BIOARCHAEOLOGICAL EXPLORATIONS OF
EPICLASSIC (A.D. 550-900) HILLTOP
SETTLEMENTS FROM THE
TULA REGION OF HIDALGO, MEXICO

A Dissertation in
Anthropology and Demography
by
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ABSTRACT

Researchers have long debated the structure of Tula Grande’s (AD 900-1150) social-political organization and nature of its influence throughout Central Mexico and beyond. After struggling with this issue for decades, researchers have more recently concluded that if we wish to understand Tula Grande’s functioning at apogee, we should first understand the site’s origin and the social dynamics that led to its foundation. To do this, we must momentarily step away from Tula Grande and turn our focus to the settlements in the region directly prior to Tula’s rise to power. The research presented in this dissertation is a direct outgrowth of this perspective, focusing on Epiclassic hilltop settlements associated with the Coyotlatelco culture complex from the Tula Valley. Coyotlatelco refers to a specific ceramic complex with links to northwestern Mexico that became common during the Epiclassic period, especially in the Tula region, and is thought to represent the sustained presence of northwestern populations in Central Mexico after the decline of Teotihuacan (100 BC-AD 550).

Overall, archaeological research in the Tula Valley has remained limited, especially when compared to other urban sites, such as Teotihuacan. Work in the region has largely focused on surface survey, settlement archaeology, and architectural, ceramic, and lithic analyses. All of these areas of inquiry are extremely important to Central Mexican archaeology and their contributions have been immense. Despite this progress, relatively few scholars have turned to skeletal remains as a source of important information, and the analyses detailed in this manuscript are an attempt to glean new information about life at Epiclassic (AD 550-900) hilltop settlements using this previously neglected resource. Traditionally, skeletal collections in Highland Mexico have been used to address questions related to population health, but newer approaches incorporate skeletal material into archaeological discourse in innovative ways. The purpose of this dissertation is to demonstrate how human skeletal remains can be leveraged to address longstanding archaeological questions in the Tula region. In the pursuit of this goal, skeletal remains from the Epiclassic hilltop centers of La Mesa and Cerro Magoni were used to better characterized the radiocarbon chronology of the study sites and to situate the settlements within the cultural context of the Tula region. Additionally, paleodietary reconstructions were completed for the study individuals to evaluate the intersection of identity and food consumption practices. Through these analyses it has been possible to confirm long standing, but untested hypotheses, answer new questions, and provide directions for further inquiry. Finally, in addition to the analysis of new radiocarbon dates and isotopic paleodiet data, this dissertation also provides a review of bioarchaeological research in Central
Mexico, a short summary of contextual information related to the La Mesa and Cerro Magoni skeletal collections, and a review of current perspectives on archaeological research in the Tula region.

Based on the radiocarbon results presented in this dissertation, it is likely that Cerro Magoni and La Mesa were founded very close in time to one another, prior to the end of the Metepec period (AD 550-650). The founding of the sites prior to AD 650 is significant because the bottomlands of the Tula Valley were potentially still inhabited by Classic period remnant populations. Overcrowding may have been one reason why the La Mesa phase settlements were placed on the inhospitable hilltops surrounding the valley, but the nearly simultaneous founding of centers on nine separate hilltops suggests that any animosity between the Coyotlatelco populations and the Classic period communities was not great enough to encourage the La Mesa phase households to live together in a large settlement. Though the La Mesa phase settlements were founded at the same time, Bayesian modelling indicates that the site of La Mesa was abandoned earlier than Cerro Magoni. This suggests that the transition from the hilltop centers to the lowlands was a gradual process, or that hilltop populations eventually merged. Additionally, modelling also shows that La Mesa phase communities were inhabited longer than researchers initially projected, suggesting that life in these settlements was actually more stable than the literature suggests.

Additionally, five previously published radiocarbon dates from the site of Tula Chico were entered into a Bayesian model to assess if the calibration of the dates could be improved and compared with the new data from Cerro Magoni and La Mesa. Unfortunately, the radiocarbon dates from Tula Chico were not significantly improved by the Bayesian model, but it is likely that Tula Chico was founded at the same time or before Cerro Magoni and La Mesa. The burning of Platform 1 at Tula Chico has long been considered one of the final events of the Epiclassic period in Tula, but the evidence presented here suggests that daily life at Cerro Magoni continued for at least several decades after the event. This may mean that the burning of Platform 1 does not symbolize a great societal shift or struggle that immediately led to Tula Grande’s rise, and it may be prudent to reassess narratives that propose the Toltec state was born from violence and conflict.

In addition to analyzing radiocarbon dates from Cerro Magoni, La Mesa, and Tula Chico, stable carbon and nitrogen data from bone collagen was analyzed for individuals from Cerro Magoni and La Mesa. Specifically, three questions were addressed. First the dietary structures of the study sites were estimated and compared to one another. These data were also compared with dietary reconstructions from other Central Mexican communities to assess if the inhabitants of Cerro Magoni and La Mesa exhibited differing dietary practices from one another and if the sites were unique when compared to other Central Mexican examples. Overall, the inhabitants of Cerro
Magoni and La Mesa likely consumed diets heavy in C₄/CAM resources, supplemented with terrestrial animals. Though diets at the two sites were similar, there was a statistically significant difference in stable carbon values, as individuals from Cerro Magoni were more carbon enriched. This may have been the result of increased maize, amaranth, or pulque consumption. Second, variation in the diets of males and females was also studied. No statistically significant differences were identified, but males at Cerro Magoni were typically more carbon enriched than females. Again, this may be the result of higher pulque consumption, and this explanation aligns well with the ethnographic record. Finally, the effect of time on stable carbon and nitrogen values was also addressed. A statistically significant correlation between time and the stable collagen trends at Cerro Magoni was found, with values increasing over time and peaking at the end of the Epiclassic period. This is significant because researchers have suggested that a shift in agricultural practice may have led directly facilitated Tula Grande’s rise to power in the AD 900.

While these observations cannot fully explain Tula Grande’s development, they do provide important new information about the Epiclassic settlements that surely contributed to the socio-political transitions of the Early Postclassic period. The data presented in this dissertation suggests that the La Mesa phase settlements were less ephemeral than researchers have previously suggested and were probably founded near the end of the Metepec period. Additionally, the sites were not abandoned at the same time, suggesting that the sociopolitical transition that led to Tula Grande’s rise was gradual. Finally, dietary evidence from Cerro Magoni and La Mesa suggests that slight differences may have existed between the two sites, and that practices at Cerro Magoni began to shift during the Epiclassic period, leading to carbon enrichment. This may have been the result of increased maize, amaranth, or pulque exploitation.
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This dissertation consists of five chapters, in addition to the introduction and conclusion. Each of these chapters addresses a different topic. The impetus for each chapter’s formulation is described below, as its authorship.

Chapter 2: Archaeology in the Tula Region: Current Understandings and Future Directions

This chapter was authored solely by Emily Kate and serves as a review of archaeology in the Tula region. This piece is intended to demonstrate Kate’s knowledge of research conducted at archaeological sites in Tula, important questions currently being studied, and potential areas of future research. This chapter also serves as a more comprehensive background for the chapters discussing radiocarbon dating in Tula and the study of paleodiet in the region.

Chapter 3: The Bioarchaeology of the Central Highlands of Mesoamerica from the Early Classic Period through the Toltec Period

This invited chapter was co-authored with Dr. Meggan Bullock of the Escuela Nacional de Antropología e Historia (ENAH). Kate authored the majority of the text, though Dr. Bullock contributed to the sections addressing the bioarchaeology of Cholula and to the areas for future inquiry in bioarchaeological theory. The chapter is scheduled to appear in The Routledge Handbook of Mexican Bioarchaeology, edited by Vera Tiesler of the Universidad Autónoma de Yucatán and is reproduced here, though it should be noted that the sections on the culture history of Central Mexico have been moved to Chapter 1 (Introduction) of this manuscript.

Chapter 4: Bioarchaeological Considerations for Cerro Magoni and La Mesa

Chapter 4 was also authored by Kate serves to purposes. First, it provides a brief overview of archaeological bias in bioarchaeological collections. Cultural sources of bias, the effects of preservation environments and excavation techniques, curation errors, and theoretical and methodological challenges inherent to paleodemography are all succinctly addressed. Second, the limited contextual information for the Cerro Magoni and La Mesa collections is discussed, as is some basic demographic data.
Chapter 5: Radiocarbon Chronology and the Tula Valley of Mexico

In its current form, Chapter 5 was authored solely by Kate. When drafted into a published paper, this chapter will appear with Dr. J. Heath Anderson and Dr. Douglas Kennett as co-authors. Overall, Chapter 5 discusses the radiocarbon chronology of Tula and the findings from new radiocarbon dates derived from burials at the Epiclassic centers of La Mesa and Cerro Magoni.

Chapter 6: Diet among Epiclassic Coyotlatelco Hilltop Populations

Chapter 6 was also authored solely by Kate. The chapter currently discusses isotopic collagen data, but will eventually be paired with data from bioapatite samples that are currently under analysis. When complete, this study will also be published with Dr. J. Heath Anderson and Dr. Douglas Kennett as co-authors and will present the first isotopic paleodiet reconstruction ever completed in the Tula region.
This dissertation could not have been completed without the generous support of several academic institutions, many researchers, and my family and friends. I would first like to thank my committee for their guidance and patience. Plans for this dissertation changed many times and my committee has always been both supportive and accommodating. I owe special thanks to my advisor, Dr. Ken Hirth, who has encouraged me to preserve even during difficult times. Additionally, I wish to thank Dr. Doug Kennett for welcoming me into his lab at Penn State, where I learned many of the skills used to complete the work presented here. I also owe my gratitude to Brendan Culleton and Laurie Eccles, who contributed significantly to my education in the archaeological sciences, but also helped me to ensure that laboratory analyses were completed despite the challenges posed by the COVID-19 pandemic. The Penn State Department of Anthropology provided a wonderful educational environment where my interests and goals were always supported, and this unique community could not function without the unwavering assistance provided by Betty Blair, Robin Kephart, and Audrey Chambers. I never encountered an administrative challenge they could not address.

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in this dissertation do not necessarily reflect the views of these funding agencies.

I reserve my deepest thanks for my family who has supported me throughout my education and always encouraged me to continue onwards. Special gratitude is due to my parents, Kevin and Linda Kate, who never doubted me, even when I doubted myself. I would not be the scholar or the woman I am today without their guidance and love. A final thank you goes to my husband and best friend, Dr. Zachary Harvey. Throughout this endeavor, Zach somehow never tired of reminding me to have confidence in my abilities and never bored of conversations circling isotopes, bones, and Tula. Next to my father, Zach is the kindest and most patient man I have ever met and I owe so much of my success and happiness to his companionship. To my dear Zach -Always the love. Always the hours.
DEDICATION

This dissertation is dedicated to my family, who has always been an incredible example of hard-work and humility. Completing a doctorate can be a difficult thing, but the greatest efforts and hardest decisions were made by the generations who came before me. My great-grandfather, Elmer Roth, grew-up in rural Ohio and was heartbroken when he was forced to leave school after the eighth grade, but later in life he watched his daughter become a highly accomplished head nurse and his granddaughter, my mother, serve as a distinguished judge. This dissertation marks a third generation of women in my family completing the education that Elmer was never given the opportunity to pursue. In this way, I owe my accomplishments to those who came before me. My love of history comes from my maternal grandfather, Donald Shalosky, who spent his life as a boilermaker. I remember taking summer trips with him to Gettysburg, where he always emphasized the importance of knowing history and doing what is right, even when the cost is great. It was this reverence for the past that drew me to archaeology, and I know my grandfather would have relished the adventure of fieldwork. My time at the College of Wooster was also deeply formative and would not have been possible without the support of my great uncle, Ross Miller, who spent his years working as a clerk in a furniture store. I also owe so much to both of my parents, but I am especially blessed to have a father who would have given everything to ensure my happiness. My dad has always had an interest in geology and science, but no one in his early life offered him the opportunities he gave to me without a second thought. Already, I have had a remarkable life, and I owe the privilege to the members of my family who worked so hard to ensure that the next generation could succeed. In the end, I hope that I always pay this gift forward and live a life that makes my family proud.
CHAPTER 1: INTRODUCTION

In 1983, Richard Diehl (1983:14) posed the question “Who were the Toltecs and what was their capital like one thousand years ago?” Dr. Diehl was neither the first nor the last archaeologist to ask this question, and though 35 years have passed, most researchers would agree that we are still unable to answer this query in a satisfactory manner. Though Dr. Diehl’s statement was likely meant as a simple rhetorical device, it echoes a series of more complex questions. Researchers have long debated the structure of Tula Grande’s social-political organization and nature of its influence throughout Central Mexico and beyond. After struggling with this issue for decades, researchers have more recently concluded that if we wish to understand Tula Grande’s functioning at apogee, we should first understand the site’s origin and the social dynamics that led to its foundation. To do this, we must momentarily step away from Tula Grande and turn our focus to the settlements in the region directly prior to Tula’s rise to power. The research presented in this dissertation is a direct outgrowth of this perspective, focusing on Epiclassic (AD 600-900) hilltop settlements associated with the Coyotlatelco culture complex from the Tula Valley. Though discussed more fully in Chapter 2, Coyotlatelco refers to a specific ceramic complex with links to northwestern Mexico that became common during the Epiclassic period, especially in the Tula region, and is thought to represent the sustained presence of northwestern populations in Central Mexico after the decline of Teotihuacan.

Overall, archaeological research in the Tula Valley has remained limited, especially when compared to other urban sites, such as Teotihuacan. Work in the region has largely focused on surface survey, settlement archaeology, and architectural, ceramic, and lithic analyses. All of these areas of inquiry are extremely important to Central Mexican archaeology and their contributions have been immense. Despite this progress, relatively few scholars have turned to skeletal remains as a source of important information, and the analyses detailed in this manuscript are an attempt to glean new information about life at Epiclassic hilltop settlements using this previously neglected resource. Traditionally, skeletal collections in Highland Mexico have been used to address questions related to population health, but newer approaches incorporate skeletal material into archaeological discourse in innovative ways. The purpose of this dissertation is to demonstrate how human skeletal remains can be leveraged to address longstanding archaeological questions in the Tula region. In the pursuit of this goal, skeletal remains from the Epiclassic hilltop centers of La Mesa and Cerro Magoni are used to better characterized the radiocarbon ($^{14}$C) chronology of the study sites and to situate the settlements within the cultural context of the Tula region. Additionally,
paleodietary ($\delta^{13}\text{C}_{\text{collagen}}$ and $\delta^{15}\text{N}_{\text{collagen}}$) reconstructions were completed for the study individuals to evaluate the intersection of identity and food consumption practices. Through these analyses, it has been possible to confirm long standing, but untested hypotheses, answer new questions, and provide directions for further inquiry.

The remainder of this chapter is designed to give an overview of the following chapters and to provide important context regarding the geography and culture history of archaeology in Highland Mexico and of the study sites. After a brief discussion of the history of Highland Mexico, the following chapter (Chapter 2) will present a review of the archaeology of the Tula region. This chapter highlights the history of work in area, how our interpretations of Tula Grande’s rise to power have shifted in the past two decades, and what important questions remain. Chapter 3, co-authored with Dr. Meggan Bullock of the Escuela Nacional de Antropología e Historia (ENAH), discusses the current state of bioarchaeological research in Highland Mexico and makes some recommendations for future work in the region. Some of these suggestions are put into action in the following chapters. Chapter 4 discusses sources of bias in archaeological skeletal collections and contextual information about the La Mesa and Cerro Magoni collections is addressed. In Chapter 5, new $^{14}\text{C}$ dates from Cerro Magoni and La Mesa are presented, and their relationship to prior discussions of Tula chronology are addressed. Chapter 6, presents isotopic paleodietary data from Cerro Magoni and La Mesa, comparing the sites and addressing how this new data fits with current discussions of dietary practices in Tula. Finally, a conclusion can be found in Chapter 7.

A Brief Culture History of Highland Mexico (AD 1-1,200)

A brief culture history of Highland Mexico from AD 1 to 1,200 can be found below with relevant cultural chronology summarized in Figure 1. Generally, Highland or Central Mexico references the Basin of Mexico, the Toluca and Tula regions, and the Mexican states of Morelos, Puebla, and Tlaxcala (Figure 2 and Figure 3). Naturally, this region’s rich past extends before and after the range of time discussed here, but this section is meant to highlight the sociopolitical developments most integral to the Tula Grande’s development. Though Tula is only briefly covered here, a more in-depth discussion can be found in Chapter 2. For clarity, some distinctions should be made between a few key terms. When used in this dissertation only “Tula Grande” will be used to refer to the archaeological site associated with the civic ceremonial complex and city inhabited by the Toltecs. Additionally, “Tula Chico” will also only be used to refer to the Epiclassic site of that name. “Modern Tula” is used to describe the current community of Tula de Allende and the surrounding area. Finally, “Tula” and the “Tula Valley” are used to describe the general archaeological region, regardless of chronological period.
Figure 1. Comparative chronology of the Central Highlands and other important regions. Sources of chronological information: (1) Cowgill 2015; (2) Mastache et al. 2002; (3) Healan 2012; (4) McCafferty 2001; (5) Plunket and Uruñuela 1998; (6) Blanton et al. 1993; (7) Urcid 2003. (*) Plunket and Uruñuela (1998) also include the Cholula IV phase from AD 700-800.
Figure 2. The Central Highlands of Mexico. Map modified from Rus (2005).

Figure 3. Important archaeological sites in Highland Mexico. Map modified from Rus (2005).
**Terminal Preclassic Transitions (100 BC-AD 300)**

The Terminal Preclassic period (100 BC-AD 300) was an important developmental moment for Mesoamerican society, as the first state level societies emerged in Mexico from preexisting chiefdoms, beginning a trajectory of social, economic, and political cycling in the Mesoamerican Highlands that continued until the demise of the Aztec Empire in the sixteenth century. In the early years of the Terminal Preclassic period, populations in Highland Mexico were concentrated at Cuicuilco in southern Basin of Mexico and at Teotihuacan in the northern Basin. Any rivalry between these two settlements was resolved by the eruptions of Popocatépetl (250-50 BC) and Xitle (AD 245-315) (Gonzales et al. 2000; Seibe 2000), which negatively affected Cuicuilco. These eruptions likely disrupted daily life throughout the Basin of Mexico, but were cataclysmic for settlements in the southern basin.

