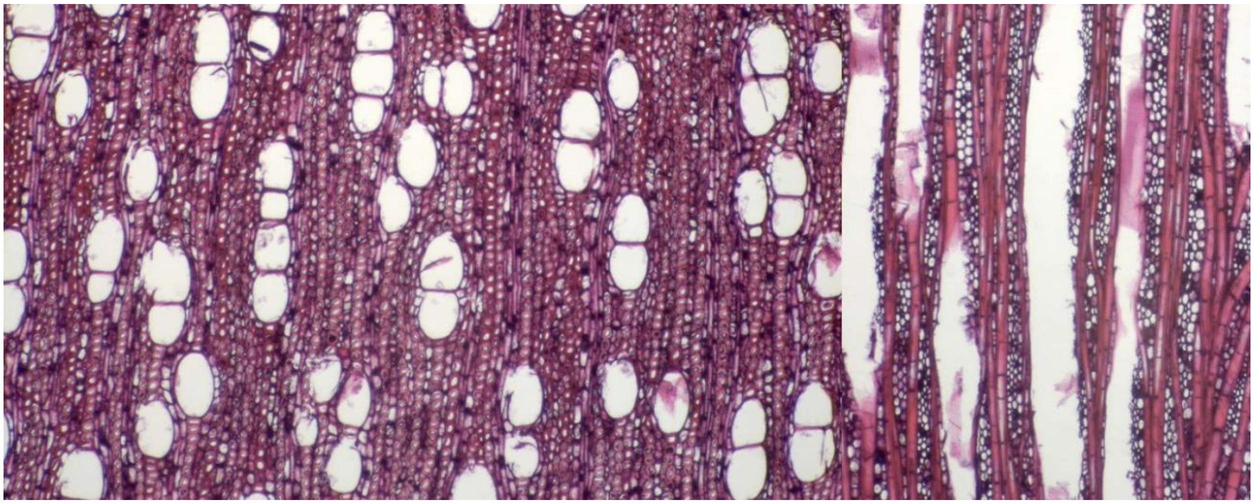
SALICACEAE *Ryania speciosa*
(corta lengua)
only species within this genus in Costa Rica

- Vessels <50-100µm, 40-100/mm^2
- Rays 4 to 10 seriate, of two sizes, 4-12+/mm
- Parenchyma absent or rare

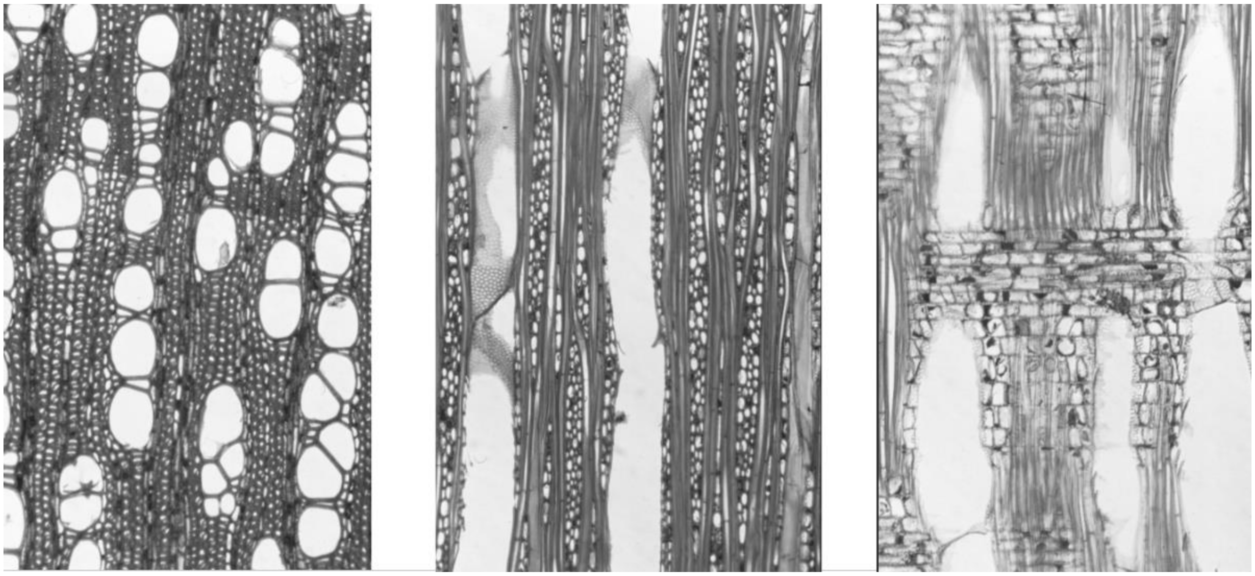


SALICACEAE *Tetrathylacium johansenii*
(palo de chancho, pantano)

- Vessels 50-100µm, 20-40/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma absent or rare

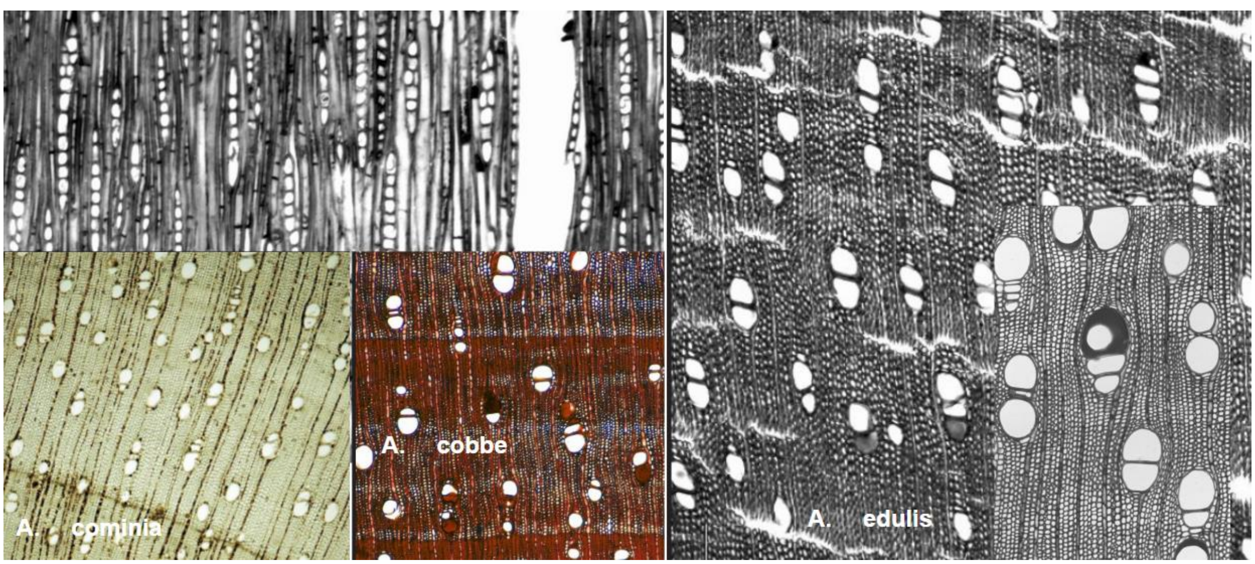


SALICACEAE *Xylosama panamensis,* (cachos de venado)
chlorantha, hispidula, oligandra, velutina