Though once a small settlement, Teotihuacan’s population increased dramatically after the eruptions of Xitle and Popocatépetl (Gonzales et al. 2000; Siebe 2000), as individuals fled settlements to the south (Córdova et al. 1994; Pastrana 1997). The landscape surrounding Teotihuacan, when augmented with canal-based irrigation systems and drained fields (Sanders 1976), provided an agriculturally productive area in an otherwise marginal landscape, and the sufficient, but limited, nature of arable land in the region simultaneously provided for the growing populations of Teotihuacan and laid the ground work for rising social complexity and economic inequality. By the end of the Terminal Preclassic, new forms of social stratification had developed at Teotihuacan and rising elites had successfully routed labor towards the completion of massive pyramids. Unsurprisingly, as Teotihuacan grew so did its influence. In northern Morelos, agricultural communities began to congregate, and evidence suggests that ties with Teotihuacan were strengthened through the obsidian trade as elites drew resources from the Otumba source near Teotihuacan (Hirth 1984). A similar pattern has also been observed in Puebla and Tlaxcala, where increases in social stratification followed trends observed at Teotihuacan during the Preclassic period, as innovations in agricultural practices also permitted the area to support growing communities that also exhibited rising social complexity. Most notably, the site of Cholula increased in size, likely also receiving refugees form the eruptions of Popocatépetl (Plunket and Uruñuela 1998, 2006, 2008).

**The Early Classic Period (~AD 300-600)**

By the Classic period (~AD 300-600), Teotihuacan had emerged as the dominant urban center of Central Mexico, reaching a population size of 100,000 individuals. At its height, Teotihuacan’s influence stretched north to the Tula region and the satellite polity of Chingú. To the south, Morelos became an important source of semi-tropical products that could not be acquired further north, and there is evidence of heavy Teotihuacan influence in Toluca as well (Sugiura et
In addition to resource acquisition from neighboring regions, Teotihuacan’s rulers also interacted with the ancient Maya, though the exact nature of these relationships is not completely understood. While Teotihuacan elites did not directly control polities in the Maya region, there was a pronounced Teotihuacano presence at sites such as Matacapan along the Gulf Coast and Kaminaljuyú in Guatemala. Additionally, evidence also suggests that Teotihuacan leaders may have directly interfered in political transitions at Tikal during the 4th century.

Because of Teotihuacan’s long-distance interactions, the city grew into a dynamic multiethnic metropolis (Millon 1981). Much of Teotihuacan’s population was housed in apartment compounds, and these apartments appear to have been grouped into neighborhoods or barrios (Manzanilla 2009). Lifeways within and between barrios at Teotihuacan were highly variable, and some outstanding examples of ethnic and cultural diversity exist (Rattray 1987). For example, on the western outskirts of the city, the Oaxaca Barrio (Rattray 1993; Spence 1990, 1996), also known as Tlailotlacoan, hosted immigrants and individuals of Oaxacan descent (Crespo and Mastache 1981). Within the barrio, a household associated with Michoacán has also been identified (Gómez-Chávez 1998), and to the northeast, the Merchant’s Barrio likely housed populations from the Gulf Coast who specialized in transporting trade goods between their homeland and the Basin of Mexico (Hirth 2020; Manzanilla 2009; Price et al. 2000). Significant differences have been observed within these barrios in cultural practices, household architecture, funerary patterns, and culinary preferences (Blanton 1994; Manzanilla 2007, 2009), demonstrating that immigrant and diaspora populations maintained ties with their origin locations and cultures, while simultaneously embracing the social and economic opportunities an urban center like Teotihuacan offered. In addition to distinct ethnic enclaves, evidence for differences in wealth and status have also been observed within and between neighborhoods and housing compounds. Overall, some compounds were simply higher status than others. For example, Tlajinga 33 is generally considered to be one of the lowest status compounds excavated at Teotihuacan, while Tetitla and La Ventilla were likely occupied by rising intermediate elites.

In addition to the maturation of Teotihuacan during the Early Classic period, the urban center of Cholula in Puebla also grew in size and influence. Significantly more resources have been expended on the investigation of Teotihuacan, but this fact should not diminish the importance of Cholula during prehispanic times. Early hypotheses suggested that Cholula was conquered by Teotihuacan during the Classic period, but little evidence for this event exists. Instead, it appears that Cholula was an independent, but important economic partner of Teotihuacan, as the centers participated in shared ceramic and obsidian trade networks. Cholula may have also secured its place in the Central Mexican landscape through its status as a significant spiritual and pilgrimage site.
Though Cholula never reached the population size of Teotihuacan, it remained an important urban center through the colonial era. While Cholula did decline briefly after the Classic period, it regained strength during the Early Postclassic period, a triumph that was not shared by Teotihuacan (Uruñuela and Plunket 2020).

Though the exact date of eventual Teotihuacan’s decline is still a matter of debate, it is generally agreed that the center’s authority was severally reduced by AD 500-600. Teotihuacan likely experienced earlier sociopolitical restructurings, but it appears that the burning of civic ceremonial buildings along The Street of the Dead (Cowgill 2015; Wolfman 1990) in ~AD 500 signaled the presence of irreparable schisms in Teotihuacano society. Early interpretations of this event suggested that Teotihuacan’s sharp demise was the result of invaders from the Bajío region of northern Mexico (Cowgill 2015; Jiménez Moreno 1966), but that hypothesis has largely been abandoned in favor of a discussion that suggests internal frictions within the city led to civil and political unrest. Most scholars would agree that Teotihuacan’s decline was unlikely to be the result of a single catalyst, and that factors such as deteriorating health in the city, increasingly limited access to basic goods and prestige items, environmental degradation, and climatic volatility may have all played a collaborative role in Teotihuacan’s rapid depopulation. While Teotihuacan was never fully abandoned, much of the polity’s inhabitants likely relocated to neighboring centers. Overall, Teotihuacan’s decline resulted in a period of decentralization that would not end until the rise of Tula Grande in ~AD 900.

The Epiclassic Period (~AD 600-900)

As population density declined at Teotihuacan, the Basin of Mexico entered a period of transition. While settlements such as Azcapatzalco did host substantial Epiclassic (~AD 600-900) populations, communities never reached the population size of Teotihuacan. Despite the relative tranquility of the Basin during the Epiclassic, tumultuous events did unfold in other regions of Central Mexico (see debate between Blanton 1972, 1974; Charlton 1975). In eastern Puebla, the site of Cantona became one of the region’s most important centers, reaching its apogee during the Epiclassic. Located along an important trade route between the Gulf Lowlands and the Central Highlands, Cantona likely secured its place in Post-Classic society by supplying neighboring regions with pulque and by engaging heavily in obsidian exchange (Toby Evans 2008).

In western Puebla and Tlaxcala, the centers of Cholula and Cacaxtla dominated the political landscape. During the Classic period, Cholula grew in importance, but during the Epiclassic an unexpected shift occurred as populations left the primary settlement and relocated to the nearby hilltop of Cerro Zapotecas. This was likely a defensive maneuver intended to dissuade attackers, but evidence of violence still exists at Cerro Zapotecas (Mountjoy 1987), as several structures show
signs of having been burned. It was not until the end of the Epiclassic that Cholula recovered and again rose to its full prominence (Mountjoy and Peterson 1973; Plunket and Uruñela 2001). In contrast, the settlement of Cacaxtla dominated Puebla and Tlaxcala for 300 years. Throughout the site’s sizeable ceremonial acropolis, elaborate murals were constructed, many of which depict active warfare and its aftermath. Functionally, the site was surrounded by moats and a wall, demonstrating the prevalence of conflict during this period. Another important example of a defensively constructed settlement can be found at Xochicalco in western Morelos. Xochicalco was an important part of the obsidian trade, acquiring most of its raw material from Ucareo in Michoacán. Like Cacaxtla, the civic structures of Xochicalco are adorned with insignias of conquest, though the artwork speaks more of tribute payments, as opposed to active bloodshed. Xochicalco also declined at the end of the Epiclassic, and Hirth (2000) suggests that the polity met its demise when tributary populations rebelled.

To the north in the Tula area, developments similar to those in the south also occurred during the Epiclassic. As Teotihuacan declined, so did Chingú, and dramatic shifts in settlement patterning and culture were observed (Anderson et al. 2016; Healan 2012; Mastache et al. 2002). While Classic period populations had lived on the Tula Valley floor to access arable land, Epiclassic populations chose to settle on steep hilltops surrounding the valley, such as Cerro Magoni and La Mesa. Based on ceramic and architectural evidence, it seems that these populations had stronger ties to Bajío cultures than to other traditions in the Basin of Mexico. Because of these differences it has been suggested that those who populated these Epiclassic Tula Valley centers were foreigners who were drawn to the area by Teotihuacan’s wavering authority and a combination of ecological factors (Anderson et al. 2016; Armillas 1969; Healan 2012; Mastache et al. 2002).

The Early Postclassic Period (~AD 900-1,200)

Though Tula Grande played a tremendously important part in shaping the social, political, and economic landscape of Early Postclassic Mesoamerica, it is generally understudied when compared to centers like Teotihuacan. At its height, Tula Grande may have hosted an urban population of 60,000 individuals with another 60,000 persons living in the more agrarian hinterlands outside of the settlement’s urban core (Mastache et al. 2002). Overall, the Tula Valley is an agriculturally productive region in an otherwise marginal landscape, especially when irrigation techniques are employed. It was likely this potential, paired with broader climatological patterns, drew populations to Tula during the Postclassic period. While the civic ceremonial architecture of Tula Grande incorporates themes present in similar Teotihuacan constructions, the site also demonstrates a culture of militarism (Mastache et al. 2002). Whether Tula Grande achieved power through compelling ideology, military force, or a combination of factors, the
polity’s influence was felt throughout much of Mesoamerica until its decline in AD 1,200. In addition to developments in Tula, other large communities in the Basin of Mexico, including Culhuacan and Xaltocan, grew during the Early Postclassic period, becoming major centers later in the Aztec period. The site of Teotenango in Toluca was bolstered by immigrants and became increasingly multiethnic as native Teotenangans mixed with incoming Otomi speakers (Sugiura 2005). Cholula once again rose to prominence in the Valley of Puebla, likely bolstered by the development of the hybridized Tolteca-Chichimeca culture in the region (McCafferty 2001b). In addition to Cholula’s expansion during the Early Postclassic, the importance of Puebla and Tlaxcala grew as the region acted as an important crossroad for trade between Central Mexico and regions further south and east.

The Study Sites and Other Relevant Locations

In addition to the culture history discussed above, brief discussions of the archaeological sites included in this research project and other relevant locations in the Tula Valley are presented here. The sites of Cerro Magoni and La Mesa are categorized as study sites, while Chingú, Tula Chico, and Tula Grande are included to provide important context. A summary table (Table 1) lists the sites, their assumed period of occupation, and general characteristics is included. This is not an exhaustive tally of sites in the Tula region, but reflects those most relevant to the research questions pursued here and those that are relatively well characterized when compared to their lesser known counterparts. Additionally, Figure 4 locates these sites on a regional map. For a more complete discussion of regional sites see Mastache and colleagues (2002). Overall, archaeological patrimony in the Tula region is quickly vanishing and materials from the sites presented here may one day be our only opportunity to study Tula Grande’s rise to power.

<table>
<thead>
<tr>
<th>Site</th>
<th>Period</th>
<th>Type</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>Teotihuacan</td>
<td>Classic (100 BC-AD 550)</td>
<td>Mexico’s First Empire</td>
<td>Basin of Mexico</td>
</tr>
<tr>
<td>Chingú</td>
<td>Classic (100 BC-AD 550)</td>
<td>Satellite Polity of Teotihuacan</td>
<td>Tula Valley</td>
</tr>
<tr>
<td>Cerro Magoni and La Mesa</td>
<td>Epiclassic (AD 550-900)</td>
<td>Coyotlatelco Hilltop Centers</td>
<td>Tula Valley</td>
</tr>
<tr>
<td>Tula Chico</td>
<td>Epiclassic (AD 550-900)</td>
<td>Lowland Coyotlatelco Center</td>
<td>Tula Valley</td>
</tr>
<tr>
<td>Tula Grande</td>
<td>Postclassic (AD 900-1150)</td>
<td>Mexico’s Second Expansionist State</td>
<td>Tula Valley</td>
</tr>
</tbody>
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Table 1. Important sites in the Tula region, their estimated chronology, and basic information.
Figure 4. Important sites in the Tula Valley of Hidalgo, Mexico. Adapted from Mastache and Cobeán (2002: Figure 4.5).

**Chingú**

During the Classic period, settlements in the Tula area were established on the valley floor, which facilitated access to arable and irrigable land and surrounded the civic center of Chingú, which is considered to have been a satellite polity of Teotihuacan (Mastache et al. 2002; Healan 2012). At its height, Chingú covered around 2.5 km², but was centrally located between the limestone zone of the southern Tula Valley and the alluvial plains to the north. The site shows strong ties to Teotihuacano culture; Teotihuacan style ceramics and talud-tablero structures were identified by Díaz (1980) during an extensive mapping and survey project. However, William Sanders, in a personal communication with Mastache et al. (2002), suggested that the habitational structures of Chingú more closely resemble Classic period rural compounds from the Basin of Mexico, as opposed to Teotihuacan style apartments. Overall, it seems likely that Chingú served as
a northern outpost for Teotihuacan, from which the exploitation of lime could be managed and sociopolitical occurrences in the region could be monitored (Hirth 2020). After the collapse of the Teotihuacan state in ~ AD 550 Chingú also declined, though populations from Chingú may have remained in the Tula valley.

**Cerro Magoni**

Mastache and Cobean (1989) conducted the first investigation of Cerro Magoni in an attempt to improve understanding of the Coyotlatelco culture. The hilltop site is the largest of the Coyotlatelco settlements in the Tula area, and is located under 1km west of Tula Grande, covering at least 4km². Further investigation by the Tula Region Immigration and Migration Project (TRIMP), of which this author is a member, revealed that the time depth and architectural sequence of Cerro Magoni’s settlement was much more complex than Mastache and Cobean (1989) first suggested (see Chapter 5), and that residential terraces and house platforms extend down the slopes, well beyond the civic ceremonial precinct on the hill’s summit. The central precinct is constructed on a large artificial platform that supports at least 9 mounds representing civic-ceremonial structures. To date, only rectangular domestic structures have been excavated at Magoni, unlike the site of La Mesa (see below). Excavations continue to confirm that the majority of Epiclassic service wares at the site are Coyotlatelco, but Cerro Magoni also contains the highest frequency of Xajay ceramics ever recorded in Central Mexico. Preliminary Instrumental Neutron Activation Analysis (INAA) conducted on ceramics from Magoni suggest that the Xajay vessels from the site were not produced locally and consist of clay unknown to the University of Missouri Research Reactor (MURR) database. Additionally, lithic materials from the site indicate that inhabitants utilized imported obsidian from at least three sources, in addition to rhyolite and basalt that was naturally available on the hill slopes. The presence of obsidian suggests trade connections, but the utilization of less desirable, yet readily available rhyolite and basalt may suggest that trade relations were tenuous or intermittent. Mastache and Cobean (1989) even suggest that three rhyolite quarries and an associated workshop were present on Magoni, and likely facilitated the manufacture of tools for the processing of maguey, a common cultigen in the Tula region. In addition to the architectural, ceramic, and lithic evidence, ongoing excavations at Cerro Magoni have revealed the burials of 25 individuals interred in domestic contexts with collections of ceramic vessels and groundstone tools.

**La Mesa**

La Mesa is a Coyotlatelco hilltop settlement located 14km east of Tula Grande. The site covers approximately 1km² and contains three civic ceremonial zones. While not as expansive as the settlements at Magoni, the domestic architecture at La Mesa includes terraces, platforms, stairways, and round and rectangular habitation structures. The appearance of circular structures in
Central Mexico is highly unusual, and Mastache and Cobean (1989) suggest that the domestic compounds at the site consisted of one larger rectangular structure and several smaller circular rooms. This hypothesis stems from similar architectural patterns observed in Northwestern Mexico in the states of Jalisco, Zacatecas, and Guanajuato, and is in direct contrast with the format of housing complexes observed at Classic period Chingú and Tollan phase Tula Grande. Additionally, the domestic structures at La Mesa were constructed using a variant of Toltec Small Stone construction, which characterized most Toltec architecture at Tula Grande, but the buildings of La Mesa and Tula Grande differ in their construction material. While domestic structures of Tula Grande were created using limestone and tepetate blocks, buildings at La Mesa utilized basalt blocks quarried from the hilltop, again suggesting a dynamic of self-sufficiency. Like the use of circular structures, the application of Toltec Small Stone construction is also thought to have originated in northern Mexico. Overall, approximately 87 burials were recovered from domestic contexts at La Mesa, though only a subsample are currently available. Most individuals were interred with utilitarian grave goods such as lithic scrapers, but some obsidian prismatic blades and bifaces were also recovered. These obsidian elements have been considered luxury goods by Mastache and Cobean (1989) as obsidian is relatively scarce at the site. Furthermore, there are no signs of obsidian reduction at La Mesa, the blades and bifaces show no signs of use, and the implements are much larger than any other obsidian tools recovered at the site. All of this is thought to indicate non-local production and involvement in trade networks that extended beyond the immediate Tula Valley. Mastache and Cobean (1989) also state that almost all ceramics from La Mesa are part of the Coyotlatelco ceramic complex, but that the vessels more closely resemble Bajío Coyotlatelco, as opposed to Coyotlatelco recovered from Tula Chico (see below). Finally, La Mesa has yielded some of the only examples of Epiclassic civic ceremonial art from the Tula area. Most notably a limestone relief sculpture of the maize god Centeotl was recovered that is very similar in style to sculptures recovered from the early Coyotlatelco levels of Tula Chico, and to forms observed at Tula Grande, suggesting a continuity in cosmic and artistic thought between the sites.

**Tula Chico**

While no burials have been recovered from Tula Chico, the site is still important to the discussion of the Tula Epiclassic. Prior to radiocarbon dating, it was assumed that Tula Chico was established after Cerro Magoni and La Mesa, and that the site was the immediate predecessor of Tula Grande. The recent compilation of all radiocarbon dates for the area by Healan (2012) (see Chapter 5) has demonstrated that Cerro Magoni, La Mesa, and Tula Chico were actually contemporaneous, shifting the favored stepwise narrative of Toltec societal development that
assumed that sites like Cerro Magoni and La Mesa were eventually abandoned, giving rise to a centralized center at Tula Chico. Though synchronous with Cerro Magoni and La Mesa, Tula Chico’s structure and organization is very different. Cobean and Mastache (1989) describe Tula Chico as an urban settlement organized on a north/south axis with a grid layout, though this distinction may have been the result of opportunities presented by the landscape. Tula Chico’s location offered a more uninterrupted building space, while the Cerro Magoni and La Mesa were more constrained by the structure of the hilltops. Tula Chico also hosts at least two pyramids, two ballcourts, and a series of rooms described as a palace complex, many of which were constructed using Toltec Small Stone construction. Overall, the ceremonial architecture of Tula Chico is very similar to what was later observed at Tula Grande. At both sites, pyramids were positioned together to form a 90-degree angle and the settlements are organized along a central axis, but as Tula Chico adheres to a north/south layout, Tula Grande is oriented 15.5 degrees east of north, like its predecessor Teotihuacan. Though not fully explored, it should be noted that several mounds at Cerro Magoni also adhere to this orientation. Beyond architectural scale and style of Tula Chico, the site also shows considerable lithic and ceramic differences from Cerro Magoni and La Mesa. Higher quantities of obsidian and fewer groundstone implements were recovered at Tula Chico than at La Mesa, leading Cobean and Mastache (1989) to suggest that Tula Chico was less agricultural than other Epiclassic hilltop sites. Most ceramics from Tula Chico are Coyotlatelco, but are different in style than the vessels found at Magoni and La Mesa. Additionally, Tula Chico also yielded examples of a ware known as Prado, which shares some stylistic characteristics with Coyotlatelco, but is considered to be an additional type (Cobean 1990). Finally, the presence of a small quantity of wares from Veracruz is also unique to Tula Chico, again suggesting the existence of trans-regional trade relationships. While no signs of cataclysmic abandonment or destruction have been found at La Mesa or Cerro Magoni, the civic ceremonial precinct of Tula Chico shows evidence of a burning event, after which the zone was left untouched. It has been suggested that the ruins of the civic ceremonial complex were left as a symbol or warning that harkened to the socio-political struggle that gave birth to Tula Grande.