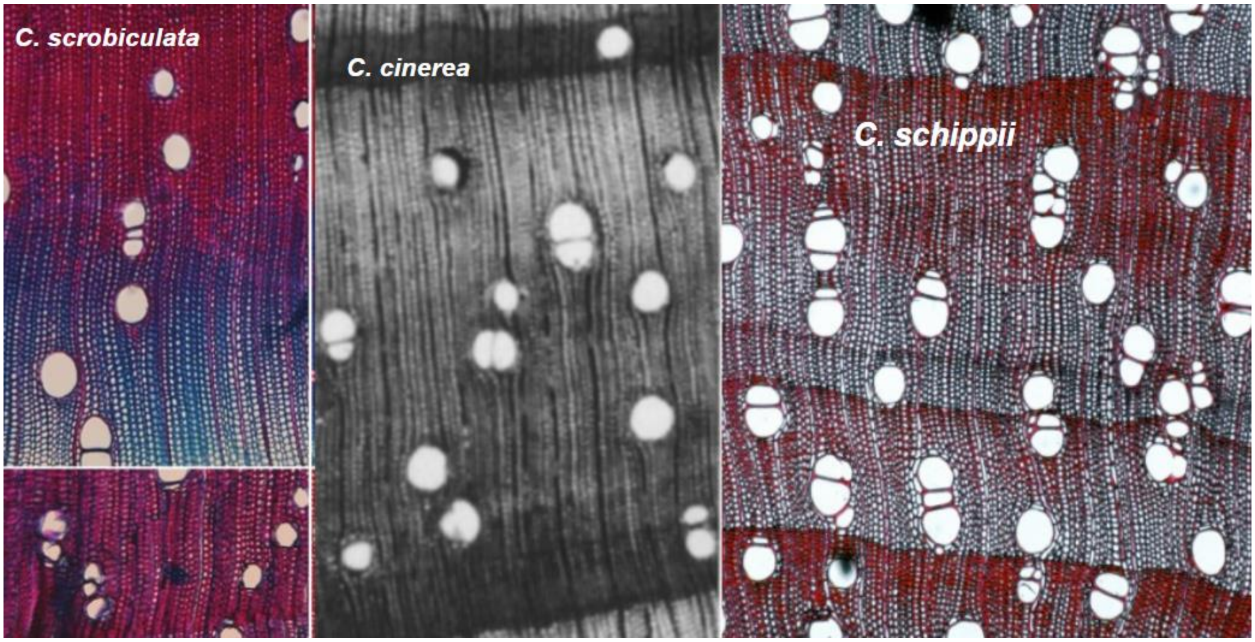
SAPINDACEAE *Allophylus* *gentryi, psilospermus, racemosus* (esquitillo)

- Vessels 50-100µm, 40-100+ /mm^2, radial multiples, tyloses common
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse, in narrow bands



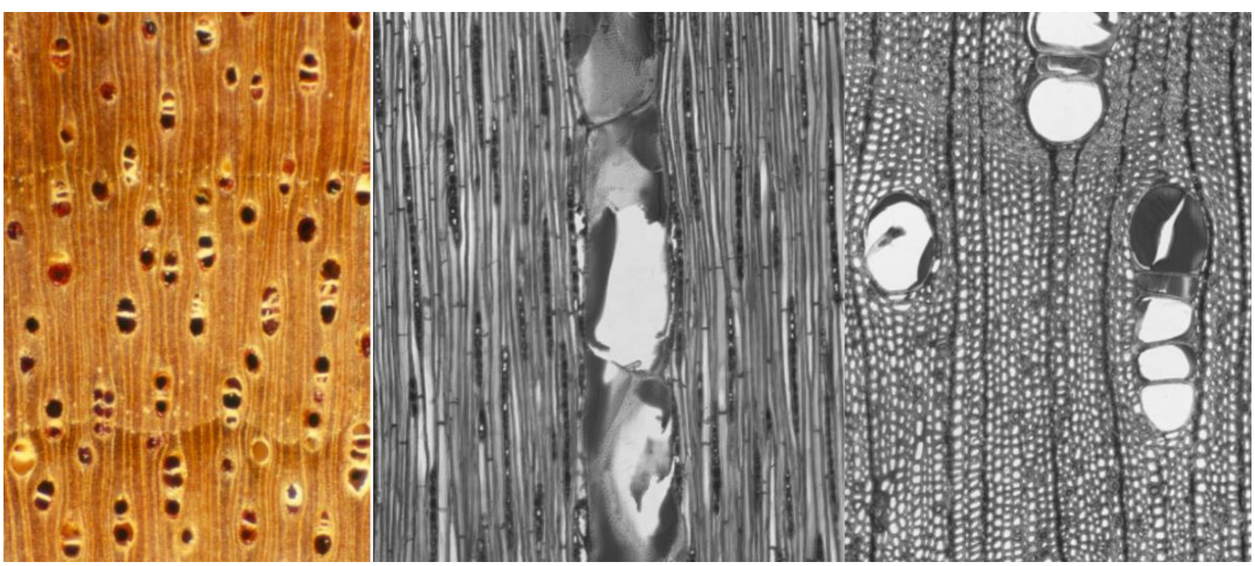
SAPINDACEAE *Cupania cinerea,* *glabra, grandiflora, guatemalensis, rufescens,* ***scrobiculata*** (cn: candelillo, gorgojero, gorgojo, pava)

- Vessels 50-100µm, 20-40 /mm^2
- Rays exclusively uniseriate, 4-12+/mm
- Parenchyma absent, rare, scanty, vasicentric



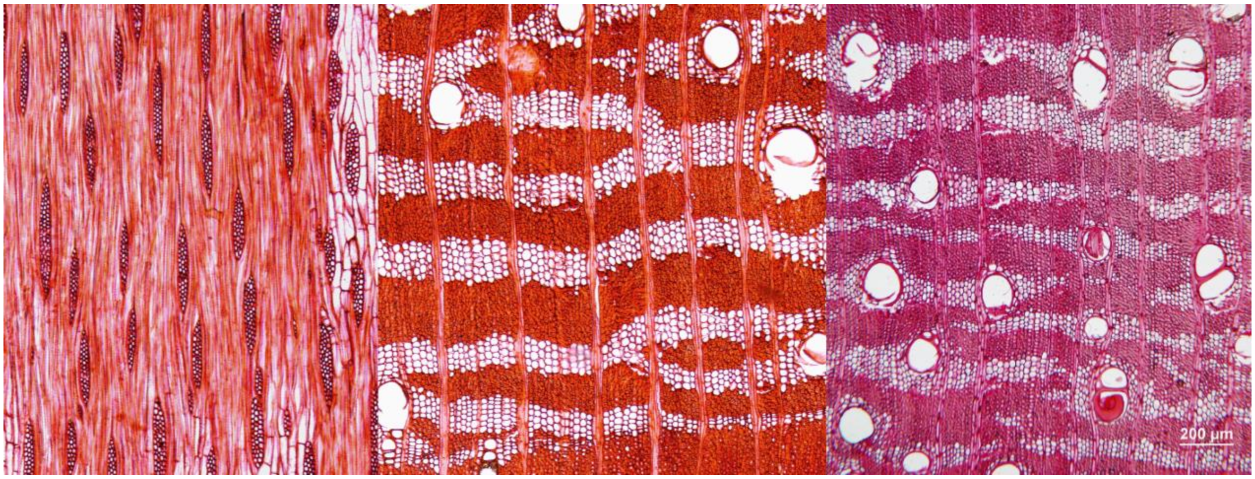
SAPINDACEAE *Matayba* *apetala, ingifolia, oppostifolia, scrobiculata*

- Vessels 50-200µm, 5-20 /mm^2, (gorgojero, laso, laso prieto, matillo)
- Rays exclusively uniseriate, >12/mm
- Parenchyma scanty



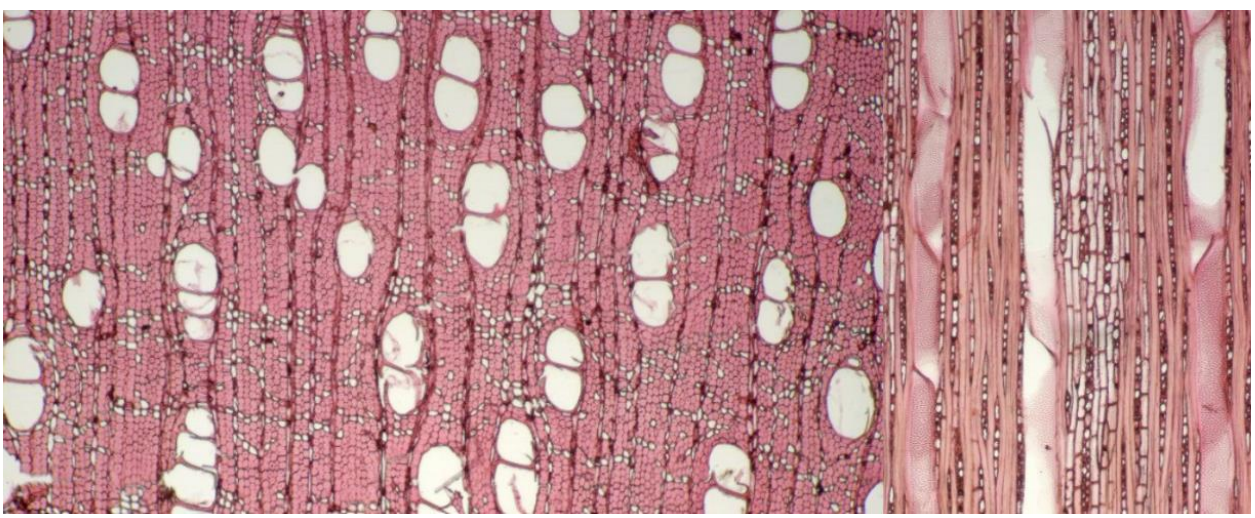
SAPINDACEAE *Sapindus saponaria* (jaboncillo, soapberry, yequiti)
Only species in Costa Rica within this genus

- Vessels 100-200µm, 5-20 /mm^2, gums in heartwood vessels
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma aliform, winged, confluent, marginal bands



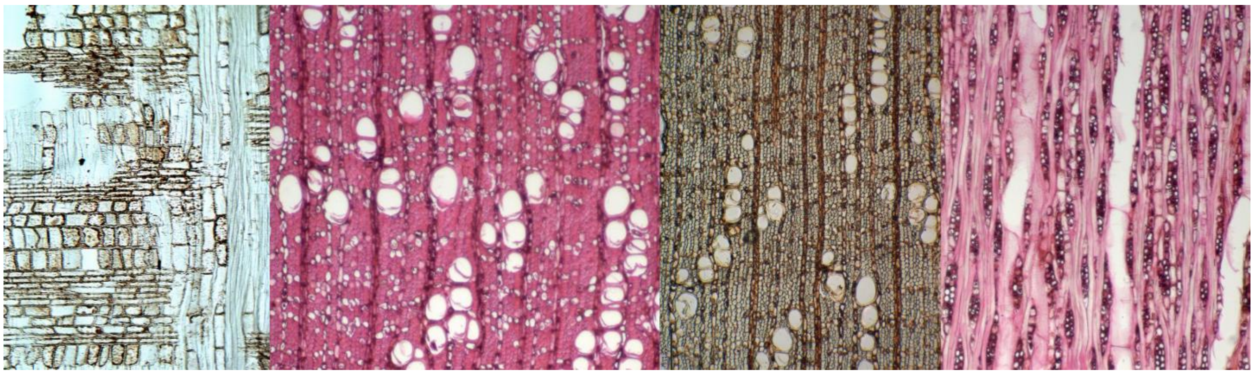
SAPOTACEAE *Chrysophyllum argenteum,* *brenesii*, *cainito, colombianum, venezuelanense* (caimito, mameicillo, nisperillo)

- Vessels 50-100µm, 20-40 /mm^2, tyloses common
- Rays exclusively uniseriate, >12/mm
- Parenchyma in narrow bands up to three cells wide



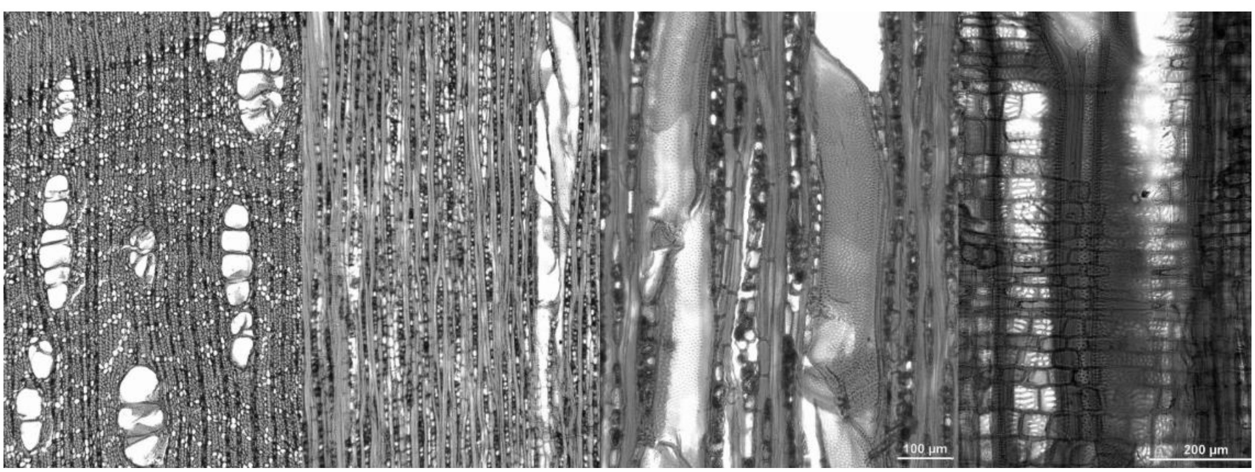
SAPOTACEAE *Manilkara zapota* *M. chicle, spectabilis, staminodella*
(mamey, sapodilla, níspero)