**Tula Grande**

Despite being the heart of Central Mexico’s second expansionist state and the third largest pre-colonial urban settlement to develop in Highland Mexico, Tula Grande is woefully understudied, and many resources typically employed in the study of ancient cities, such as a complete map, are simply not available for Tula Grande. Additionally, rampant destruction of archaeological material in the region has yielded the production of these resources largely impossible. Despite these challenges, some facts are known about Tula and its functioning. The
site was likely founded at the terminus of the Epiclassic period (~AD 900) and maintained a place of prominence until ~ AD 1,200. At its height, the city of Tula Grande covered between 11 km² and 16 km² and is thought to have contained upwards of 2,000 highly organized multifamily residences that hosted a central population of 60,000 (Healan and Stoutamire 1989). Extensive agricultural lands and non-centralized settlements existed outside of the city’s immediate boundaries. Like all mature cities, Tula Grande actively engaged in the economic, political, and ideological discourses of the day, and maintained an authoritative presence beyond the Tula Valley. Currently, we estimate that the rulers of Tula wielded influence as far as the Bajío, the Huasteca region, the Gulf Coast, and the Yucatan peninsula (but see Smith and Montiel 2001). Additionally, it is also suggested that envoys of Tula Grade even reached Guatemala and El Salvador (Mastache et al. 2002). In addition to its political and economic dealings, Tula Grande’s rise also played an important role in the developing cosmic ideology of Central Mexico, as even the Aztec lords of Tenochtitlan (AD 1325-1521) viewed Tula Grande as birthplace of wisdom, refinement, and artistic genius. It was at Tula Grande that the canon of old gods from Teotihuacan was merged with an expanded cosmic view that revered the epic conflicts of the trickster deity Tezcatlipoca and the hero lord Quetzalcoatl. Imagery of Tezcatlipoca and Quetzalcoatl, shrouded in a militaristic and at times macabre artistic style, quickly spread throughout Central Mexico and the Maya region, influencing political and religious perspectives long after Tula Grande’s decline.

Conclusion

In summary, this chapter outlined the structure of the following chapters and briefly summarized key periods in Central Mexican culture history and defined important archaeological sites relevant to the discussion of Tula Grande’s rise to power. In Chapter 2, the archaeology of the Tula region will be discussed more fully, with emphasis on the cultural transitions the area experienced during the Epiclassic period. In Chapter 3, the bioarchaeology of Highland Mexico is reviewed and is followed by an evaluation of 14C dating in Tula in Chapter 5. Chapter 6 discusses paleodiet in the region and presents new isotopic data from individuals from Cerro Magoni and La Mesa. Finally, Chapter 7 provides a short conclusion.
CHAPTER 2: ARCHAEOLOGY IN THE TULA REGION: CURRENT UNDERSTANDINGS AND FUTURE DIRECTIONS

Introduction
Archaeological research in Central Mexico has long been focused on the development and function of state-level societies. Having sequentially hosted three expansionist states prior to the Colonial period, Central Mexico is frequently characterized as an exemplary example of political cycling. Sometimes referred to as chiefly cycling (Anderson 1990, 1996; Flannery 1999; Milanich 1996; Rees 1997), this model emphasizes an ebb and flow of social, political, and economic centralization. In the Latin American context, political cycling was made famous by the work of Joyce Marcus (1992; 1998) who proposed the Dynamic Model, which drew attention to three peaks of centralization that were surrounded by troughs of decentralized activity. Traditionally, this model highlights the apogee of Teotihuacan (100 BC- AD 650) as the first centralized peak, followed by Tula Grande (AD 900-1200) and Tenochtitlan (AD 1300-1521). Given the grandeur of these urban centers and their impressive reach, it is not surprising that research in the region has heavily focused on periods of centralization, especially those involving Teotihuacan and Tenochtitlan. When contrasted with Teotihuacan and Tenochtitlan, Tula Grande’s form and function is much less understood and generally understudied. Despite this shortcoming, Tula Grande’s somewhat mysterious rise to power has captivated researchers for over 80 years. Even after eight decades of work, we are still left with one burningly obvious and deceptively complex question: How did Tula Grande come to power? Despite an initial focus on Central Mexico’s centralized powers, researchers are gradually reaching the conclusions that 1) the periods of decentralization preceding centralized episodes are critical to our understanding of how complex social structures regenerate after perturbation and 2) these troughs are actually worthy of independent study (Clayton 2016, 2020).

In Central Mexico, the period preceding the rise of Tula Grande is known as the Epiclassic (AD 550-900) and is considered a period of intense restructuring that was punctuated by conflict and unrest. While this intense social climate permeated much of Central Mexico, it was especially prevalent in the Tula Valley of Hidalgo, the area where Tula Grande rose in ~AD 900. Understanding the social and political developments of the Epiclassic in the Tula region is likely the key to comprehending Tula Grande’s culmination of power, but Epiclassic settlements in the region have only undergone limited study. The remainder of this chapter has two goals. First, what we know about Tula Grande’s rise will be summarized and the currently accepted narrative will be presented. Second, this chapter will draw attention to areas where our knowledge requires
refinement, while also proposing ways in which progress could be made. More specifically, the history of archaeological work in Tula will be reviewed, followed by a summary of events from the Classic period through the Postclassic period. Next, explanations for the cultural shifts of the late Classic/early Epiclassic and late Epiclassic/early Postclassic periods are reviewed. Finally, the hypotheses presented by Anderson and colleagues (2016) that seek to explain how the events of the Epiclassic led to Tula Grande’s rise will be discussed individually with emphasis on how research could move forward in the future.

**Current Interpretations of Archaeology in Tula**

**A Brief History of Research in the Tula Region**

Though some excavations at Tula Grande were conducted in the late 1800s, our modern understanding of Tula largely began with work of Jorge Acosta in the 1940s (1940, 1941, 1942, 1943, 1944, 1945, 1956, 1956-57, 1957, 1960, 1961, 1964, 1974, 1983). Acosta spent nearly 20 years excavating the ceremonial precinct of Tula Grande and this work has been summarized by Cobeán and Mastache (1988, 1999). In the 1960s and 1970s, Tula Grande also hosted the University of Missouri Project, led by Richard Diehl and Robert Benfer, and the INAH Project, directed by Eduardo Matos. Largely informed by trends in processual archaeology, these projects shared several overarching goals, some of which were more effectively met than others. Specifically, researchers hoped to study the settlement patterns of the broader region, assess the ceramic complexes found within the city, refine the city’s sequence of occupation, excavate residences and craft areas, and generate an understanding of Tula Grande’s “defining” traits (Mastache et al. 2002).

The results of these efforts were highly varied. One of the most frequently cited deliverables of this research was the estimation of Tula Grande’s geographic size, and by 1982 at least three differing interpretations had been published. Investigations by Stoutamire (1974; 1975; Healan and Stoutamire 1989), as part of the Missouri Project, suggested that Tula Grande’s urban core covered 13 sq. km. In contrast, researchers working with the INAH Project (Yadeun 1975) presented a more conservative estimate of 11.38 sq. km. Finally, using aerial photographs, Crespo and Mastache (1982) proposed that the city actually had a maximum expanse of 16 sq. km and may have been constructed using at least three alignment systems. Both the size of the city and the potential use of one or more grid systems remains highly contested, but this controversy is generally fruitless. Overall, the differences in the site’s estimated urban size are the result of variation in methodology. For example, Yadeun (1975) chose to not include mounds under 1 meter tall in his survey, which truncated his estimate of the city’s expanse. In contrast, Crespo and Mastache (1982) included the areas nestled near the base of the hilltops surrounding the Tula Valley.

Ultimately, discussions are centered on one’s definition of an urban environment and the
manner in which boundaries are drawn and further inquiry into the issue are impeded by several factors. Surprisingly, the urban center of Tula Grande, definitional challenges aside, has never been mapped. Research at Teotihuacan has benefitted from the herculean efforts of Millon (1973) and ethnohistoric records of Tenochtitlan have provided important focal points for research at both sites, but the lack of map of Tula Grande yields research planning and execution challenging. This issue is compounded by preservational difficulties in the Tula region. While structures at Teotihuacan were built of stone, adobe bricks were used at Tula Grande and only the foundations of buildings were crafted of more durable material. In short, there are no intact walls left on the surface to map or to use as guide points for further investigation. The modern city of Tula has experienced considerable growth in the past four decades, and many sectors of the Tula Grande’s ancient urban environment have been destroyed by construction projects. Additionally, the adoption of modern agricultural techniques has wrought significant damage to archaeological remains. Deposition in the region is typically shallow and modern plows can churn soil up to one meter in depth. With each passing year more Tula Grande is swallowed by modernity, and many of the projects conducted in the 1960s and 1970s could not be completed today.

While much of the archaeological work conducted at Tula Grande was focused on survey, some excavations, beyond those of Jorge Acosta, have been conducted. Mastache and colleagues (Mastache et al. 2002) estimate that approximately twelve Toltec period residences have been excavated at Tula Grande since the 1880s. Their titles and relevant citations can be found in Table 2. Unfortunately, the results of these excavations are highly variable. Some residences were only partially excavated and some were not mapped. There are significant differences in the reliability and accuracy of the surviving records and some of the acquired data was never published. In more extreme cases, the excavated collections were not retained or were lost during disasters like laboratory fires. In addition to these residences, some work was also conducted at crafting locations throughout the city. Healan, Pastrana, and colleagues (Healan 1986; Pastrana 1990; Healan et al. 1983) excavated and studied an obsidian workshop, and in 1989 Healan also published assessments to two ceramic tube workshops. A pottery workshop was also studied by Hernandez et al. (1999) and the modern ceramic chronology of Tula Grande and the surrounding region was formulated by Cobean (1978; 1990). Finally, specialized production zones for jade, shell, bone, serpentine, and tecali objects (Healan and Stoutamire 1989; Diehl and Stroh 1978) were also studied. Despite this work, a full reconstruction of Tula Grande’s economy has never been attempted. Especially within the household contexts, chronology also been a challenging problem. In some areas of the city, especially in the ceremonial precinct, stratigraphy can extend several meters. Sometimes these deep deposits represent relatively singular events that were used to artificially expand the buildable space
of Tula Grande’s ceremonial area. Others cover up to 1,000 years of activity, including the Colonial Period. While, the ceremonial precinct of Tula Grande was adapted over time, following the Latin American tradition of “remaking” sacred space, many of the excavated residential spaces contain relatively simple stratigraphy and this fact underlies a deceptively complex problem. Tula Grande was likely at its apogee for 300-400 years, but without a robust radiocarbon dating program, it is very difficult to temporally place simple deposition events at Tula Grande. Therefore, it is difficult to compare contexts because questions of synchronicity arise.

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<th>Residence</th>
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<tr>
<td>Casa Tolteca</td>
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<td>Palacio Tolteca</td>
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<td>Dainí</td>
<td>Peña and Rodríguez 1976</td>
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<td>Colonia Pemex</td>
<td>Matos 1974</td>
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<td>El Corral</td>
<td>Mandeville and Healan 1989</td>
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<td>El Canal</td>
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<td>Cerro La Malinche</td>
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<td>El Vivero</td>
<td>Fernández 1994</td>
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<td>El Salitre</td>
<td>Healan 1986; Healan et al. 1983</td>
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<td>Units U27 and U28</td>
<td>Getino and Fuentes 1986; Salazar 1991</td>
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<td>U98</td>
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Table 2. Excavated residences from Tula Grande. Presented by Mastache et al. 2002.

Of course, the discussion above only describes our understanding of Tula Grande’s urban core during the city’s peak period of centralization. Prior to the late 1980s, very little could be said about Tula Grande’s hinterland or the region prior to the Toltec apogee. In an attempt to remedy this, Mastache, Cobean, and Healan launched The Tula Region Project. The project had two primary goals: 1) generate a regional understanding of Tula Grande’s formation processes and 2) explore the composition of the city’s rural hinterland. The initial survey area covered a 17km radius surrounding Tula Grande, though this was later modified to more realistically reflect pre-Hispanic land use in the area. Using a combination of aerial data and survey, the project proceeded from the theoretical perspective that changes in settlement patterning and grouping were directly reflective of altering social relationships and levels of political organization. Additionally, researchers were careful to note that the study area likely only covered Tula Grande’s “primary hinterland” and that the city’s immediate interaction sphere was probably much wider (Mastache et al. 2002). While the full results of this survey were not published until 2002, some conclusions of the study did trickle into the Central Mexican literature in the 1980s and 1990s and interest began to shift onto the Epiclassic period (AD 550-900). This was likely the result of two synergistic forces. First, cultural links were made between the late stages of Teotihuacan’s decline and Epiclassic sites in the Tula
Specifically, the appearance of the Coyotlatelco ceramic tradition was identified as an intrusive phenomenon, which was highly pronounced in the Tula region and present in late-stage Teotihuacan deposits. This led researchers to question the origin and nature of the populations that utilized Coyotlatelco ceramics and their potential relationship to Teotihuacan’s decline. Over the decades, researchers have largely concluded that individuals associated with the Coyotlatelco tradition had little to do with Teotihuacan’s demise (Cowgill 2015) and that they were certainly not “invaders from the north” (Mastache and Cobean 1989), but this connection to the Coyotlatelco tradition in the Tula area did encourage Central Mexican archaeologists to shift their focus. Second, researchers concluded that reaching an understanding of Tula Grande’s rise to power would require a more complete analysis of population behavior during the preceding periods in the Tula Region. This led to increased interest in the Epiclassic Coyotlatelco settlements in the area and the eventual development of an accepted narrative describing Tula Grande’s rise. This narrative is summarized below with emphasis on the manner in which interpretations have shifted over the past decade.

**Current Understandings of Tula Grande’s Rise**

Our modern understanding of Tula Grande’s rise, and more generally, our understandings of the Tula Region, are summarized best by a few key publications. First, *Ancient Tollan: Tula and the Toltec Heartland* (Mastache et al. 2002) summarizes the results of The Tula Region Project and synthesizes much of the older literature into a palatable discussion. Second, Healan’s article from 2012 provides some refinements on topics presented by Mastache and colleagues (2002) and discusses relevant data from areas beyond the immediate Tula Valley. Anderson and colleagues (2016) more explicitly discuss the sequence events leading to Tula Grande’s formation, with emphasis on the Epiclassic Coyotlatelco hilltop settlements in the region, and Hernández and Healan (2019) provide an updated interpretation of the origin of the Coyotlatelco ceramic tradition.

**Classic Period–Chingú Phase**

As of 2002 (Mastache et al.), the interpretation of events leading to Tula’s rise followed a four-step process that began in the Classic period and extended into the Postclassic. During the Classic period, most sites in the Tula Valley show considerable signs of association with Teotihuacan and clear connections can be seen in site planning and architecture, ceramic consumption, the use of similar traditions of chipped and polished stone traditions. Typically, Teotihuacan associated sites were located among the Tula Valley lowlands and foothills. Mastache and colleagues (2002) divide these Teotihuacan affiliated sites into three groupings: sites over 80 hectares, sites between 10 and 15 hectares, and sites with dispersed occupation. During survey, four 80+ hectare sites were identified and the largest was the site of Chingú (Figure 5), which likely dominated the region as a satellite polity of Teotihuacan. Located near the center of the Tula Valley, Chingú occupied a strategic position between the arable land to the north and the limestone quarries.
to the south, both of which it likely exploited. Excavation and survey by Díaz (1980) indicate that the Chingú likely reached its apogee during the Tlamimilolpa phase (AD 150-350), but declined in size and density during the Xolalpan (AD 350-550) and Metepec periods (AD 550-650). Culturally, Teotihuacan traditions were heavily expressed Chingú. Talud and tablero facades are present on civic-ceremonial buildings and one of Chingú’s ceremonial precincts is stylistically similar to the Ciudadela. Chingú was also constructed using a cardinal orientation like that observed at Teotihuacan. Díaz (1980) argued that the habitation structures of Chingú resembled smaller renditions of the apartment compounds of Teotihuacan, but Sanders (Mastache et al. 2002) suggested that they were more like Classic period rural homesteads from the broader Basin of Mexico. Finally, like most sites in the area, Chingú’s ceramic assemblage was dominated by wares manufactured at Teotihuacan or that were sourced through pre-existing Teotihuacan trade networks.

Figure 5. Classic Period Settlement in Tula.
Site of Chingú marked with additional large Classic period settlements to the north emphasized. Modified from Mastache et al. (2002, Figure 4.1)

In addition to Chingú, three additional large sites were located in the northern region of the Tula Valley, along the Río Tula. Only Julián Villagrán was ever explored, but its remains were
consistent with the cultural trends observed at Chingú (Mastache et al. 2002). Overall, populations at these three sites are likely to have been heavily involved in agricultural production and the management of the irrigation systems that expanded arable land. While it would be interesting to study these sites further, they have unfortunately been destroyed in recent decades. Beyond the clearly Teotihucan style settlements in the region, two Classic period Oaxacan communities, Acoculco and El Tesoro (Cook de Leonard 1956-1957), have also been described. According the Crespo and Mastache (1981) these communities were occupied during the Late Tlamimilolpa phase and maybe the Metepec phase. While most Classic period settlements in Tula were located in lowland regions or among foothills, Acoculco and El Tesoro were hilltop settlements. Though 15-17% of the recovered ceramics were Teotihuacan wares, 54-63% were Oaxacan styles. Furthermore, evidence also suggests that at least a portion of these Oaxacan wares were locally manufactured (Mastache et al. 2002). While it might be tempting to suggest that the inhabitants of Acoculco and El Tesoro were direct migrants from the state of Oaxaca, the explanation for their presence in Tula is likely more nuanced. Teotihuacan hosted several ethnic enclaves, one of which was the Oaxaca Barrio. Researchers generally agree that Acoculco and El Tesoro were the result of “leapfrog migration” and suggest that these communities housed specialized stucco workers and master masons who may have assisted in the quarrying of limestone for export to Teotihuacan (Crespo and Mastache 1981; Mastache et al. 2002). If this is true, then the decision of ethnic Oaxacans to develop a separate community away from Chingú is potentially very interesting, though the behavior may simply reflect a practical decision to be closer to the Tula limestone quarries. Overall, it appears that the Tula Valley was directly colonized by Teotihuacan during the Classic period and that Teotihuacan’s interest in the region was multifaceted. As noted above, limestone was probably quarried in Tula and sent to Teotihuacan as lime, which was used in building projects (Barba et al. 2009; Murakami et al. 2013) and to process maize. Additionally, Sanders (Mastache et. al 2002) also thought that the Tula Valley may have been used as an auxiliary zone of agricultural production used to help feed growing populations at Teotihuacan. Finally, it is possible that officials at Chingú served as Teotihuacan’s northern eyes and ears as Tula has traditionally been viewed as the gateway to northern Mexico, which is thought to have been culturally and developmentally distinct from Central Mexico.

By the Late Tlamimilolpa phase and Metepec phase Teotihuacan was in decline. As a result, population density in the Tula Valley seems to have plummeted. According the Mastache and colleagues (2002) the region probably entered a somewhat transitional period, where Teotihuacan ceramics were found interspersed on the valley floor with a ceramic type known as Coyotlatelco. Additionally, ceramics that seem to be a hybridized form between the two have also
been found, but researchers are careful to note that the sample is small. Coyotlatelco is an incredibly diverse ware type and it is possible that these “hybridized” wares are simply an unclassified form of Coyotlatelco. Regardless, the brief co-existence of these wares suggests that there was a transitional period between the Classic and Epiclassic periods and researchers suggest that the Tula valley floor was abandoned by the end of the Metepec phase (AD 650).

**Epiclassic Period - The La Mesa Phase**

The presence of Coyotlatelco ceramics has become a defining characteristic of the Epiclassic period in Central Mexico, especially in the Tula region. As of 2002, researchers believed that the Epiclassic period of Tula could be divided into two phases. The first phase, the La Mesa phase, was thought to have occurred between AD 550 and AD 650. The second period, the Corral/Prado phase, was estimated to occur between AD 650 and AD 750/800. Through the compilation of radiocarbon dates from the region, Healan (2012) was able to demonstrate that the sites of La Mesa (La Mesa phase) and Tula Chico (Corral/Prado phase) were actually contemporaneous, an observation that collapsed the La Mesa phase and the Corral/Prado phase into a single period (AD 650-900) (Figure 6). In the following sections, the La Mesa and Prado/Corral phase settlements will initially be independently described. Then the implications of their synchronicity will be discussed. Most research conducted at these sites was completed before their contemporaneity was realized, so there is a natural bifurcation in the literature and the sites are mostly discussed in separation. Even though the site types were synchronous, the cultural differences that originally led researchers to believe they were asynchronous still exist.
Figure 6. Epiclassic Coyotlatelco Occupation in Tula. Epiclassic Coyotlatelco Occupation in Tula with La Mesa phase settlements and Tula Chico emphasized. Modified from Mastache et al. (2002, Figure 4.6)

Approximately nine La Mesa Phase settlements were identified in the Tula Region and they represent a stark break with Classic period traditions. While Teotihuacan affiliated settlements were commonly located in the valley lowlands and among foothills, La Mesa Phase settlements were situated on large hills that were commonly surrounded by steep bluffs on at least one side. Generally, these hills were rocky with poor topsoil coverage and limited access to key resources like water. Universally, the La Mesa phase sites contained large quantities of Coyotlatelco ceramics. Overall, it is also believed that these sites were indicative of a new cultural phenomena in Tula, one in which site planning, construction methods, lithic industries (Mastache and Cobeana 1990; Patiño 1994; Rees 1990; Jackson 1990), and political structures differed significantly from those of the preceding Teotihuacan period (Mastache and Cobeana 1990; Mastache et al. 2002). According to Mastache and colleagues (Mastache et al. 2002), each of the sites appears to have had at least one civic ceremonial precinct, which was not built in an overtly Teotihuacano tradition. While the general dimensions of the precincts were similar, no two ceremonial complexes are the same. Overall, the La Mesa phase hilltops were heavily landscaped with terraces and platforms,
and the size of each settlement varied significantly. Among assemblages recovered from the sites, there is evidence of some local ceramic production and limited long-distance trade. Of the nine La Mesa phase settlements, only two, La Mesa and Cerro Magoni, have ever been excavated. The remaining seven sites have been destroyed by agriculture and development. What is known about each of these sites is summarized below.

**La Mesa**

Excavated by Mastache and Cobean, La Mesa is located 14 km east of Tula and the settlement is estimated to cover approximately 1 sq. km. Overall, the site is strategically located, facilitating sightlines to several surrounding valleys. La Mesa hosted three ceremonial precincts, around which agricultural terraces and habitation zones were centered, though empty spaces between these zones were identified. This led Mastache and colleagues to suggest that the site was not densely occupied. As mentioned above, the ceremonial precincts of La Mesa were not constructed in the Teotihuacan style. Instead, open, rectangular plazas were built on the highest peaks of the hill and were surrounded by terraced platforms. Each precinct was adorned with a pyramid-like structure and a long rectangular building. Interestingly, the buildings within the largest of these precincts closely mirror the orientation Pyramid B and Palacio Quemado at Tula Grande. Additionally, the rectangular ceremonial structures at La Mesa have colonnaded porticos that are very similar to the colonnades observed at the Palacio Quemado, and these colonnades are thought to be derived from the architectural tradition “Salas-Claustros”, which originated in northern Mexico (Hers and Braniff 1998). La Mesa may have also contained a ballcourt, though further excavation is required to confirm this hypothesis.

Two types of residential structures were present at La Mesa. Rectangular domestic structures consisting of one or two rooms with a colonnaded portico likely served as the primary residential space, while circular structures between 1 m. and 10 m. in diameter served as out buildings and work spaces, though the smallest of these circular buildings were probably granaries. The foundations of the rectangular buildings were constructed using the Toltec Small Stone method, which was also observed at Tula Grande during the Tollan phase (AD 900-1150). Generally, this method is thought to have origins in northern Mexico, as Classic period sites like Cerro del Hiustle in Jalisco (Hers 1989), La Quemada in Zacatecas (Jiménez 1989; Nelson 1997; Kelley 1971), San Bartolo in Guanajuato (Castañeda 1989, and Toluquilla and La Ranas in Queretaro (Velasco 1989; Marquina 1964) all display variants of Toltec Small Stone construction. Overall, Mastache and colleagues (2002) found that the rectangular structures were better constructed than the circular features, as they contained stucco floors, adobe and stone walls, and sculpted stone panels. In contrast, the circular buildings were made of mud and wattle and had
earthen floors, but burials were recovered from under the floors of both rectangular and circular structures, sometimes at very high densities.

Overall, there is little evidence of social stratification among the burials. When grave goods were recovered, they were almost always utilitarian in nature and few in number, though some interments contained grey obsidian prismatic blades that were up to 20cm in length. Healan (1989) and Cobean (1991) preliminarily concluded that the blades may have been manufactured using obsidian from Ucareo-Zinapécuaro in Michoacán. The appearance of obsidian blades is of note because at least 80% of the stone tools recovered from La Mesa were made of local basalt, probably from the outcroppings on the hilltop (Jackson 1990). Many of these tools were likely used in the growing the processing of maguey, which can be used produce fibers, aguamiel, and pulque. The remnants of huge Coyotlatelco ollas, up to a meter in diameter, suggest that water or fermenting beverages were stored. This information led Mastache and colleagues (2002) to suggest that the terraces of La Mesa were principally used to grow maguey, though the presence of potential granary platforms suggests that amaranth or maize was also exploited.

Temporally, Mastache and colleagues (Mastache and Cobean 1989; Mastache et al. 2002) suggested that La Mesa was used for a limited time, estimating that the site was occupied from AD 550-650 (but see below). This conclusion was reached through assessments of the site stratigraphy, ceramics, and a limited course of radiocarbon dating. Overall, the stratigraphy of La Mesa has been described as uncomplex. La Mesa contains a high percentage of Coyotlatelco ceramics, which is unsurprising given its temporal and geographic location. As mentioned above, Coyotlatelco is a highly diverse ware and some examples found at La Mesa are similar to types observed at Tula Chico and in the Basin of Mexico, while others are not. Typically, the Coyotlatelco designs from La Mesa are simpler than those seen at other sites. Additionally, a type of brown-and-red monochrome olla was also observed at La Mesa and has not been recorded at any other site (Mastache and Cobean 1990). Though discussed more fully in Chapter 5, radiocarbon dating of all available burials recovered from the site and subsequent Bayesian modeling suggests that La Mesa was actually founded between AD 633 and 656 and abandoned between AD 783 and 836, with a use span of 132 to 185 years and an estimated interval of 134 to 195 years. This suggests that the site was founded later than Mastache and colleagues originally predicted and was in use for a longer duration.

**Cerro Magoni**

Though Cerro Magoni is possibly the largest Epiclassic Coyotlatelco site in the Tula Region, little has been published. Based on survey and limited excavation, Mastache and colleagues (2002) declared that Cerro Magoni may have been the direct antecedent of Tula Chico. The site is
located just 1 km east of Tula Grande and covers at least 4 km². The slopes of the site were completely covered in terraces, which likely facilitated agriculture, and a rhyolite quarry was identified by Mastache and colleagues on the eastern slopes of the settlement. This quarry and associated workspaces represent the most sophisticated lithic production chain observed at an Epiclassic site in Tula (Rees 1990). Despite Cerro Magoni’s size, Mastache and colleagues (2002) concluded that Cerro Magoni could not be considered an urban settlement due to the observed population density. To date, only one civic ceremonial precinct has ever been detected at Cerro Magoni’s summit and officials are hesitant to permit exploration of the mounds in this area of the site given concerns regarding the conservation of the structures.

During a mapping project in 2012, 9 mounds were identified that may contain civic ceremonial architecture and approximately 4 of these features are aligned in an orientation similar to that of Street of the dead at Teotihuacan. Unlike at La Mesa, only rectangular domestic structures have been recorded at Cerro Magoni and Mastache and colleagues (2002) reported simple stratigraphy in the residential zones. This led to the hypothesis that Cerro Magoni was also only inhabited for a century or less. Recent radiocarbon dating of burials from the site and associated Bayesian analyses (Chapter 5) suggest that the site was founded between AD 577 and 667 and abandoned between AD 815 and 953 with a span of 150 to 249 years and an interval of 164 to 343 years. The Epiclassic ceramics at the site are almost entirely Coyotlatelco and are styled in a manner more consistent with the trends seen at Tula Chico and in the Basin of Mexico. While infrequently noted, the figurines from Cerro Magoni adhere to at least three types. The first type is Coyotlatelco, but the second type appears to be more closely affiliated with figurines from Teotihuacan. Finally, the third, and least frequently found, type resembles figurines from west Mexico (Mastache et al. 2002). In addition to the Coyotlatelco ceramics, a significant percentage of Xajay ceramics were also recovered. This ceramic type is associated with a hilltop culture in northern Mexico known as the Xajay Regional Development and its presence at Cerro Magoni represents the southernmost occurrence of the ware (Anderson et al. 2016). In 2016, samples of Coyotlatelco and Xajay from Cerro Magoni ceramics were submitted to the University of Missouri Research Reactor Center (MURR) for composition analysis. In an unpublished report (Pierce and Glascock 2017), researchers noted that the Coyotlatelco ceramics were likely all manufactured in the Tula region, but that the Xajay wares were non-locally produced. Additionally, the chemical signature of the paste was unique when compared to the MURR database, and it is possible that the Xajay materials were manufactured in the Bajío region of northern Mexico.

**Other La Mesa Phase Observations**
In addition to excavations at La Mesa and Cerro Magoni, there have been some additional
observations regarding La Mesa phase sites in the area and some general conclusions. Mastache and colleagues (2002) note that most La Mesa phase sites shared at least some characteristics with one another. Some sites share ceramic assemblages or lithic traditions, while others have commonalities in settlement placement and architecture. Despite these commonalities, the La Mesa phase sites do not represent a culturally homogenous phenomenon. For example, the lesser studied site of Atitalaquia contains large ollas, like those found at La Mesa, but hosts a lithic tradition that differed from other sites in both materials utilized and in the crafting technology. Unlike other La Mesa phase sites, the boundaries of Atitalaquia appear to be poorly demarcated and the domestic zones at the site are somewhat dispersed, though a centralized ceremonial precinct with an accompanying habitation area can be found on an “almost inaccessible” (Mastache et al. 2002:68) hilltop surrounded by cliffs. In contrast, the site of El Aquila was constrained to a small, highly strategic hilltop between two dep ravines and was densely occupied. No two civic ceremonial complexes are the same at the La Mesa phase sites, though some are more similar than others, and variation is observed in the orientation and construction patterns in habitation areas. While circular structures are common at La Mesa, they are rare at the other sites. Though rectangular domestic spaces are present at all the sites, those at La Mesa are larger and their colonnaded porticos are unique. At Atitalaquia, the walls of domestic spaces are unusually thick. Mastache and colleagues (2002) also note that though some common types of Coyotlatelco ceramics are present at all La Mesa phase sites, the form and decoration of the vessels varies widely. This is especially interesting considering the unpublished report from Cerro Magoni that suggests that Coyotlatelco ceramics were locally produced in Tula and not imported. In lithic technology, sites varied significantly in the raw materials used, suggesting differing access to trade networks. Though Cerro Magoni is thought to have contained a rhyolite workshop, there is little evidence that rhyolite tools were distributed to neighboring sites (Rees 1990; Mastache and Cobean 1989). Overall, this lack of continuity has been an important area of inquiry in Tula, with explanations generally suggesting that at some time the populations of the La Mesa phase hilltops shared a cultural tradition that was potentially highly variable and different from the traditions observed in the Basin of Mexico. It has also been suggested that relationships between the La Mesa phase centers were very tense and possibly prone to violence or unrest, though direct evidence of this is limited. Based on the current evidence it is unlikely that one single La Mesa phase site was dominant over the others.

Epiclassic Period- The Prado and Corral Phases

Prior to 2012, the Prado phase was considered to be the next step in Tula Grande’s rise. According to Mastache and colleagues (2002), the Prado phase was thought to extend from AD 650 to 850, and is represented by a single site known as Tula Chico. In many respects, Tula Chico
has been considered a proto-Tula, as it shares many organizational and architectural similarities with Tula Grande. The Prado phase is named for the Prado ceramic complex, which was first discovered at Tula Chico. Overall, the complex consists of Coyotlatelco ceramics, some of which appear at other sites in the area, though differences are present. Additionally, the Prado complex also contains red-on-brown ceramics that are most similar to types found in the Bajío region during the Classic period (Cobean 1978; 1982; 1990; Martínez and Nieto 1987; Lopez Aguilar et al. 1998) and a series of types that had never before been seen at Coyotlatelco centers in the area. Cobean (1978, 1990) suggests that the most iconic of these unusual wares is a tripod cylindrical vessel with either incised or painted designs, which have been seen in other Epiclassic sites such as Chapantongo and Huichapan and in southern Querétaro (Lopez Aguilar 1998; Nalda 1975). Overall, the Prado complex has been recovered from some of the deepest deposits at Tula Chico (Cobean 1982; Cobean and Suárez 1989).

Economically, Tula Chico appears to have had a larger trade network than the La Mesa phase sites. Excavations at Tula Chico reported higher percentages of obsidian artifacts than at the La Mesa phase sites. Healán and Cobean (Mastache and Cobean 2002) suggest that the obsidian at Tula Chico was from at least three sources. The majority is likely from Ucareo in Michoacan with smaller quantities from Zacualtipan in Hidalgo and Sierra de las Navajas. There is also evidence of prismatic blade production area at Tula Chico and of long-distance ceramic trade, as vessels from central Veracruz have also been recovered (Cobean 1982; 1990).

By the Corral phase (AD 750-850) Tula Chico was at least a quasi-urban community with a 3 sq. km. nucleus surrounding a ceremonial precinct (Stoutamire 1975; Yadeun 1975; Mastache et al. 2002; Healán and Stoutamire 1989). Additionally, Corral phase occupations have been identified on hills of Cerro La Malinche and El Cielito and in the space where Tula Grande’s civic ceremonial center would eventually be built. Given the close proximity of these locations, it is possible that they collectively represent the extent of Tula Chico’s contiguously occupied settlement. If this hypothesis is true, Tula Chico may have covered 5 to 6 sq. km. The Corral phase occupations at Tula Chico are characterized by the presence of the Corral ceramic complex, which primarily consists of Coyotlatelco ceramics, though they are thought to be more similar to Coyotlatelco wares from the Basin of Mexico, as opposed to other Coyotlatelco wares found in the Tula region (Rattray 1966; Blanton and Parsons 1971; Nichols and McCullough 1986). The primary civic ceremonial center at Tula Chico is located on an elevation surrounded by steep cliffs on the western side. Like the La Mesa phase settlements, the area surrounding the site nucleus was heavily modified in ancient times through the construction of terraces and platforms. Though very few stratigraphic excavations were ever conducted at Tula Chico, Cobean and Suárez (Cobean
1982; Cobean and Suarez 1989) suggest that some structures had at least four construction phases. Using aerial photography, Mastache and Crespo (1982) proposed that up to three grid systems were used to organize the settlement and that it was constructed on a north-south axis. Though less frequently discussed there is evidence of Epiclassic buildings under the civic ceremonial precinct of Tula Grande (Acosta 1945; Cobean 1994) and several researchers have suggested that a secondary civic ceremonial precinct belonging to Tula Chico may be under Tula Grande’s architecture (Mastache and Crespo 1982; Diehl 1983).

As mentioned above, the Epiclassic is frequently described as a period of intense social and political unrest that sometimes erupted in overt violence, and researchers have long posited that conflict in the region may have been a driving force behind Tula Grande’s eventual rise. Despite the popularity of this hypothesis, evidence of overt conflict in the Tula area is limited. One of the only examples of destruction was uncovered at Tula Chico in the civic ceremonial precinct. Specifically, there is evidence that buildings were burned, with the most striking example being found on Platform 1. In addition to charring, there is also evidence of a roof collapse that crushed several braseros and other ceramic vessels (Cobean and Suárez 1989; Cobean 2000). Interestingly, it appears that the burnt buildings were not modified after the burning event, even though daily life continued in the spaces around them. This has led researchers to suggest that the damaged structures were left as a monument to the events that precipitated Tula Grande’s dominance (Stocker 1983). Others have even suggested that the burning event at Tula may be evidence of historic events that gave rise to the mythological struggle between Tezcatlipoca and Quetzalcoatl (Mastache and Crespo 1982; Mastache and Cobean 1985). As with Tula Grande, very limited radiocarbon dating has been conducted at Tula Chico, but two samples from collapsed beams from the burning event have been analyzed. Though they are discussed more fully in Chapter 5, it appears that the burning event occurred between AD 700 and AD 878. After this time, it is thought that Tula Grande was founded and a new civic ceremonial precinct was built.

As noted above, the Epiclassic period ended (~AD 900) with the founding of Tula Grande’s ceremonial precinct, though the timeline of construction is still insecure. Mastache and colleagues (2002) generally suggest that Tula Grande reached its apogee at AD 1,000. This period corresponds to the city’s maximum expansion and highest population density. At the time, Tula Grande was the largest urban center in Mexico and is thought to have hosted around 2,000 multifamily residences (Mastache et al. 2002). By AD 1,200 the city had declined and much of the population had relocated.