- Vessels 50-100µm, 40-100+ /mm^2, radial in multiples, tyloses common
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse, in narrow bands



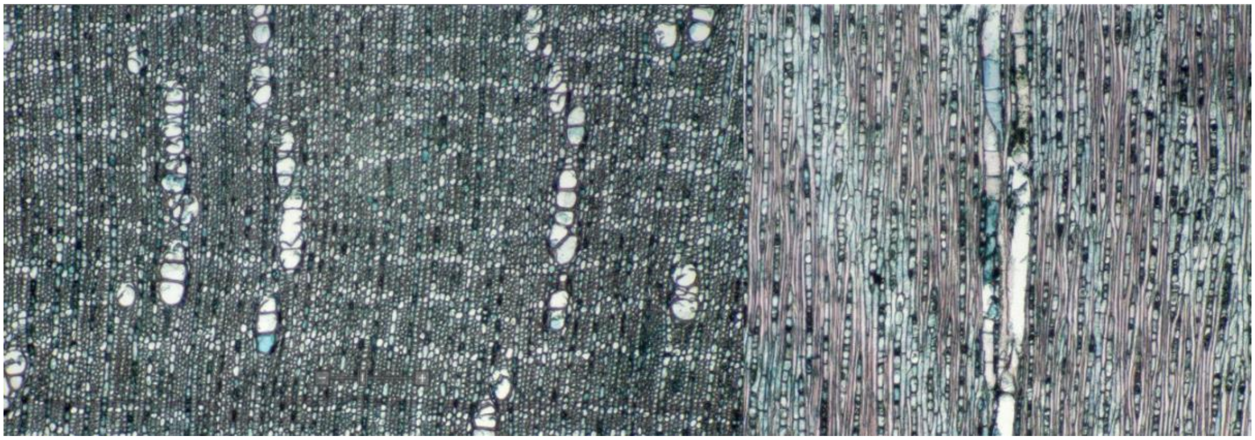
SAPOTACEAE *Pouteria campechiana* (canistel)
P. amygdalicarpa, chiricana, durlandii, exfoliata, fossicola, filipes, glomerata, juruana, laevigata, lecythidicarpa, reticulata, sapota, silvestris, torta, viridis

- Vessels 100-200µm, <5-20/mm^2, in radial chains
- Rays exclusively uniseriate, >12/mm
- Parenchyma in narrow bands



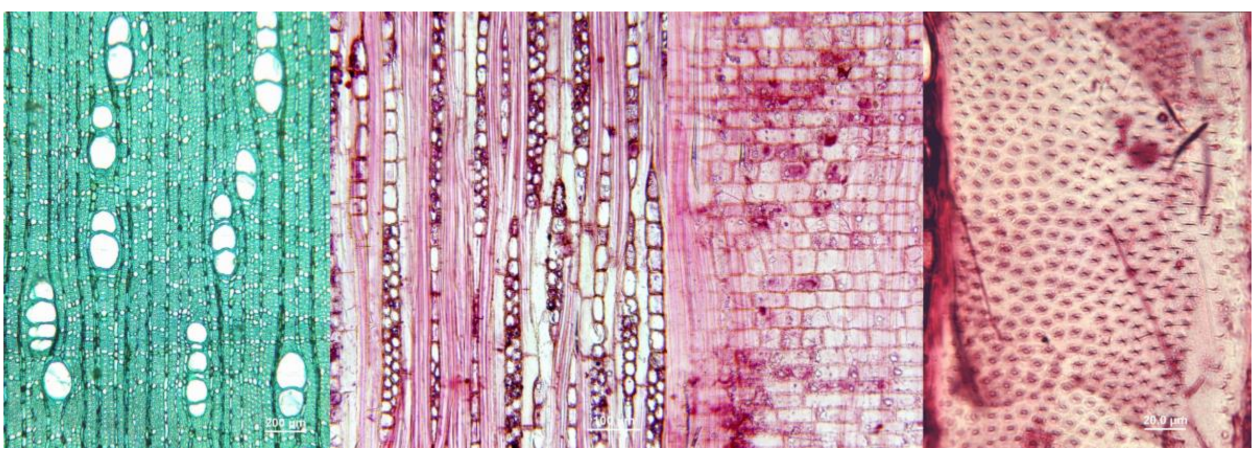
SAPOTACEAE *Pouteria durlandii* (mamey, nisperillo, mameicillo)
P. amygdalicarpa, chiricana, campechiana, exfoliata, filipes, fossicola, glomerata, juruana, laevigata, lecythidicarpa, reticulata, sapota, silvestris, torta, viridis

- Vessels 50-100µm, <5-20/mm^2, in radial chains
- Rays exclusively uniseriate, >12/mm
- Parenchyma in narrow bands, reticulate



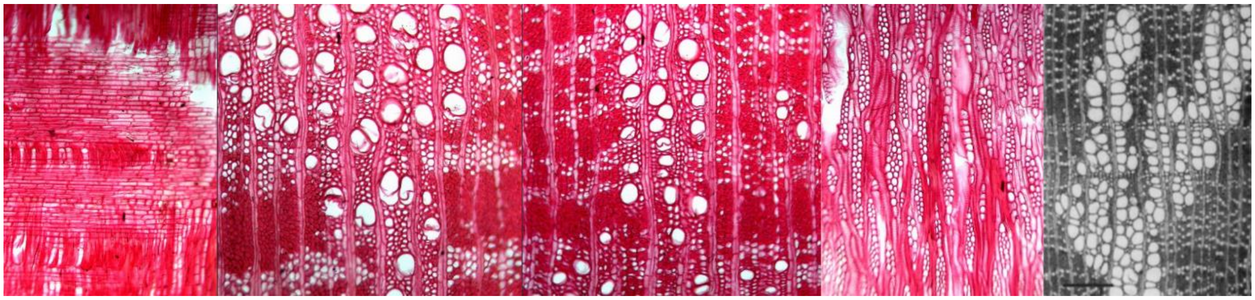
SAPOTACEAE *Pouteria sapota* (mamey, nisperillo, mameicillo)
P. amygdalicarpa, chiricana, campechiana, durlandii, exfoliata, filipes, fossicola, glomerata, juruana, laevigata, lecythidicarpa, reticulata, silvestris, torta, viridis