Implications of La Mesa phase and Prado/Corral phase Contemporaneity

As noted above, the La Mesa phase and Prado/Corral phases were originally interpreted as
diachronic stages in a sequence of societal development that would eventually end with the founding of Tula Grande. This narrative fit well with the Dynamic Model proposed by Marcus, which proposes an escalation of centralization that is later followed by a period of decentralization. While the overall model proposed by Marcus can still be applied to the transition from Teotihuacan’s decline to Tula Grande’s rise, the synchronicity of the La Mesa and Prado/Corral phases suggests that the culmination of power and population at Tula Grande was not a simple process with clear transitional steps. Most obviously, the contemporaneity of the La Mesa sites and Tula Chico indicates that the landscape of Epiclassic Tula was far more crowded than researchers initially projected. Theoretically, archaeology in Tula is almost always discussed at the site-level and each community is treated as an independent polity. While critiques of this perspective can be made, it does emphasize the fact that there were many more social and political actors present in the region prior Tula Grande’s rise than researchers initially hypothesized. Anderson and colleagues (2016) note that recent investigations at Cerro Magoni suggest that the site may have been as large as Tula Chico. This fact, paired with the geographic proximity of the sites, leads to the important question of how these two communities interacted with one another and how these interactions contributed to Tula Grande’s rise. Previous discussions of intersite dynamics in Tula are addressed in more detail below, but many researchers favor explanations centered upon potential sociopolitical tensions between sites and generally coercive consolidations of power. In addition to questions surrounding the politics of Epiclassic Tula, the increased number of contemporaneous sites in the region simply means that more households were present in the area than was originally anticipated. Ecologically, Hidalgo is considered to be a relatively marginal landscape, especially if arable land is not heavily modified and maintained. A denser population during the Epiclassic would have increased demand for goods such as ceramics, raw materials used in lithic production, food, and even water. Given the increased density of sites, the manner in which households and communities met these needs becomes an important question that has not been clearly answered, though some hypotheses have been brought forward. Overall, the synchronicity of the La Mesa and Prado/Corral phase sites has caused researchers to revisit assumptions regarding community interaction and the sociopolitical structure of Epiclassic Tula. In the following section previously proposed explanations for the observed Epiclassic cultural changes and Tula Grande’s rise will be discussed.

**Explanations for Culture Change in the Tula Region**

As mentioned above, there were two primary periods of culture change in Tula. The first corresponded with the decline of Chingú and the settlement of the La Mesa phase hilltop communities. The appearance of the Coyotlatetelco ceramic complex in Tula is considered one of
the hallmarks of this shift and many researchers agree that understanding the origins of the Coyotlatelco complex is an important part of unravelling the events of the Epiclassic period. Below, the origins of the Coyotlatelco complex are discussed. The second cultural shift occurred at the end of the Epiclassic period with the rise of Tula Grande as an expansionist state. Discussions surrounding Tula Grande’s development remain more abstract, but hypotheses put forth by Anderson and colleagues (2016) are used to characterize current discussions surrounding Tula Grande and to propose areas of further research.

The Origin of Coyotlatelco and Its Arrival in Tula

As discussed above, the Epiclassic period in Tula is marked by a dramatic shift in settlement and ceramic patterning, specifically the adoption of the Coyotlatelco tradition. Coyotlatelco ceramics were first identified in post-Metepec contexts at Teotihuacan (Armillas 1950; Séjourné 1956) and in early levels at Tula (Acosta 1945). The first systematic study of the ware was conducted in 1966 by Rattray. While the Coyotlatelco complex is a highly diverse ware, it does have a series of defining characteristics. Typically, plain brown or cream slipped hemispherical tripod bowls are decorated with red painted motifs. These motifs are highly varied in complexity (see Cyphers 2000; Dumond and Muller 1972; Gaxiola 1999 for discussions of variation in complexity and differences between Complex A and Complex B), though geometric designs are heavily favored (Cobean 1990; Martínez Landa 2009; Nichols and McCullough 1986; Rattray 1966; Solar Valverde 2006; Vargus 1975). These painted vessels are frequently accompanied by negative polychromes, monochromes with incised or stamped designs, ritual pieces like censers and braziers, and red slipped wares that are complimented by site specific imported ceramics and other strictly utilitarian vessels (Cobean 1990; Hernández and Healan 2019; Rattray 1966). For several decades, researchers have discussed the origin of the Coyotlatelco complex and three primary hypotheses have emerged from the literature, though some are more favored than others. Perhaps the least favored explanation is that Coyotlatelco ceramics are a local outgrowth of wares already present in the Basin of Mexico during the Classic period or from wares recovered from earlier times (Dumond and Muller 1972; Sanders 2006). In contrast, many researchers have argued that Coyotlatelco is completely non-local to Central Mexico with proposed origin locations north and west of the Basin of Mexico reaching as far as Zacatecas and Jalisco (Braniff Cornejo 1972; Jiménez Moreno 1966; Mastache and Cobean 1989, 1990; Mastache et al. 2002; Rattray 1966). Finally, a third opinion has more recently emerged that suggests that Coyotlatelco is a hybridization of Teotihuacan style wares and a non-local tradition (Beekman and Christensen 2003; Fournier Garcia 2006; Gaxiola González 2006; López Pérez et al. 2006; Manzanilla 2005; Sugiura 2006). The origin of the Coyotlatelco complex has become an important
question in Central Mexican archaeology because most researchers, supporters of the local hypothesis aside, agree that the appearance of Coyotlatelco at Teotihuacan and Tula is indicative of contact between populations from Central Mexico and a poorly understood and defined culture from northern Mexico. Furthermore, the high prevalence of Coyotlatelco ceramics and other associated cultural traits in Tula during the Epiclassic has led researchers to suggest that the appearance of the tradition in the region is directly related to a significant migration event, which somehow led to Tula Grande’s rise in ~AD 900.

Overall, it is most likely that Coyotlatelco ceramics have their ultimate origin in the Bajío region of West Mexico (Hernández and Healan 2019), but evaluation of the ceramic record from the Basin of Mexico and regions north and west of Central Mexico suggest a complex and long-standing history of back-and-forth interactions that began during the Formative period (2500 BC – AD 200). Noting that Coyotlatelco sites in Central Mexico display lithic assemblages that favor obsidian from the Ucareo-Zinapécuaro source in Michoacán, Healan (Healan 1997) launched a study of settlement patterning and obsidian use in the region. During this study, excavations were conducted at 30 sites, which allowed for the reconstruction of the ceramic record in the region from the Late Formative to the Late Postclassic periods, producing an uninterrupted sequence covering 2,000 years of habitation (Hernández 2000). Generally, this region demonstrates a long tradition of red-on-brown pottery and the earliest known type is the Chupícuaro tradition. Initially, Chupícuaro was first identified within the mortuary contexts of the Chupícuaro site, but type has also been recovered from other sites in the Lake Cuitzeo Basin and the examples identified by Hernández and Healan (Hernández 2000; Hernández and Healan 2019) were recovered from stratified domestic middens and residential structures. Examples of Chupícuaro wares have also been found at Late Formative sites in Central Mexico. These wares may represent the migration of individuals from Bajío to Central Mexico, trade between the regions, or emulation, but it is clear that populations from northern and Highland Mexico were aware of one another and interacted in some manner (Darras 2006). Overall, the Chupícuaro heartland covered the northeastern corner of Michoacán, and the southern portions of Guanajuato and Queretaro with evidence of interaction within Highland Mexico to the east and south.

During the Early Classic Mixtlan phase, settlement in the Bajío was centered around the Lake Cuitzeo Basin and the ceramics demonstrate continuity with earlier Chupícuaro wares. Within the Mixtlan complex, red-on-brown bichromes were still manufactured, but were less popular than bichrome and polychrome pieces that incorporated red, black, and white slips and painted designs. Interestingly, these wares have also been recovered in central Guanajuato, though in that region they are referred to as the Morales complex. In the Cuitzeo Basin, nonlocal negative polychromes
types were also recovered that indicate contact between Mixtlan culture and populations in the Zacapu Basin in the west that used the Loma Alta I complex (Carot 1990, 1992) and communities in central Guanajuato to the north who used the previously mentioned Morales complex (Braniff Cornejo 1999). Additionally, the Mixtlan, Loma Alta I, and Morales complexes share decorative elements that are important components of the Tezoyuca complex. This little studied tradition is associated with 13 hilltop sites found in the Teotihuacan Valley Basin prior to Teotihuacan’s apogee. Additionally, isolated examples of Tezoyuca wares were also recovered at other sites, including Cuicuilco. Overall, the tradition was well represented in the eastern portion of the Central Basin and has been interpreted to represent an ethnic enclave hailing from the Bajío (Bennyhoff 1967; McBride 1974: Sanders et al. 1979). Interestingly, radiocarbon dating conducted by Cowgill (1997) and Carballo (2011) suggest that the Tezoyuca occupations are from ~150 BC. This information is significant because it suggests that the Tezoyuca settlements in the Basin of Mexico actually predate the Mixtlan and Loma Alta I complexes. Hernández and Healan (2019) suggest that these findings are indicative of sustained relationships between Central Mexican and Bajío populations that began during the Chupícuaro phase. This interaction evolved into a shared mode of ceramic production that included similarities between red painted wares and systems of exchange. This trend laid the groundwork for the intensified interactions observed during the Late Classic and Epiclassic periods.

In the Ucareo-Zinapécuaro area, cultural continuity continued into the Middle Classic Choromuco phase when two new ceramic types emerged, the Atzimba and Ramon complexes. The Atzimba complex, which is primarily observed in the Cuitzeo Basin, is likely directly descended from the Mixtlan complex, but demonstrates increased interest in complex geometric red painted or resist designs and other stylistic traits from regions to the west and north. The Ramon complex actually marks the earliest documented settlement in the immediate Ucareo area and is characterized by flat-bottomed out-flaring tripod vessels that are decorated with large red motifs. Overall, Ramon wares are very similar to vessels from southern Queretaro and Guanajuato, which suggests that the populations that settled in the Ucareo area had strong ties to the birthplace of the prior Chupícuaro culture. By the Middle and Late Classic Perales phases, there appears to have been a cultural unification between populations living in the Cuitzeo Basin and the Ucareo Valley and the regional center of Las Lomas was founded. It was at this time that Ucareo obsidian was heavily exploited and actively exported to other regions of Mesoamerica. Ceramically, this period is characterized by the Cantinas Red-Orange complex. Though this complex is diverse, the widespread use of red-on-brown out-flaring tripod bowls is thought to relate directly to the development of the Coyotlatelco complex. By AD 600, ceramic types in the Ucareo-Zinapécuaro
area shifted again, with the decline of Cantinas and the inclusion of Rosalinda Red on Brown Incised, Campo Red on Brown, and Garita Brown Black wares.

Overall, this sequence demonstrates that relationships existed between Bajío populations and Central Mexican communities by the Late Formative period and continued throughout pre-Columbian times. Based on the ceramic record, these relationships waxed and waned in their intensity, but were always characterized by back-and-forth exchanges of cultural canon that eventually led to the dramatic appearance of the Coyotlatelco tradition in the Tula region. Hernández’s and Healan’s opinion that the Coyotlatelco culture observed in Tula originated in the southern and southeastern Bajío is also strengthened by observations made regarding Epiclassic ceramics in Tula. For example, Prado and Corral wares from Tula Chico are remarkably similar to the Cantinas vessels mentioned above, and Cantinas wares and Coyotlatelco from Tula share several decorative motifs, some of which have a very long history of production in the southern Bajío. Coyotlatelco ceramics from La Mesa share similarities with Campo Red on Brown wares and designs found on earlier Ramon Red on Brown ceramics. The diagnostic Prado ware, Guadalupe Red on Brown Incised, and the Late Classic Perales ware, Rosalinda Red on Brown Incised, combine ceramic traits from the Bajío with designs found at Teotihuacan during the Tlamimilolpa and Xolalpan phases. This led Hernández and Healan (2019) to suggest that the Prado diagnostic wares, and other wares such as Rojo Inciso Postcocción Xajay (Nalda 1991), were actually formed to imitate Teotihuacano designs. Examples of Prado and Corral wares have also been recovered from burials in the eastern Bajío at the site of Barrio de la Cruz (Saint-Charles Zetina and Enríquez Farais 2006) in collections from other southeastern Queretaro sites (Hernández and Healan 2019; Nalda 1991), suggesting back and forth interactions between populations at Tula Chico and the Bajío, perhaps characterized by outgoing and return migration events.

Though it appears apparent that the changes observed in Tula during the Epiclassic period were the result of contact between populations in the Bajío, the reason for the shift in cultural patterning is less well understood. Migration has long been a proposed explanation given the extensive nature of cultural change observed, though the scale and patterning of the immigration event has long been debated. While ceramic, lithic, settlement, and some biological evidence seem to support the immigration hypothesis, theorizing the impetus for the migration event(s) remains more challenging. Most researchers would agree that singular, ultimate causes of population movement are rare and the Epiclassic period is unlikely to be an exception. The most probable explanation was actually put forth in 1969 by Pedro Armillas and suggests that climatic fluctuations that reduced consistent rainfall in regions north of Tula, including the Bajío, prompted individuals to leave their homes in the north and settle in the Tula region. Compared to the arid frontier, Tula
may have presented a manageable environment in an otherwise marginal landscape. Additionally, populations from the Bajío may have been drawn to the south as Teotihuacan was declining, as the decentralization of the region may have provided social, political, or economic opportunities that were previously limited. Given the decline of the Chingú era settlements in Tula during the transition between the Classic and Epiclassic periods and synchronous observations from Teotihuacan, Armillas’ suggestion that economic decline and subsequent opportunity provided an important motivation for migration is likely, especially given the history of contact between the regions. Until recently, his hypothesis that climate volatility pushed populations from northern Mexico was largely untested, but work by Kennett and Marwan (2015) has strengthened the argument proposed by Armillas. Using the published climate record and oxygen isotope analyses of cave stalagmites from Juxtlahuaca Cave in Guerrero, Kennett and Marwan (2015) demonstrated that from 200-850 CE Central Mexico experienced a period of drying that was punctuated by a period of significant climate volatility from 600-700 CE that was most severe during the 7th century. Given this evidence, it seems likely that climate conditions in northern Mexico may have grown continually more difficult during the Epiclassic period, providing a strong motivation for relocation.

Tula Grande Rising

The most recent discussion of Tula Grande’s rise to power (location marked in Figure 7) was presented in 2016 by Anderson and colleagues. Overall, this piece laid out the step-wise narrative of societal change discussed above, emphasizing the contemporaneity of the La Mesa phase sites and Tula Chico. Additionally, Anderson and colleagues (2016) put forward a series of hypotheses that seek to explain Tula Grande’s eventual rise to power. Broadly, these hypotheses are centered around the concept of stimulus regeneration (Bronson 2006). Bronson’s stimulus regeneration is a theoretical companion to Marcus’ work on political cycling. Specifically, stimulus regeneration is the formation of a new political entity that is stabilized through the use of distant and historic memories of prior centralized periods. Typically, this approach employs the “glory” of past societies to encourage populations to accept newly formed hierarchies. In the case of Tula Grande, Anderson and colleagues suggest that the Toltecs looked to Teotihuacan’s history and culture as a method of societal stabilization. With stimulus regeneration acting as overarching theory, Anderson and colleagues also propose that Tula’s rise in prominence led to the consolidation of “the fractious landscape” (2016:432) of Epiclassic Tula through one or more methods.
First, Anderson and colleagues (2016) suggest that Tula Chico’s Corral phase leaders gained control of the arable bottom lands in Tula, which provided surplus food to support a rising ruling class and labor to fuel monumental construction. In this instance, Anderson and colleagues are quick to note that this ruling class may have either gained control over preexisting communities, or fostered the development of new settlements. Second, Anderson and colleagues propose that Epiclassic period began with the importation of an already complex sociopolitical structure from the Bajío. In Tula, Prado wares have only been recovered from Tula Chico and are present in some of the earliest construction phases of elite buildings at the site. Cobean (1990) has suggested that this ware was used only by elite members of Tula Chico’s society and its early appearance in this context may indicate the immediate presence of an established elite class during the Epiclassic. Third, Anderson et al. (2016) note that Tula Grande may have developed as a conquest state, with Tula Chico conquering other populations in the region, though there is no evidence of destruction.
at either La Mesa or Cerro Magoni. Alternatively, Corral phase Tula may have existed as a disembedded capital (Blanton 1978) in which political and decision-making functions are separated from commercial and economic activities. In this situation, a capital is founded through mutual consent and collaboration. Sixth, the inhabitants of Tula may have employed a multifaceted agricultural system that utilized both the irrigation of seed cultigens like maize or amaranth and cactus species such as agave and nopal. This suggestion is an outgrowth of the suggestion made by Parsons and Darling, who suggested (2000) the importance of maguey cultivation as a necessary compliment to maize agriculture in arid regions of Mesoamerica. Perhaps through this modified agricultural system, populations at Tula were able to revitalize Classic period irrigation systems and maximize food production in the region during the Postclassic period. Finally, the abandonment of Tula Chico and the La Mesa phase settlements may have occurred at similar times, with their populations merging under a shared political or ideological canon upon the founding of Tula Grande. Under this paradigm, rulership at Tula Grande would have likely been more collaborative. Anderson and colleagues are careful to note that several of the proposed methods of consolidating power may have occurred in collaboration.

Overall, explanations for the cultural changes of the early Epiclassic period in Tula have begun to clarify over the past decade, as more attention has been given to the climate record and to archaeology in the Bajo region in Mexico. As more information is produced about life in northwestern Mexico it is likely that our understanding of Epiclassic hilltop populations in Tula will continue to grow. In contrast, understanding the consolidation of power at Tula Grande seems to be an open question. As noted above, some potential methods of change have been proposed by Anderson and colleagues (2016), but none of these hypotheses have ever been thoroughly tested, nor have means of testing the hypotheses been discussed in the literature. The remainder of this chapter evaluates the plausibility of these potential methods of change and proposes ways in which each hypothesis could be tested.

The Path Forward
Consolidation of bottomland populations to develop surplus

Anderson and colleagues’ first hypothesis suggests that the Corral phase rulership of Tula Chico consolidated bottomland populations with access to arable land, so that an agricultural surplus could be establish. This surplus was then used to supply the elite households of Tula Chico and to provide for the construction of impressive civic ceremonial structures. This consolidation may have taken place through the take-over of preexisting bottomland settlements, through the sponsorship of new communities, or a combination of the two approaches. Under this framework, the take-over of pre-established settlements was likely a more coercive action, while the planting of new communities may have been more collaborative. The first step in testing this hypothesis
should be the identification of bottomland settlements that may have been under Tula Chico’s rule, or were sponsored by elite households of Tula Chico. Given the current state of modern Tula and the quickening rate of development, it is unlikely that new surveys of the area will yield results that are more informative than those conducted in the past. The results of the most complete survey of the region are located in the appendix of Mastache and colleagues’ volume on Ancient Tollan (2002). This dataset lists sites throughout the Tula region and their potential chronological placement. Though much of the archaeology in Tula has been destroyed, it may be possible to identify bottomland sites that fit with Anderson and colleagues’ (2016) hypothesis. If the elites of Tula Chico sponsored the development of new settlements, it can be expected that the settlements were founded after the beginning of the Corral phase in AD 750. If settlements on the bottomland were founded prior to the Corral phase, it is more likely that Tula Chico consolidated influence among pre-existing communities. Additionally, sponsored settlements may have developed more quickly than communities that grew organically. Of course, assessing both the timing and rate of settlement development would require high precision radiocarbon dating, paired with Bayesian modeling. Ideally, a sequence of dates would be developed for the settlements under analysis, as opposed to a single date or a group of dates with no known association with one another. Additionally, an improved chronological sequence of events for Tula Chico and early Tula Grande would be required for comparison to the bottomland data. If a surplus of resources from the bottomlands fueled the construction of civic ceremonial structures during the Corral and early Tollan phases, the bottomland settlements should precede the development of these buildings with sponsored settlements not occurring before AD 750.

Assessing the timing of bottomland settlement development would only be the first step addressing the hypothesis of bottomland consolidation and the creation of agricultural surplus. The second step would be to assess the relationship between Tula Chico and the bottomland communities. If elite households from Tula Chico sponsored new communities, it would be expected that the material culture of Tula Chico and the bottomland settlements would be very comparable. While the bottomlands may not display elite goods, such as Prado ceramics, it is likely that the bottomland would display access to the same non-elite goods as households at Tula Chico. Specifically, there may be similarities in the composition of lithic raw materials used or in the types of preferred household ceramics. Researchers in Tula have shown that La Mesa phase settlements had differing access to lithic raw materials and preferred different ceramic wares. Given this already existing diversity in the Tula region during the Epiclassic, it is reasonable to suggest that settlements with similar material culture shared access to the same trade routes and goods, generating a comparable distribution of household items. In contrast, differentiating pre-established
bottomland settlements that were consolidated by Tula Chico from unaffiliated sites is a more complex problem. If settlements existed in the bottomland prior to the Corral phase and were later consolidated by Tula Chico, a shift in material culture may have occurred after the development of a new hierarchical relationship. Much like sponsored communities, pre-existing consolidated communities may have begun to display cultural materials and trade network access that mimics the patterns observed at Tula Chico.

With this said, Anderson and colleagues (2016) are correct in asserting that identifying bottomland sites that were directly affiliated or sponsored by Tula Chico would be a methodologically and theoretically difficult task. Additionally, it is also true that the elite households of Tula Chico may have both sponsored new settlements and incorporated existing settlements simultaneously. Regardless, testing this hypothesis would require significant investments in survey, radiocarbon dating, and eventual excavation of bottomland settlements. Additionally, work at Tula Chico would require significant expansion. Our current understanding of Tula Chico is very limited and the current radiocarbon record is problematic (see Chapter 5). Therefore, there is little data with which to compare future research from the bottomlands. Supporting or disproving the settlement consolidation/sponsorship hypothesis would require a substantial multi-disciplinary effort conducted at a scale which archaeology in Tula has never before experienced.

**Composite cultivation**

In addition to the potential sponsorship or consolidation of surplus producing bottomland communities, Anderson and colleagues also suggest that a composite cultivation system may have played an important role in the success of populations living in Tula. During the Classic period, the communities affiliated with Chingú constructed irrigation systems that likely facilitated maize agriculture in the region. After the Classic period, these systems were abandoned, but during the Epiclassic extensive terraces were constructed at the La Mesa phase hilltop settlements. According to Anderson and colleagues (2016) this space was probably used to grow maguey. In ancient times, maguey was exploited throughout Mexico, but was rarely viewed as a staple crop like maize. In most of Central Mexico, maize dominated the diet, as the climatic conditions of the region allowed for productive and relatively predictable growth. In Hidalgo and in northern Mexico, maize agriculture was far less forgiving. If irrigated, maize could be grown in some areas of the Tula bottomland. Anderson and colleagues (2016) suggest that during the Toltec apogee, the Classic period irrigation systems managed by Chingú may have been revitalized to permit maize agriculture once again, but that maguey cultivation also persisted. This approach would have proven beneficial for three primary reasons. First, the resources provided by maguey are all very calorically valuable.
Second, though some food stuffs provided by maguey are seasonal, portions of the plant can be used year-round. Finally, maguey and other cacti are very hardy and grow well in rocky regions with poor soil and limited rainfall. This means areas of Tula that would not have supported maize, like hill slopes, could be filled with maguey.

While this suggestion does not explain the social mechanics of how Tula Grande became a centralized state, it does produce a plausible explanation of how the dense population of Postclassic Tula was supported in such a marginal landscape. The dietary trends in Tula are discussed more fully in Chapter 6, but to test the composite cultivation model, a few approaches could be pursued. First, if the maguey cultivation systems of the Epiclassic were different from those of the prior Classic period, we may expect to see differences in the isotopic paleodiet signatures of the Classic and Epiclassic period populations. No burials from Chingú were ever recovered and an oil refinery was constructed on the site, but perhaps analyzing remains from the Classic period agrarian site of Julián Villagrán or the Oaxacan affiliated sites of El Tesoro and Acoculco could provide a valuable estimate of diet during the Classic period in the Tula region. If the Epiclassic did usher in new subsistence strategies, we would expect the dietary signatures of individuals from the from each period to potentially differ. Maize is a C₄ plant, while maguey is a CAM plant. The distinction between these two plant classes is discussed more fully in Chapter 7, but C₄ plant use photosynthetic systems that differ from those employed by CAM plants. Differences in these systems create variation in carbon uptake, which can result in identifiable differences in carbon ratios. While the signature of CAM plants can overlap with C₄, it could be possible to identify populations that did not demonstrate strict maize reliance. If background data summarizing the expected isotopic values of maguey products in Tula were produced, it may be possible to more precisely estimate the exact manner in which diet shifted. Additionally, if maize agriculture were revitalized in Tula during the Postclassic, it is likely that there would be a gradual increase in maize consumption over time. Testing all of these hypotheses would likely require that burials all undergo radiocarbon testing as well to ensure that subtle trends were not missed.

Second, analyzing botanical data from Classic, Epiclassic, and Postclassic settlements in the Tula region would also help to clarify shifts in subsistence strategies. During the Classic period, maize remains would be expected to dominate and during the Epiclassic more maguey and other cactus species. By the Postclassic, more maize remains should appear, though not at the same density as during the Classic period. Thus far, there is no published botanical information for Classic period or Epiclassic Tula and only limited findings from the Postclassic appear in print. Mastache and colleagues (2002) also suggest that an increase in maguey production should be paired with a corresponding increase in groundstone tools and ceramic vessels used to process and
store maguey products. This explanation has been proposed as a potential reason for the high percentage of groundstone scrapers and large ollas at La Mesa phase settlements. Finally, Anderson and colleagues (2016) propose that ceramic vessels could be tested for residues related to pulque brewing. This approach has been used at Teotihuacan by Correa-Ascencio and colleagues (2014) to trace bacteriohopanoids left by alcohol producing bacterium. While this approach was successful, residues could only be identified on 4.6% of tested vessels (14 of 300). This rate of positive identifications is obviously linked to the prevalence of maguey exploitation, but these residues are also difficult to detect. This approach could be applied in Tula, but would require the testing of a very large sample, especially if intersite comparisons were to be made.

**Importation of a complex social structure from Bajío**

Third, Anderson and colleagues suggest that the importation of a pre-existing complex social structure from the Bajío may have spurred increasing social complexity at Tula Chico, which eventually led to Tula Grande’s rise as a centralized power. Again, this hypothesis assumes Tula Chico’s dominance during the Epiclassic. An ideal first step in testing any hypothesis regarding the important of a complex social structure would be to confirm the presence of social hierarchy at Tula Chico. Researchers at Tula suggest that the presence of Prado wares is indicative of social status and that Tula Chico’s civic ceremonial architecture is significantly grander than the structures observed at neighboring sites, like Cerro Magoni. Though these assertions may be correct, they remain fairly untested. Civic structures at Tula Chico remain only partially excavated and no ceremonial structures have ever been explored at Cerro Magoni, though survey of the site suggests that they are present in significant numbers. Additionally, households are so rarely excavated in the Tula region that it is impossible to assess if some lineages could be considered higher status than their neighbors within the same community.

Even if more were known about the social landscape of Epiclassic Tula, very little is known about the social structure of society in the Bajío during the Epiclassic and prior periods. Therefore, it would be difficult to ascertain if the societal structure observed in Tula reflected patterns observed in the Bajío. In the past ten years efforts to conduct research in the Bajío have increased, but the current state of archaeology in Tula and the Bajío makes productive interregional comparison very difficult. Finally, cultural observations from both the Bajío and Tula should be anchored within a substantial radiocarbon record, which is currently lacking in both regions. For the importation of social hierarchy hypothesis to be supported, cultural patterns indicative of hierarchy should be observed earliest in the Bajío, perhaps during the Classic period. Additionally, they should also be apparent among the oldest deposits at Tula Chico. If indicators of social complexity can be identified in both the Bajío and in Tula and their appearance follows the expected sequence, then
it is possible that complex social structures were imported from northwestern Mexico to Tula. This may have created a situation in which elite lineages were well positioned to manipulate society and consolidate influence during the Epiclassic and Postclassic periods. With this said, the importation of a social hierarchy does not explain the mechanisms through which power was concentrated and expanded.

Tula Chico as a conquest state that took control of other settlements

One proposed method of consolidation is the conquest of neighboring settlements by Tula Chico. The first step in testing this hypothesis would be to identify the sites potentially controlled by Tula Chico, whether they be bottomland communities or La Mesa phase hilltop settlements. As with the hypothesis surrounding consolidation, community sponsorship, and surplus acquisition, identifying potential bottomland sites remains problematic. Coyotlatelco hilltop settlements were certainly active during the Epiclassic period (see Chapter 5) and they may have been conquered by Tula Chico. Inter-site animosity has been a popular point of conversation in Tula for many decades, and authors have long suggested that relationships between the various La Mesa phase settlements and Tula Chico were tense. The reason for this assertion is the presence of architectural, ceramic, and lithic differences among the Epiclassic settlements and the evidence of burning on Platform 1 at Tula Chico. Additionally, researchers have also suggested that the mythological struggles between the deities Quetzalcoatl and Tezcatlipoca are historic metaphors for the events that gave birth to Tula Grande.

If Tula Chico did conquer other settlements in the region through force, there should be clear signs of conflict. For example, there may be signs of violence among the individuals interred at the sites. Communities may be strategically located to maximize the visibility of the surrounding region and placed in difficult to access areas. Defensive structures may be present at the sites with stretches of uninhabited “no man’s land” between communities. If conflict erupted during the middle or late Epiclassic period, after Coyotlatelco settlements were already functioning, adjustments to site layout and location may also be observed. Additionally, there may be evidence of destruction such as the burning of civic and domestic buildings. When these criteria are considered, the likelihood of Tula Chico rising as a conquest state seems unlikely.

Of the Epiclassic sites in Tula, only Cerro Magoni and La Mesa have produced skeletal remains. Overall, these skeletal collections show very few signs of interpersonal violence (González Sánchez 2017) especially when compared to ancient populations that experienced overt conflict and raiding (Milner 1995; Milner and Ferrell 2011). Most of the injuries observed among the La Mesa and Cerro Magoni populations were non-fatal, having healed well before death. Many of the observed traumas are more likely to have been accidental, or the result of other factors such
as domestic violence. Additionally, there are no signs that individuals were left unburied for an extended period after death. Among the remains, there are no individuals whose bones were weathered or bleached by the sun or signs of scavenging activity. In instances of raiding violence, it is not uncommon to find signs of bodies being left unattended for extended periods prior to formal burial, and this does not seem to have occurred in Tula.

It is true that the La Mesa phase hilltop settlements do provide an advantageous position with high visibility of the surrounding area, but there is no evidence of defensive structures within or surrounding the sites. This contrasts with other Epiclassic centers in Mexico, which do display strong evidence of defensive capabilities. For example, the hilltop site of Los Mogotes in southern Hidalgo hosts a meter-tall wall surrounding the settlement and many areas of Xochicalco in Morelos are surrounded by walls as well. In northern Hidalgo, the main access point from the valley floor to the mesa where the civic ceremonial site of Pahñú is located is intentionally narrow and surrounding by steep cliffs on both sides. Finally, some scholars have even suggested that hilltop settlements in the Bajío were intentionally constructed to be invisible from the valley floor, so that the community’s inhabitants could avoid unwanted attention. One of these features are present at Epiclassic sites in Tula. Additionally, survey of Cerro Magoni shows that habitation and landscape modification was not limited to the hilltop’s summit and extended down the slopes. While Tula Chico’s civic ceremonial center is approximately one kilometer from Cerro Magoni, by the late Epiclassic the populations of the two sites were probably abutting one another with very little buffer area, if any existed at all (Mastache et al. 2002). Considering that Tula Chico and Cerro Magoni were the largest Epiclassic centers in Tula, researchers usually suggest that these two settlements competed with one another for control of the region, but there is very little evidence that any animosity erupted in violent subjugation.

As mentioned above, the only recovered sign of strife is the burning of Platform 1 at Tula Chico, after which the structure was left unaltered. It has been suggested that this event is the sole evidence of a conflict between Epiclassic communities in Tula and that the remains of Platform 1 were left as a symbol of the struggle that gave birth to a consolidated Tula Grande. While this explanation is potentially correct, alternative narratives are also plausible and worth consideration. For example, Platform 1 is not the only documented fire burning of a civic ceremonial building at Tula. The second example is the Palacio Quemado, which was one of the main civic ceremonial structures at Tula Grande. The Palacio Quemado was excavated by Acosta (1956) and the burning of the structure was initially interpreted as evidence of conflict directly related to Tula Grande’s decline in the Postclassic period, and the removal of carved relief panels was considered a sign of looting. More recently, this interpretation has been challenged by Sterpone (2000) who proposes a
more neutral explanation after speaking with the workmen who originally excavated the Palacio Quemada for Acosta. Essentially, Sterpone suggests that the roof of the palace had already collapsed prior to the fire, and that many of the removed carved relief panels were found in neat stacks covered by the collapsed roof. These stacked panels were better preserved and less altered by fire than other materials in the building, leading Sterpone to propose that the Palacio Quemada was actually abandoned well before the fire and that workers were in the process of systematically removing the façade panels when the roof collapsed. This collapse subsequently protected the stacked panels from the later fire. Though no absolute radiocarbon dates are available for this sequence, it does suggest that the abandonment of Tula Grande’s civic ceremonial precinct was a process of slow decay, not cataclysmic upheaval (Iverson 2017; Sterpone 2000).

This revised narrative for Tula Grande’s decline is important because it encourages us to reconsider interpretations of the abandonment of Platform 1 at Tula Chico. It is possible that Platform 1 was simply a disused civic building that caught fire accidentally. In another work, Sterpone (2000) notes that ethnohistoric accounts indicate that under systems of corporate leadership in Central Mexico and upon the death of the organization’s leader, the new figurehead is given the opportunity to re-locate the meeting place of group. If populations in Epiclassic Tula adhered to this governance model (see below) it is possible that Platform 1 was a such a meeting place that was moved upon a natural change in leadership. In Chapter 5 the existing radiocarbon dates for Tula Chico are recalibrated and explored more fully, but there is a low probability that the burning of Platform occurred in the final 50 years of the Epiclassic period and a high probability that life at Cerro Magoni and La Mesa continued for an extended amount of time after the abandonment of Platform 1. This suggests that the destruction of Platform 1 was not the cataclysmic final moment of the Epiclassic period.

**Tula Grande as a disembedded capital and the collaborative merging of populations and ideology**

Though Anderson and colleagues (2016) separate hypotheses related to the merging of populations and the functioning of Tula as a disembedded capital, it is more logical to discuss them together. According to Anderson and colleagues (2016), the political merging hypothesis suggests that the destruction of Platform 1 and the abandonment of Cerro Magoni occurred at the same time, directly prior to the development of Tula Grande. This shift would then represent the joining of populations from Tula Chico, Cerro Magoni, and other La Mesa phase settlements who were supposedly competing with one another. Under this paradigm, the decision to build a new civic ceremonial precinct at Tula Grande was politically neutral because the new seat of power would be located equidistant from Tula Chico’s and Cerro Magoni’s ceremonial precincts.

Anderson and colleagues (2016) also suggest that Tula Grande represented a new
hybridization of Central Mexican and northern ideological traditions. For example, the orientation of Tula Grande and the placement of key buildings harkens back to Teotihuacan, while features such as columned halls and skull racks may have originated in northern Mexico, having been brought to the region by migrants. Furthermore, the disembedded capital hypothesis proposes that Tula Grande’s adopted a collaborative form of governance in which multiple stakeholders worked together to make decisions. Additionally, based on architectural evidence, it is proposed that this trend may have begun during the Corral phase at Tula Chico and expanded through time.

It is important to note that Blanton’s original (1978) interpretation of a disembedded capital at Monte Alban suggested that collaborative forms of political decision making took place, but that this overarching governmental structure did not interfere in the economic dealings of the separate entities. In the Central Mexican literature, this suggestion was met with widespread criticism (Sanders and Santley 1978; Willey 1979), given the innate relationships between ideology, lineage, and economy in ancient Mexico. Furthermore, the adoption or expansion of public ritual can be used as a method of soothing rifts between factions, facilitating increased economic incorporation (Carballo 2013). The construction of Tula Grande’s ceremonial precinct obviously represents an increase in investment in the civic architecture that would have housed important public ceremonies.

Overall, it does seem unlikely that economic decisions would be divorced from political or ideological functions at any time in Tula’s history, but Tula Grande rising as a consolidated or collaborative entity seems the most likely explanation for the events of the Postclassic period. Especially in its early forms, the consolidated governance structure of the Corral phase and later Postclassic period may have been more decentralized, growing in complexity and solidarity over time. As noted above, there are almost no signs of violence in the Tula Region during the Epiclassic period or during the early Postclassic period. Yet, it is obvious that population and power did become centralized at Tula Grande. While coercion can occur without violence, the narrative of animosity between the La Mesa phase settlements and Tula Chico should not be assumed true. Evidence of cultural difference is not definitive evidence of distrust. Additionally, populations that are not fond of one another can work collaboratively, especially if the outcome benefits all parties. An interesting method of assessing the level of interaction between the La Mesa phase settlements and Tula Chico would be to reconstruct the genetic relationships of individuals buried at the sites. If relationships were negative, marriages between lineages at separate sites would not be expected. In contrast, if productive relationships prevailed between the communities, intermarriage would be expected, even in instances where communities maintained independent economic systems.