- Vessels 100-200µm, <5-20/mm^2, in radial chains
- Rays 1 to 3 cells, 4-12+/mm
- Parenchyma in narrow bands
- gums in heartwood vessels



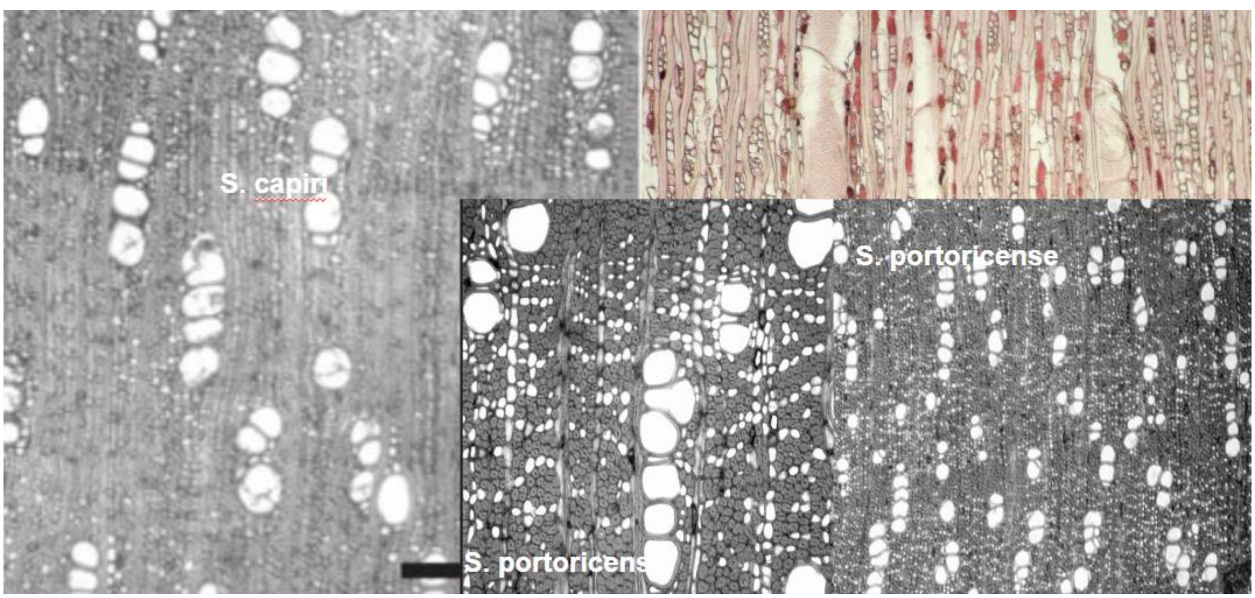
SAPOTACEAE *Sideroxylon* celastrinum, capiri, obtusifolium, persimile, portoricense, stenospermum (espino rico)

- Vessels 50-100µm, 40-100+/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma reticulate, bands, scalariform



SAPOTACEAE *Sideroxylon spp.* capiri, celastrinum, obtusifolium, persimile, **portoricense**, stenospermum (espino rico)

- Vessels in chains, 50-100µm, 20-100/mm^2
- Rays 1 to 3 cells, >12/mm
- Parenchyma diffuse in aggregates, marginal bands

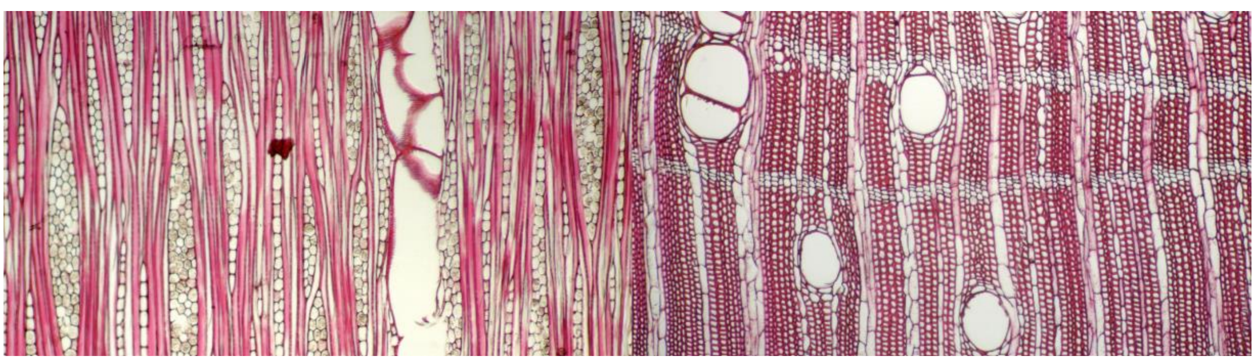


SCROPHULARIACEAE *Buddleja americana,* *nitida* (butterfly bush)

- Vessels 50-100µm, 20-100/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma scanty

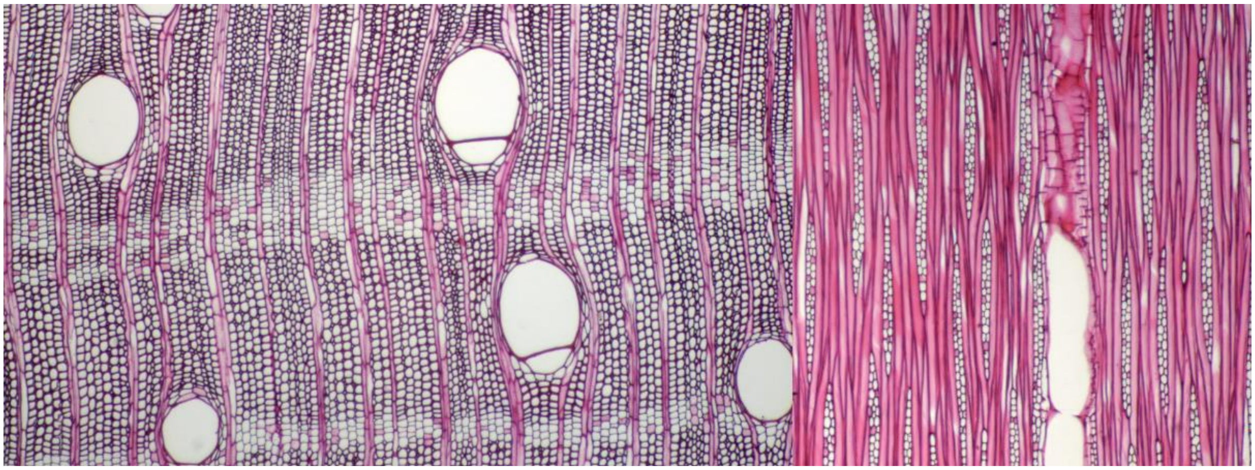
SIMAROUBACEAE *Simaba cedron,* *polyphylla*, *orinocensis* (cedron)

- Vessels 100-200µm, <=5/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, <4-12/mm, all storied
- Parenchyma vasicentric, banded, marginal bands



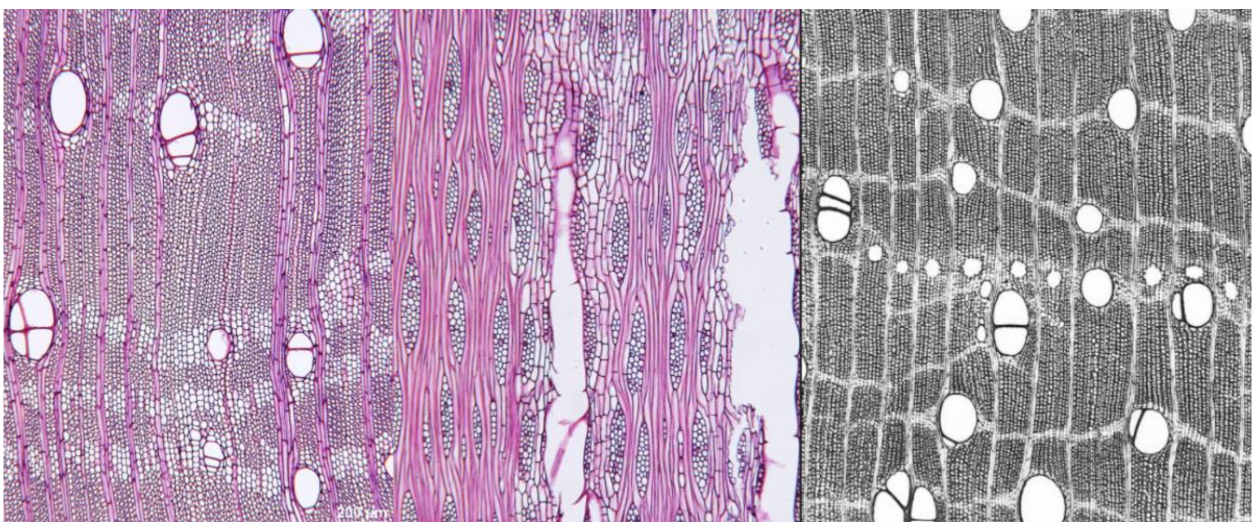
SIMAROUBACEAE *Simaba orinocensis,* *polyphylla, cedron* (calunga)

- Vessels 100-200µm, <=5/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, <4-12/mm, all storied
- Parenchyma vasicentric, banded, marginal bands



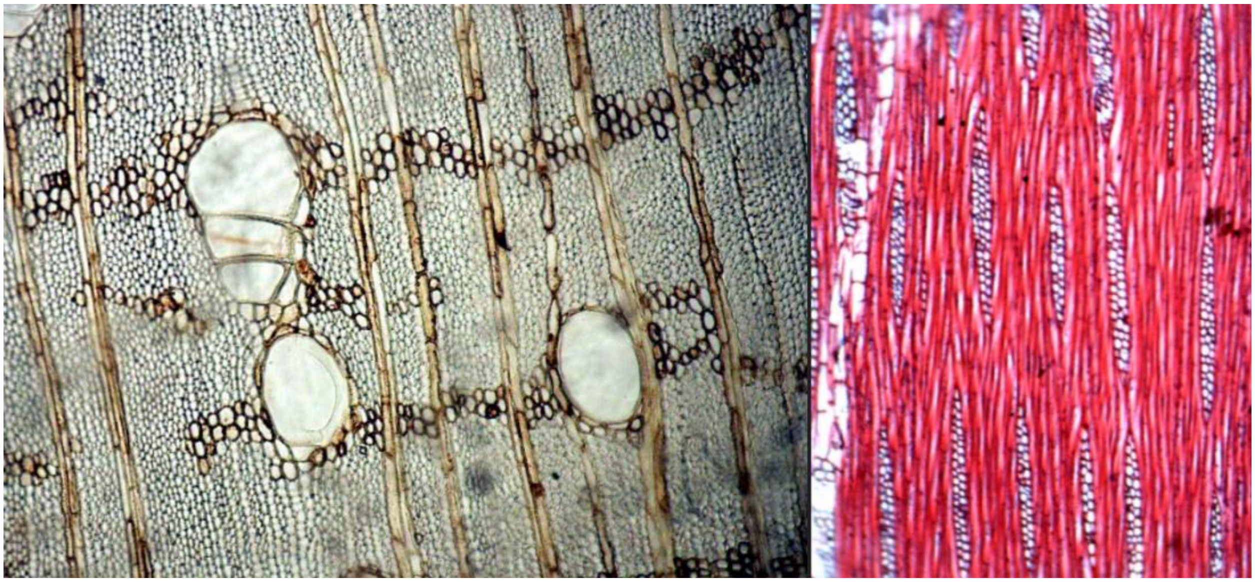
SIMAROUBACEAE *Simarouba amara,* *glauca* (aceituno, olivo)

- Vessels 100-200+µm, <=5/mm^2
- Rays 1 to 3 cells, 4 to 10 seriate, 4-12/mm, all storied
- Parenchyma aliform, confluent, banded



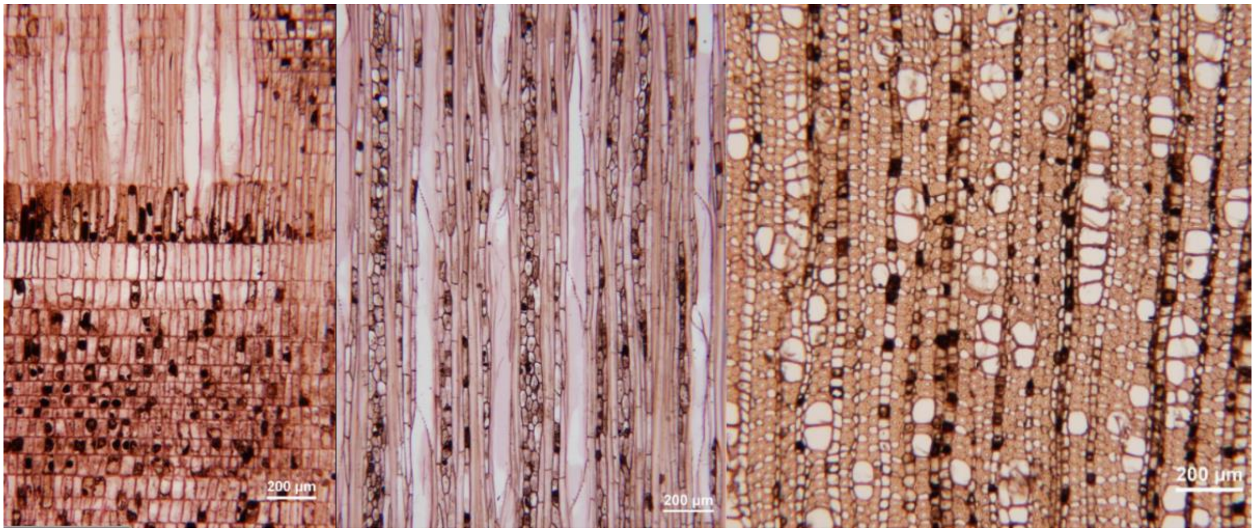
SIMAROUBACEAE ***Simarouba glauca,*** *amara (*marupa, paradise tree*)*