While the collaborative merging, of populations and ideology seems the most likely
explanation for the rise of Tula Grande, there are some assertions made by Anderson and colleagues (2016) that are unlikely or require further research. First, it is suggested that the burning of Platform 1 and the abandonment of Tula Chico occurred at the same time and at the end of the Epiclassic period. As is discussed further in Chapter 5, it is more likely that Platform 1 was burned prior to the abandonment of Cerro Magoni. Additionally, it is likely that Cerro Magoni and La Mesa were abandoned at different times. Populations may have begun to leave the smaller La Mesa phase settlements earlier, with large settlements like Cerro Magoni being abandoned later. This supports the hypothesis that the transition to centralization was gradual. Additionally, it is suggested that the location of Tula Grande’s civic ceremonial precinct was a neutral space located between Cerro Magoni and Tula Chico. This also requires further investigation, as Mastache and colleagues (2002) note that there may have been an earlier ceremonial precinct under early levels of buildings from Tula Grande. Mastache and colleagues (2002) suggest that these features may have belonged to Tula Chico, but this question has never been answered in a satisfactory manner.

Finally, Anderson and colleagues (2016) generally assume that Tula Chico was the dominant settlement in the region, though Cerro Magoni may have been a comparable peer. This suggestion is solely based on the appearance of Prado ceramics at Tula Chico and the overall size of Tula Chico’s ceremonial structures. These buildings are assumed to be grander than others from Epiclassic Tula, but only the structures from La Mesa have ever been explored. Therefore, it is possible that comparable investments in civic architecture were present at other sites such as Cerro Magoni. While this may seem to be a minor point, assuming Tula Chico’s dominance does influence the direction and tone of discussion surrounding Tula Grande’s rise. Such assumptions have long caused problems in Tula archaeology, as was revealed by Healan’s (2012) observation that the La Mesa phase settlements and Tula Chico were actually contemporaneous. Because they were assumed to be diachronic, complete narratives of societal development were elaborated upon without the support of adequate data. Overall, archaeology in Tula has made significant strides in the past few decades, but much work remains incomplete, and the urgency of the situation is only exacerbated by the near constant destruction of archaeological material in the region. Archaeological inquiry in Tula is an example of how new data can dramatically change interpretations of events and how important the preservation of cultural patrimony is to future inquiry. Indeed, there are some questions about Tula that may never be answered because the cultural material no longer exists.
CHAPTER 3: THE BIOARCHAEOLOGY OF THE CENTRAL HIGHLANDS OF MESOAMERICA FROM THE EARLY CLASSIC PERIOD THROUGH THE TOLTEC PERIOD

Introduction

Bioarchaeological research in the Central Highlands of Mexico has a rich past built upon the dedication and tenacity of Mexican and international biological anthropologists and archaeologists. While some examples of biological research from Central Mexico exist from the eighteenth and early nineteenth centuries it was not until the mid-1970s that bioarchaeology, as defined by Buikstra (1977), was commonly practiced in Central Mexico. Since the 1970s, bioarchaeological research has continued to develop in the Highlands of Mexico, as the region provides no shortage of interesting contexts in which bioarchaeological research can be conducted.

The following pages provide an overview of the bioarchaeological work that has been completed in the Central Highlands of Mexico (see Figure 8 and Figure 9) using skeletal collections from the Classic period (~AD 300) to the terminus of the Toltec period (~AD 1,200). Generally, Central Mexico references the Basin of Mexico, the Toluca and Tula regions, and the Mexican states of Morelos, Puebla, and Tlaxcala. This chapter addresses bioarchaeological work conducted in these subregions, although some areas are more heavily represented than others simply because more research has been completed in those locations. Additionally, this chapter draws primarily on the published literature, and readers interested in any of the topics discussed should not consider this chapter as providing a comprehensive bibliography. Several topics of interest in Mexican bioarchaeology will be addressed within the context of regional and temporal limits detailed above. According to a number of scholars, the following topics have become increasingly important in Highland bioarchaeology: (1) paleodemography, paleopathology, and ancient health, (2) paleodiet reconstructions, (3) migration, and (4) human sacrifice (Márquez Morfín and Hernández Espinoza 2019; Serrano Sánchez and Meza Peñaloza 2019; Spence and White 2009; Willermet and Cucina 2018). Finally, in the concluding section of the chapter, some suggestions for future directions in Central Mexican bioarchaeology are discussed.
Figure 8. The Central Highlands of Mexico. Map modified from Rus (2005).

Figure 9. Important archaeological sites in Highland Mexico. Map modified from Rus (2005).
Research Topics Within Highland Bioarchaeology
Paleopathology, Paleodemography, and Ancient Health

While bioarchaeological research in Central Mexico began in the mid-nineteenth century, interest in the discipline increased after the intellectual shifts of the 1970s in the anthropological sciences. In addition to Buikstra’s contributions to the field of bioarchaeology (1977), the work of Saul (1972) also significantly influenced osteological research in Highland Mexico. Saul proposed the utilization of the “osteobiography”, an approach that seeks to collate all possible osteological data from single individuals so that a comprehensive, but scientifically sound, life narrative can be generated. Additionally, the work of Cohen, Goodman, Martin, and Armelagos (Goodman et al. 1984) in the United States also shaped research in Central Mexico, drawing attention to the potential connection between skeletal pathologies and stressful or unhealthy living conditions. In 1992, this relationship was re-addressed by Wood and colleagues (Wood et al. 1992), with the publication of the “Osteological Paradox”. The Osteological Paradox posited that factors such as selective mortality, heterogenous frailty, and demographic non-stationarity could confound interpretations of relationships between pathology and ancient health conditions. While the Osteological Paradox is frequently discussed in Mexican paleopathological literature, renditions of the Goodman et al. (1984) model have become the most prevalent theoretical paradigm in Highland Mexico, with the “Nutrition and Health Index” (Steckel and Rose 2002) garnering increasing popularity. Additionally, demographic reconstructions of demographic population dynamics in Central Mexico have their roots in the work of Ubelaker (1974), though the work of Swedlund and Armelagos (1969) and Acsádi and Nemeskéri (1970) has also been highly influential (for examples and discussions of the trends mentioned above, see Bullock et al. 2013; Camargo Valverde and Partida Bush 1998; Ceja and Hernández 1998; Civera Cerecedo and Márquez Morfín 1998; Del Castillo Chávez and Márquez Morfín 2006; Gómez de León Cruces 1998; González Lición and Márquez Morfín 2009;; Hernández Espinoza 2004, 2006; Hernández Espinoza and Márquez Morfín 2010; Hernández et al. 2008; Márquez Morfín 2006a, 2006b, 2008, 2009; Márquez Morfín and Gómez de León 1998; Márquez Morfín and Hernández Espinoza 2006, 2019; Márquez Morfín et al. 2001; Márquez Morfín et al. 2002; Márquez Morfín and Jaén 1997; Márquez Morfín and Storey 2007). In recent decades, three types of studies have been conducted using skeletal collections from the Central Highlands: (1) targeted studies of specific pathologies, (2) studies of population health and demography for specific archaeological sites or subregions, and (3) large-scale comparative analyses. Each are addressed below.
Targeted Studies of Pathology, Congenital Disorders, and other Case Studies

Researchers in Central Mexico have published studies that address specific conditions or assess individual instances of extreme pathology or developmental abnormality. Here we provide a few examples of such studies, though many more examples are available in the literature. Diseases like tuberculosis and treponemal infections have been of interest to bioarchaeologists working in the Americas for several decades. The prevalence of these diseases in the ancient record, their unique skeletal effects, and the questions surrounding their origin have made them excellent candidates for bioarchaeological research in Mexico. For example, work by Mansilla and Pijoán (1995) and Mansilla and colleagues (2000) has sought to record treponemal infections among pre-contact Central Mexican populations. Mansilla and colleagues (2000) suggest that a complex history of epidemiological evolution in Mexico occurred in which yaws was replaced by bejel, which was ultimately replaced by syphilis during the Spanish colonial period. While changes in lesion patterning may have occurred at various intervals in Central Mexican prehistory, differential diagnoses of the treponemal infections from skeletal lesions alone, especially when based on only a few archaeological examples, should be regarded with extreme caution. Doing so with skeletons that are many centuries old also implies that the treponemal diseases did not evolve over time, and they produced the same suite of skeletal lesions as reported in cases dating to the last century or so in much different social and environmental settings. Many researchers concur that it is impossible to distinguish between differing treponemal infections using only skeletal lesions, and the methods proposed by Rothschild and Rothschild (1995) to distinguish between infections have long been considered highly controversial (for review see Baker et al. 2020; Harper et al. 2011). Additionally, Colonial treponemal victims from Mexico City have also been studied, yielding new information about the skeletal manifestations of syphilis and its societal impacts (Márquez Morfín and Meza Manzanilla 2015; Schuenemann et al. 2018). Martínez Mora and colleagues (2014) provide a summary of previously published archaeological cases of pulmonary tuberculosis in Mexico and the broader Americas, while also describing osteology of an additional case from Zacatecas and the DNA analysis of the tuberculosis pathogen itself. In addition to the study of specific pathogenic diseases, others have published reports on congenital and developmental disorders. Jaén (1977; 1996) provides a summary of early observations of various pathological conditions in Mexico, providing special focus on genetically linked developmental disorders, including acromegaly. Uruñuela (1989:72) has documented an individual from Cholula with skeletal manifestations of Klippel-Feil syndrome. Others have also investigated cases of craniosynostosis (Comas Camps 1966; Vera and Serrano Sánchez 1993; Hernández Flores et al. 2001). Additionally, a few rare instances of individuals exhibiting dwarfism have been recovered and reported upon (Bautista Martínez and
In addition to studies of disease outbreak and congenital and developmental disorders, studies of bioarchaeological phenomena have also been used in conjunction with archaeological data to interpret important aspects of ancient lifeways. Researchers such as Serrano Sánchez (1966) have analyzed patterns in the prevalence and severity of osteoarthritis in Central Mexico, while Jaén Esquivel, Pijoán, Cid Beziez, and colleagues (Cid Beziez 2004; Jaén Esquivel et al. 1995; Pijoán and Mansanilla 2004, 2007, 2008) have employed analyses of traumatic injuries to assess trends in violence in ancient Mesoamerica. Finally, in some instances, careful excavation and skilled bioarchaeological interpretation have yielded remarkable results. Sugiura and colleagues (2003) present a striking case study on the bioarchaeology of childbirth through the analysis and anthropological interpretation of the burial of a young woman and her infant from El Islote 20 along the lakeshore of the Chignahuapan Marsh. In this instance, evidence clearly indicates that mother and child perished during childbirth, and both individuals were given a highly ritualized burial that likely reflected the community’s complex relationship with the local marshland. Though many of these studies only discuss one individual or a small collection of skeletons, they are highly significant. As global interest in these conditions grows, recording all available cases becomes increasingly important for comparative studies, as this is the only way rare conditions can be successfully studied in the ancient past.

Site and Regional Studies

In addition to studies that evaluate specific pathologies, there are many publications that record the paleopathological conditions and demographic composition of single populations or a small series of communities. Many of these studies have centered around Teotihuacan (Alvarado and Manzanilla 2017; Rojas Lugo and Serrano Sánchez 2011; Serrano Sánchez 1984, 2003; Storey 1992), but research has also been conducted at other Highland Mesoamerican centers and sub-regions. During the Epiclassic and Postclassic periods, many smaller sites developed in the Basin of Mexico. Though none reached the size of Teotihuacan, they still occupied an important place in political landscape, developing complex relationships with Tula Grande in the north and Cholula in the south. Many of these sites have yielded skeletal collections, though many of them are very small. For example, Meza-Peñaloza and colleagues (Meza-Peñaloza et al. 2019) have reported the skeletal remains from the Epiclassic ritual site of Xaltocan, where the crania of decapitated victims were deposited. Through the evaluation of non-metric traits, the authors found evidence that sacrificed individuals were likely part of migrant populations that entered Central Mexico after the decline to Teotihuacan. Spence and colleagues (2013) also re-analyzed individuals from the Epiclassic site of Cerro Portezuelo. Based on δ¹⁸O evidence, Spence and colleagues (Spence et al.
suggest that only a few individuals were long-distance migrants, though over seventy percent of the collection is missing and unavailable. Cisernos (2007) also evaluated material from Tlalpizáhuac, Ixtapaluca to assess health and social stratification during the Epiclassic and Early Postclassic periods, and Lagunas and López Alonso (2004) have utilized skeletal materials from the site of Huamango to address questions surrounding Otomí cultural affiliation. Ceja-Moreno (1987) and Pijoán and colleagues (Pijoán et al. 1991) have documented Postclassic individuals from Azcapotzalco, one of whom likely suffered from a treponemal infection. Finally, Cisneros and colleagues (Favila Cisneros 2008; Favila Cisneros et al. 2006) have studied communities from the marshlands of the Toluca Valley.

Further to the north, in Hidalgo, several skeletal collections have been recovered and analyzed. Tula Grande was the only urban center to develop north of the Basin of Mexico and over 100 individuals have been recovered from the site and studied (Mansilla and Pompa 1990; Paredes et al. 1988; Serafin et al. 1994), though a return to those collections would likely be worthwhile. Currently, very little is understood about the rise of Tula Grande, and studies of Epiclassic collections from Hidalgo may help to propel research forward. Fournier and Vargus Sanders (2002) have discussed skeletal material from Chapantongo in their study of Otomí culture during the Epiclassic, and Huster and Morehart (2019) have presented information regarding newly excavated burials from the Coyotlatelco site of Los Mogotes. Finally, Kate (in preparation) is currently studying skeletal collections from the sites of Cerro Magoni, La Mesa (also see González Sánchez 2017), Pahñú, El Zethe, and Huesomenta to address questions of Epiclassic migrations.

In Morelos, Tlaxcala, and Puebla, fewer skeletal collections have been studied, though significant attention has been given to materials from Cholula. At Xochicalco, Valenzuela and colleagues and Garza Gómez (Garza Gómez 1994; Valenzuela Jiménez et al. 2005) have evaluated skeletal materials from potential sacrificial victims and skeletal elements that were ritually modified postmortem. Similarly, Talavera and colleagues (Talavera et al. 2001) have also studied culturally modified human remains from Cantona. At Cholula, planned excavations and salvage projects at Cholula have resulted in the recovery of a relatively large number of human skeletal remains from both domestic and ceremonial contexts, most of which have been dated to the Postclassic and Colonial Periods (Castro Morales and Garcia Moll 1972; Ferré D'Amaré and Xalpa Benítez 1967; Lagunas Rodríguez and Ocaña del Rio 2013; López Alonso et al. 1976; McCafferty 2007a; Morales-Arce et al. 2019; Romero 1937; Suárez Cruz 1985, 1989; Uruñuela 1989). While skeletons from Classic, Epiclassic, and Early Postclassic contexts exist, they are limited in number, so they have typically been pooled with much larger Late Postclassic samples for bioarchaeological analyses of the prehispanic population. In addition to investigating the cultural and biological traits
of the population of Cholula through research into funerary and ritual practices, cranial modification, dental mutilations, trepanations, and osteometric and morphological data (Ferré D'Amaré and Xalpa Benítez 1967; Lagunas Rodríguez 1972,1973,1989; Lagunas Rodríguez and Ocaña del Río 2013; Lopez Alonso 1972, 1973; Lopez Alonso et al. 1970,1976, 2002; Lopez Alonso and Salas Cuesta 1989; Romano 1973; Sánchez Saldaña 1973; Serrano 1972, 1973; Uruñuela 1989), analyses of these collections have also incorporated paleodemography and paleopathology to reconstruct ancient health. These studies have documented skeletal evidence of traumas, osteoarthritis, nutritional deficiencies, dental pathologies, infectious disease, general physiological stress, and markers of occupational stress (Bullock Kreger 2010, 2013; Mansilla Lory 1978, 1980, 1994; Márquez Morfín 1996; Márquez Morfín et al. 2002; Uruñuela 1989). Paleodemographic reconstructions of the skeletons recovered from the Proyecto Cholula have generally indicated elevated infant and childhood mortality (albeit with a likely underrepresentation of subadults due to poor preservation) and high young adult mortality with few individuals surviving into old age (Bullock et al. 2013; Lopez et al. 1970; Marquez Morfin et al. 2002; Serrano 1973 (Late Postclassic remains only)). However, when sacrificial burials were removed from the paleodemographic sample and an aging technique (e.g. Transition Analysis) that corrects the issue of age mimicry was applied, young adult mortality was reduced and a significant number of individuals survived past the age of 50 (Bullock Kreger 2010; Bullock et al. 2013). To date, no studies have addressed health trends through time at the urban center due to particularly small Classic and Epiclassic sample sizes, although pooled skeletal samples from Cholula have been included in a number of the large-scale, comparative analyses discussed below.

Large-Scale Comparative Analyses

In addition to targeted studies of specific conditions and site-level or regional studies of skeletal collections, a concentrated effort has been made in the last three decades to generate a robust framework that permits inter-site and cross-cultural comparisons of health among ancient populations from Mexico and beyond. These efforts have consistently employed the “Nutrition and Health” paradigm (Steckel and Rose 2002) and have reached significant fruition through the efforts of Márquez Morfín, Hernández Espinoza, Storey, and their colleagues. In one of the earliest modern paleodemographic studies in Central Mexico, Rebecca Storey (1992; also see Storey 2006) laid the groundwork for future demographic work in her analysis of the Tlajinga 33 compound at Teotihuacan. Overall, Storey worked to increase our understanding of how Teotihuacan differed from Old World urban centers and sought to produce a demographic profile of the Teotihuacan populations. Using a combination of paleopathological analyses, demographic models, and archaeological data Storey revealed that stabilizing population levels may have been an important
administrative goal for Teotihuacan leaders and that during periods of decline the urban center may have relied on in-migration to maintain its numbers. While Storey’s early work has become a pillar of Highland bioarchaeology, it only focused on a single barrio from Teotihuacan, leaving significant space for expansion.