- Vessels 100-200+µm, <=5-20/mm^2
- Rays 4 to 10 seriate, 4-12/mm, all storied
- Parenchyma aliform, confluent, banded, reticulate



SIPARUNACEAE ***Siparuna pauciflora,*** *thecaphora, grandiflora, gesnerioides, tetraceroides* (pasmo hediondo, pasmo, limoncillo)

- Vessels in radial multiples, 50-100µm, 20-40/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma diffuse in aggregates



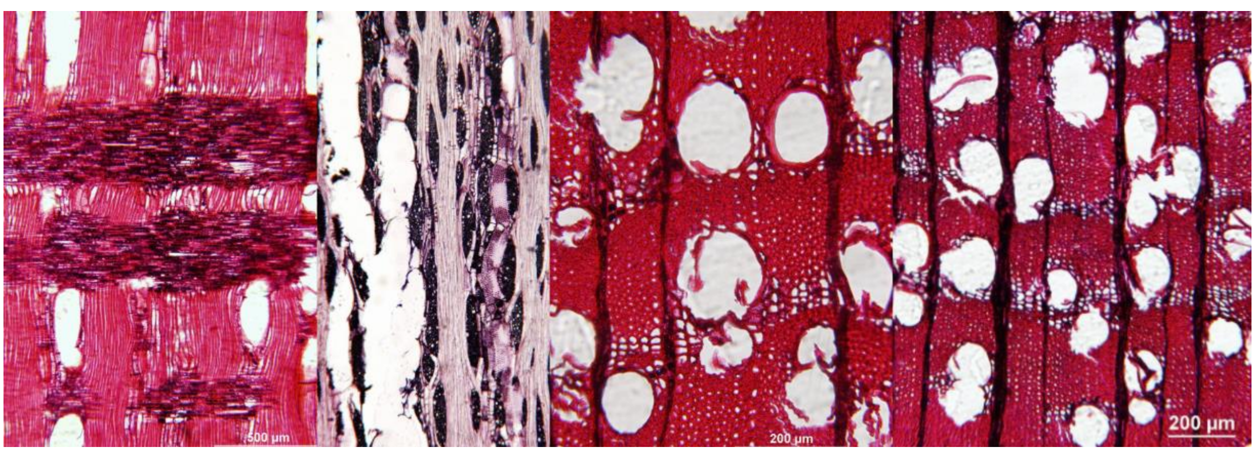
STAPHYLEACEAE *Turpinia occidentalis* (cedrillo de montaña)

Only species in Costa Rica within this genus

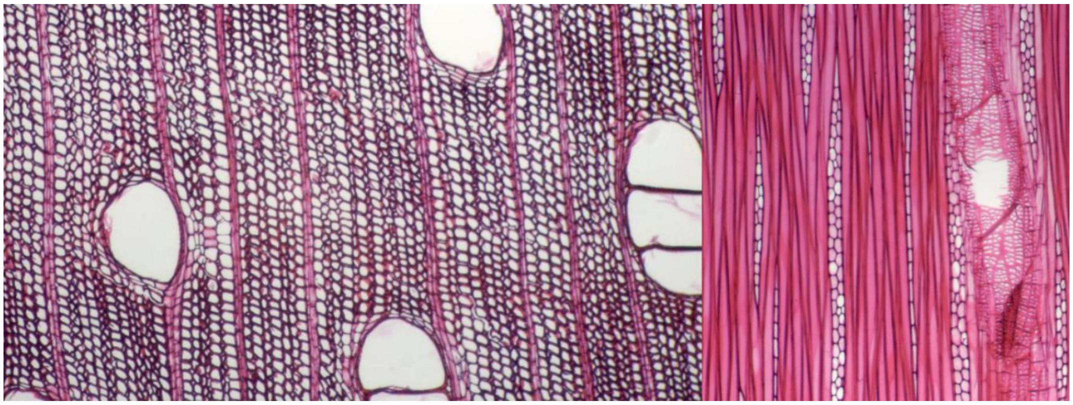
- Vessels 50-200µm, 5-100/mm^2
- Rays 4 to 10 seriate, 4-12/mm
- Parenchyma absent, rare, scanty, diffuse

ULMACEAE *Ulmus mexicana* (mexican elm, In Costa Rica known as *Tirrá*)

- Vessels 100-200µm, 5-20/mm^2
- Rays 4 to 10, 4-12/mm
- Parenchyma vasicentric, aliform, marginal bands
- Tyloses common

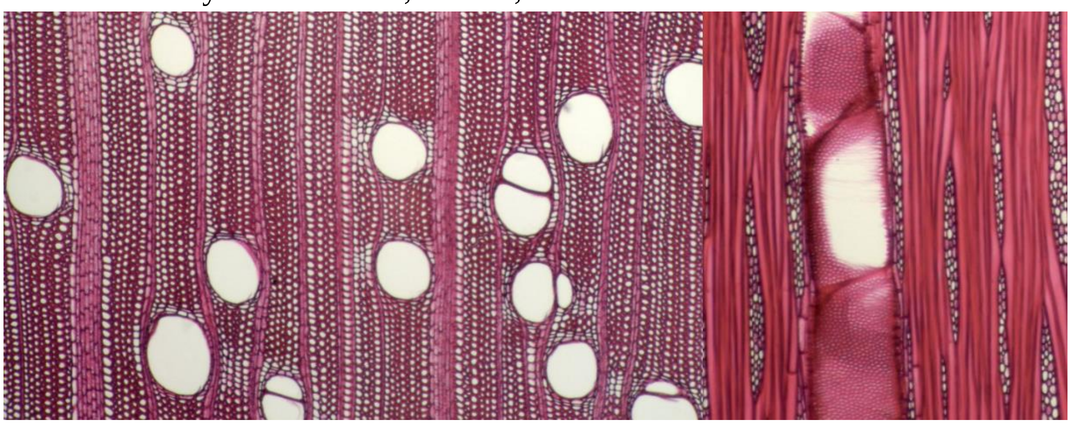


URTICACEAE *Cecropia garciae,* *insignis, obtusifolia, peltata* (trumpet tree)



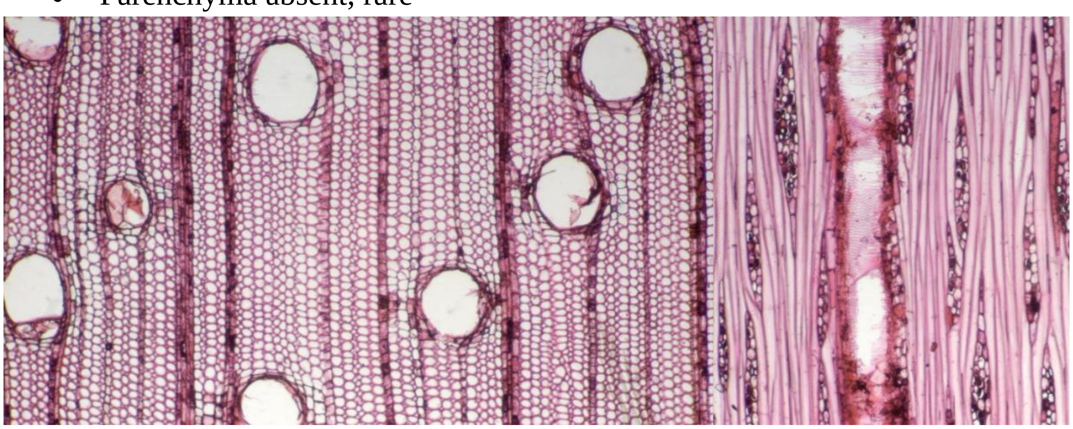
URTICACEAE *Cecropia obtusifolia,* *insignis, garciae, peltata*

- Vessels >=200µm, <5/mm^2
- Rays 4 to 10, <4-12/mm
- Parenchyma vasicentric, aliform, confluent



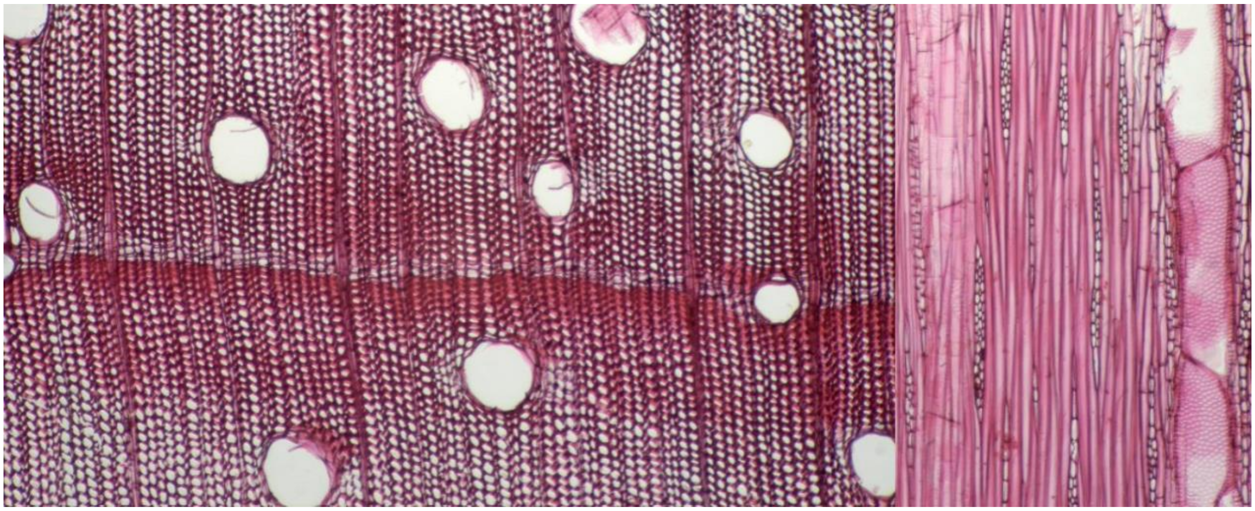
URTICACEAE *Cecropia peltata,* *insignis, garciae, obtusifolia* (guarumo, trumpet tree)

- Vessels 100-200µm, 5-20/mm^2
- Rays 1 to 3 cells, 4-12/mm
- Parenchyma absent, rare



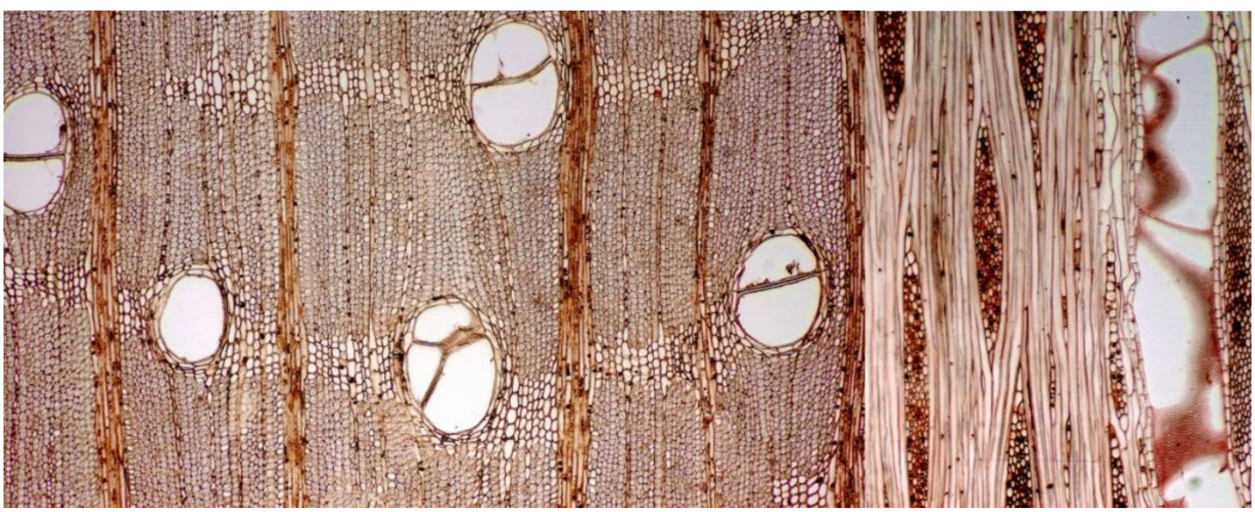
URTICACEAE *Pourouma bicolor,* *minor (*uvito, magabe, guarumo macho)

- Vessels 100-200+µm, <5-20/mm^2, tyloses common
- Rays 4 to 10, 4-12/mm
- Parenchyma vasicentric, aliform, marginal bands\
- *P*. *minor* → vessels >200



VOCHYSIACEAE *Vochysia ferruginea,* *allenii, gentryi, guatemalensis*
(mayo, flor de mayo, botarrama, tecla)

- Vessels 100-200+µm, <5-20/mm^2
- Rays 4 to 10, of two sizes, 4-12/mm
- Parenchyma diffuse, aliform, confluent, bands



VOCHYSIACEAE *Vochysia guatemalensis,* *ferruginea*, *allenii*, *gentryi*
(mayo, flor de mayo, botarrama, tecla)

- Vessels 100-200+µm, <5-20/mm^2
- Rays 4 to 10, of two sizes, 4-12/mm
- Parenchyma diffuse, aliform, confluent, bands