Since the 1990s, Márquez Morfín, Hernández Espinoza, Storey, and colleagues have used the “Nutrition and Health” approach to generate standardized data that can be used to address important questions in Mesoamerican bioarchaeology. Specifically, two key areas of interest have emerged. First, researchers have sought to understand how patterns in health changed over time in Mesoamerica, especially in relation to shifts in subsistence and the rise of urbanism. Second, authors have assessed how differences in social and ecological environment and human microadaptation yield variable health outcomes. To answer these questions, researchers have analyzed trends in age at death, patterns of growth and developmental stress, stature and skeletal robusticity, dental and infectious pathology, anemia, degenerative joint disease, and traumatic injury. Furthermore, this information has been used to estimate trends in mortality, fertility, and life expectancy. While the efforts to standardize information collection and generate directly comparable datasets is highly commendable, it should be noted that this approach is not without its shortcomings. First, no new method can account for the small sample sizes and fragmentary preservational state of many skeletal collections in Central Mexico. Second, the Nutrition and Health paradigm does little to address problems with current methods of estimating age-at-death. Therefore, estimates of life expectancy are likely biased due to the chronic underestimation of older individuals. Third, the Nutrition and Health perspective also emphasizes the use of lifetables as a primary method of studying mortality, which is problematic given the assumptions of demographic stationarity and stability inherent to paleodemographic lifetable analyses (among other issues) (Milner et al. 2018). Finally, the lingering issue of the osteological paradox will always haunt approaches that do not accurately assess the relationship between age-at-death, risk of mortality, and the presence/absence of skeletal lesions. With this said, one of the earliest products of this Nutrition and Health approach was presented by Márquez Morfín and colleagues in 2001. By comparing skeletal collections from Tlajinga 33, Monte Alban, Palenque, and Copán, it was noted that individuals from the Maya region suffered from more pathological lesions than individuals from Central Mexico, but that Tlajinga 33 yielded the lowest life expectancy overall. Márquez Morfín and colleagues suggested that parasite loading and infectious disease were more common in the Maya region due differences in climate and ecology. This early work was followed by several publications discussed below that expanded the interpretations presented in 2001 and included data from important sites such as Tlatilco, Cuicuilco, Cholula, Teotenango, Tenochtitlan, and the
While Márquez Morfín, Hernández Espinoza, Storey, and colleagues have published many comparative studies (Márquez Morfín 2011; Márquez Morfín and Hernández Espinoza 2006, 2019; Márquez Morfín et al. 2002; Storey et al. 2012; Storey et al. 2017), two additional examples are of particular significance. In 2002, Márquez Morfín and colleagues (Márquez Morfín et al. 2002) contributed to the edited volume, *The Backbone of History: Health and Nutrition in the Western Hemisphere* (Steckel and Rose 2002), providing a comparative analysis of materials from Mexico. Over 700 skeletons were included in the report and the results of the study were in agreement with the hypotheses proposed by Cohen (Cohen 1989) regarding the health effects of urban development. It was concluded that at Teotihuacan, individuals living in lower status compounds had a higher prevalence of skeletal stress indicators (also see Manzanilla et al. 1999; Rattray and Civera 1999). Overall, adult individuals displaying multiple skeletal indicators of stress were more common at the lower status barrio of Tlajinga, when compared with La Ventilla, and only juveniles from Tlajinga displayed pathological conditions indicative of prolonged periods of nutritional or medical distress. When the health disparities of Central Mexican communities were compared with other communities from the western hemisphere, it was noted that health generally declined at large Mesoamerican centers through time and that individuals in low status communities in urban Highland Mexico likely suffered the most. Finally, in 2006 Márquez Morfín and Hernández Espinoza published the edited volume, *Salud y Sociedad en el México Prehispánico y Colonial*, which expanded the analyses of their publication from 2002, but also provided detailed descriptions of their interpretive framework and data collection and analysis techniques. While Márquez Morfín, Hernández Espinoza, and colleagues have continued to publish their findings, this edited volume has also provided an important resource and framework for the next generation of researchers.

Overall, Highland Mexico supported the largest ancient urban centers in the western hemisphere, and the region is a critical component of the ongoing discussions surrounding the dynamics of urban growth, maintenance, and renewal in times of turmoil. It is likely that New World and Old World urban centers responded differently to rising social complexity (Kohler et al. 2017), and this variation may have generated variable outcomes in population health and well-being. This is an area of research in which large comparative studies that incorporate sizeable skeletal collections from urban centers in Highland Mesoamerica can have a significant impact on the global bioarchaeological community.

**Paleodiet Reconstructions**

While the studies of paleopathology and paleodemography have existed in Central Mexican bioarchaeology for many decades, analyses of paleodiet are far more recent. Historically,
researchers hoping to reconstruct ancient food systems could only rely on contextual indicators of diet such as faunal and botanical remains, but recently, isotopic methods of reconstructing diet have been applied in Mexico. These atomic approaches commonly use carbon ratios from bone collagen ($\delta^{13}C_{\text{collagen}}$), bone bioapatite, and enamel bioapatite ($\delta^{13}C_{\text{apatite}}$) and nitrogen isotope ratios from bone collagen ($\delta^{15}N_{\text{collagen}}$) to reconstruct ancient dietary patterns. Broadly, this approach can be used to distinguish between diets that are heavy in C$_3$ and C$_4$ plants (O’Leary 1988; Smith and Epstein 1971), to identify marine resource consumption, and to estimate an organism’s trophic position (Epstein and DeNiro 1981; Schoeninger and DeNiro 1984).

In the Central Highlands, isotopic approaches to dietary reconstructions have been used to explore two areas of interest: the transition to agriculture in Mexico and how sociopolitical factors, like status or ethnic identity, influenced diet and access to resources. One of the earliest explorations of dietary transition was conducted using material from the Tehuacán Valley of Puebla. In 1967, MacNeish generated a diet profile of populations in Tehuacán for a 7,000-year period using data from coprolites and excavated plant and animal remains. Using results from human bone collagen, Epstein and DeNiro (1981) and Farnsworth and colleagues (1985) tested the viability of MacNeish’s (1967) hypothesis. Despite the study’s small sample size, Farnsworth and collaborators (1985) concluded that Tehuacános potentially shifted from a hunting and gathering subsistence pattern to an agricultural system earlier than was hypothesized. While the transition to agriculture has been an important topic of research globally, the work of MacNeish, Epstein, DeNiro, Farnsworth, and colleagues also demonstrates how faunal and botanical data can be used in conjunction with isotopic data to test hypotheses.

While diet reconstructions from the Tehuacán Valley provides us with an image of transitional foodways in Puebla, Storey and colleagues (2019a) generated a “first glimpse” of early agricultural populations from Altica, a site that provides the earliest known evidence of maize cultivation in the Teothuacan Valley. Though $\delta^{13}C_{\text{collagen}}$ and $\delta^{15}N_{\text{collagen}}$ data was only available from four Preclassic individuals, the authors were able to conclude that the populations of Altica were likely reliant on C$_4$ plants such as maize, a supposition that is supported by paloethnobotanical analyses conducted by McClung de Tapia and colleagues (2019). Overall, the subsistence profile of the site was interpreted as evidence of a milpa-based agroecological system, which may have included the exploitation of both foraged and cultivated resources. The work of Storey and colleagues (2019a) provides important preliminary data regarding early farming in Mexico, but it also brings forth questions regarding potential lacustrine resource exploitation (Finlay and Kellner 2007)) and the use of alternative sources of terrestrial protein, such as rodents or insects (Widmer and Storey 2017), that cannot be answered using only an isotopic approach, further demonstrating
the important relationship between isotopic studies of diet and supporting evidence from the botanical and faunal record.

Teotihuacan has hosted the most pre-Aztec studies of paleodiet in the Central Highlands, and researchers have used Teotihuacan’s diverse population to explore how sociopolitical factors influenced resource access. Analyses of $\delta^{13}$C and $\delta^{15}$N have been conducted using remains from several barrios such as Tlajinga (White et al. 2004a; Storey et al. 2019b), the Oaxaca barrio (White et al. 2004b), Teopanzolco (Casar et al. 2017a, 2017b; Mejía Appel 2017; Morales-Puente et al. 2012), La Ventilla, and San José 520 and from the sacrificial burials of the Feathered Serpent Pyramid (Nado 2017; Nado et al. 2017). Many of the studies of diet at Teotihuacan combine isotopic studies of migration with paleodiet reconstructions to test if the diets of immigrants differed from locals. White and colleagues (2004a) published one of the earliest studies of this type using material from Tlajinga 33, which in many ways was an extension of Storey’s (1992) earlier work. Through a combination of $\delta^{13}$C$_{collagen}$ and oxygen phosphate analyses ($\delta^{18}$O$_{phosphate}$), White and colleagues (2004a) determined that the inhabitants of Tlajinga 33 relied on food systems originating with C$_4$ plants, and the authors hypothesized that maize was the population’s primary source of nutrition. Furthermore, no differences in diet were detected between individuals of differing social status, between males and females, or between first generation immigrants and locals. Nevertheless, a decrease was observed in $\delta^{13}$C$_{collagen}$ values from the Early Tlamimilolpa phase to the Late Xolalpan/Metepec phases. Though sample size was small, White and colleagues (2004a) suggested that this trend could indicate an increased reliance on maize over time, which may have been linked to provisioning challenges at Teotihuacan.

While White et al. (2004a) focused on a subset of the original burials from Tlajinga 33, Storey and colleagues (2019b) provided additional information on the Tlajinga compounds by comparing the $\delta^{13}$C$_{collagen}$ and $\delta^{15}$N$_{collagen}$ signatures of individuals from Tlajinga compounds 17 and 18 with those of additional individuals from Tlajinga 33. Storey and colleagues (2019b) used this data to address three questions. First, they assessed if diets were consistent across all the Tlajinga compounds. Second, they evaluated if the lack of dietary differentiation observed by White and colleagues (2004a) between higher status and lower status individuals was maintained once the study sample was expanded and compounds other than Tlajinga 33 were included. Finally, by conducting $^{14}$C radiocarbon dating on all individuals in the study, Storey and colleagues (2019b) were able to re-assess White and colleagues’ (2004a) hypothesis that maize consumption increased from the Tlamimilolpa phase to the Late Xolalpan/Metepec phases. Broadly, Storey and colleagues (2019b) found that all Tlajinga compounds relied heavily on foods originating within a C$_4$ or CAM plant system, but that there was a statistically significant difference between the mean $\delta^{13}$C$_{collagen}$
values of individuals from Tlajinga compounds 17, 18 and 33. This suggests that individuals from compounds 17 and 18 were supplementing their diets with C3 or CAM resources, while the inhabitants of Tlajinga 33 likely consumed more maize. Despite these differences in $\delta^{13}C_{\text{collagen}}$ values, no differences were identified in $\delta^{15}N_{\text{collagen}}$ values suggesting that all compounds consumed similar proportions of terrestrial animal protein and that higher status individuals did not have higher protein diets than lower status persons. Finally, Storey et al. (2019b) did not find statistical evidence to support White and colleagues’ suggestion that maize consumption increased from the Tlamimilolpa phase to the Xolalpan phase, once again demonstrating that isotopic studies of diet are iterative and frequently open to adaptive interpretations.

While few dietary differences were detected among the inhabitants of the Tlajinga compounds, some interesting patterns have emerged from other barrios and contexts at Teotihuacan. For example, Nado and colleagues (Nado et al. 2017; Nado 2017) used $\delta^{13}C_{\text{collagen}}$, $\delta^{13}C_{\text{apatite}}$, and $\delta^{15}N_{\text{collagen}}$ data from La Ventilla, San Jose 520, and the Feathered Serpent Pyramid to assess if sacrificial victims exhibited the same dietary profiles as other residents of Teotihuacan. Broadly, La Ventilla represents a higher status barrio, while San Jose 520 was likely inhabited by the urban poor. Though the sample size from each context was small, Nado and colleagues determined that the inhabitants of San Jose 520 likely supplemented their diet with more C3 or CAM resources, while the inhabitants of La Ventilla primarily relied on C4 resources. While no differences in $\delta^{15}N_{\text{collagen}}$ were identified among the Tlajinga compounds, statistical differences were observed between La Ventilla and San Jose 520, with inhabitants of La Ventilla likely consuming more animal protein. Even with the diversity displayed between La Ventilla and San Jose 520, the dietary patterns of the sacrificial victims of the Feathered Serpent Pyramid appear to be unique. While many of the Feathered Serpent individuals display local $\delta^{18}O_{\text{carbonate}}$ values, their $\delta^{13}C_{\text{collagen}}$ values suggest a higher reliance on C3 derived resources, at least within the protein component of the diet, and $\delta^{15}N_{\text{collagen}}$ values suggest intermediate levels of animal protein consumption, when compared with results from La Ventilla and San Jose 520. This information led Nado and colleagues (2017) to conclude that the sacrificial victims of the Feathered Serpent Pyramid may have maintained a distinctive identity in the years leading to their death that set them apart from other populations at Teotihuacan.

While diets at Tlajinga, La Ventilla, and San Jose 520 appear to have been homogenous across individuals within each compound, work at Teopancazco (Casar et al. 2017a, 2017b; Mejia Appel 2017; Morales-Puente et al. 2012) has demonstrated interesting inter-compound dietary diversity, some of which may be attributed to individuals of unique social, migratory, or health
status. While only a subsample of the Teopancazco collection has undergone dietary reconstructions, the patterns observed by Casar and colleagues (Casar et al. 2017a, 2017b) could be the result of the study’s larger sample size, which could permit the identification of previously unobserved trends. Overall, isotopic dietary reconstructions are emerging as an important tool for archaeological investigations in the Central Highlands that can be used to supplement studies of botanical and faunal remains, to assess how dietary and provisioning practices changes over time, and how the lives of socially and demographically distinct cohorts differed from one another. This approach is already proving fruitful in Colonial populations, allowing researchers to address novel research questions surrounding colonialism, famine, and structural violence (Cadena Duarte 2016), and will likely yield interesting results when more comprehensively applied to Preclassic and Classic populations.

Migration

For many decades, migration was rejected as a serious area of inquiry in both archaeology and paleodemography. However, since the 1990s, migration has become an important part of bioarchaeological research, bolstered by methodological and theoretical advances. Studies of migration in Highland Mexico have become increasingly common and generally fall into two categories. Researchers may work to identify individual first-generation migrants and diaspora communities, or they may attempt to detect instances of population replacement and genetic admixture. Both approaches have significant merit and are usually used to address different types of questions. Among studies that seek to locate first-generation migrants, isotopic approaches are becoming increasingly popular. To conduct studies of first-generation migration researchers commonly employ several isotopic systems, such as stable oxygen ($^18$O) and radiogenic strontium ($^{87}$Sr/$^{86}$Sr) and lead ($^{206}$Pb/$^{204}$Pb, $^{207}$Pb/$^{204}$Pb, $^{208}$Pb/$^{204}$Pb). Much like studies of diet, this approach has been widely applied in the Maya region, but in Central Mexico isotopic studies of migration have been most commonly used to analyze materials from Teotihuacan. However, ongoing isotopic investigations of skeletal remains from Cholula and the Epiclassic Tula region are continuing to expand our understanding of ancient mobility and migration throughout Central Mexico (Bullock, in press; Bullock et al. n.d.).

Some of the earliest isotopic investigations of migration at Teotihuacan assessed if individuals originating from Oaxaca, Teotihuacan, and other locations could be distinguished from one another (Stuart-Williams et al. 1996; White et al. 1998). Through $^18$O$_{\text{phosphate}}$ analyses of individuals from Tlajinga 33 and Monte Alban in Oaxaca, White and colleagues (1998) were able to demonstrate that each location did generate distinct isotopic signatures that could be used to distinguish individuals of Oaxacan origin from those of Teotihuacan origin, a conclusion that
supported the earlier results of Stuart-Williams and colleagues (Stuart-Williams et al. 1996). In a further expanded study, Price and colleagues (Price et al. 2000) employed $^{87}\text{Sr}/^{86}\text{Sr}$ analyses to assess if the inhabitants of the Oaxaca barrio and the Merchants’ barrio were immigrants, how long potential migrants had lived at Teotihuacan, and if individuals buried in the Late Classic contexts of the Cueva de las Varillas and the Cueva de Pirul were immigrants. Using a combination of strontium ratios derived from bone and tooth enamel, Price and colleagues (Price et al. 2000) found that individuals from the “foreign” barrios and from the tunnel contexts demonstrated highly variable locations of origin, but that most individuals had spent significant time at Teotihuacan prior to their death. During further investigations of the Oaxaca barrio, White and colleagues (White et al. 2004b) found that at least four-fifths of the sampled individuals had either immigrated to Teotihuacan or had been born at Teotihuacan, but spent significant time away from the city during their life. This pattern was consistent through time suggesting that continual interaction occurred between Oaxaca and members of the Oaxacan diaspora. Additionally, no patterns were observed in post-marital residence patterning and it appears that women and children, some of whom were under five years of age, were part of the migratory flow. Finally, no differences in status were observed between migrants and non-migrants, suggesting that neither Teotihuacano or Oaxacan origin yielded increased social prestige. Similar trends were also observed by Solis Pichardo and colleagues (2018) and Morales and colleagues (2018) during their investigations of the multiethnic barrio of Teopancazco where it was concluded that over forty percent of individuals were first generation immigrants to Teotihuacan.

With this said, researchers in Mesoamerica should be cautious in their interpretations of non-local isotopic signatures given the region’s long history of using nixtamalization to prepare maize. During this process, grains are soaked in an alkaline solution to loosen the hulls from the kernels, improve the taste and aroma of the grain, remove mycotoxins, and enhance the nutritional quality of the food. In Mesoamerica a lime solution was commonly used to treat maize, and in many instances the lime was of non-local origin. For example, lime used at Teotihuacan may have come from the Tula region of Hidalgo (Mastache et al. 2002). Therefore, prolonged consumption of maize treated with non-local lime may skew isotopic signatures of local individuals. A similar phenomenon has been observed in regions where modern agricultural lime is used and should be considered more fully in archaeological contexts (Andreasen and Thomsen 2021; Frei et al. 2020; Thomsen and Andreasen 2019).

Although Cholula has received considerably less attention than Teotihuacan, its relationships with other regions of Mesoamerica, its cultural influence as a market, its status as a pilgrimage site, and its ethnic composition through time have long been of archaeological interest.
A recent δ¹⁸O and Sr/⁸⁶Sr study of 50 individuals drawn from Postclassic (AD 900-1500) domestic contexts sought to identify immigrants in order to assess the effects of migration on the urban demography of the center and to evaluate the experiences of immigrants in this residential zone (Bullock in press; Bullock et al. n.d.; Lopez Alonso et al. 1976). Approximately forty percent of the individuals included in the isotopic analysis had nonlocal signatures, suggesting that the Postclassic population that resided in this zone was highly mobile. Furthermore, immigrants came from multiple regions, and it would appear they were readily assimilated into what was a multicultural and multiethnic urban society (Bullock in press; Bullock et al., n.d.).

In addition to isotopic studies of first-generation migration, other researchers have sought to identify large-scale population replacements and admixtures using a combination of methods such as biological distance approaches, blood-group phenotyping, analyses of protein coding loci, albumin variants, and mitochondrial DNA haplogroups. While opportunities to apply these approaches are prevalent in Central Mexico, these methods have most commonly been applied to the spread of the Uto-Aztecan language family and to the potential population replacements of the Epiclassic and Post-Classic periods. In the case of the Uto-Aztecan language origin, bioarchaeological approaches have been used to test two competing hypotheses. The broadly favored hypothesis posits that the language family began in the American Southwest and spread south to Mesoamerica (Dyen 1956; Miller 1984), although Hill (2001) has suggested a Central Mexican genesis with northward expansion. Regardless of its origin, the Uto-Aztecan language of Nahuatl was entrenched in Highland Mexico by the Post-Classic period. Attempts to isolate the origin of Uto-Aztecan using biological data from modern and ancient individuals has yielded mixed results. For example, blood phenotype data gathered by Brown and colleagues (1958), a protein-coding loci study by Spuhler (1979), dental analyses by Turner (1993), and mtDNA work by Smith and colleagues (2000), Malhi and colleagues (2003) and Kemp and colleagues (2005) all support a Southwestern origin of Uto-Aztecan. Specifically, researchers using analyses of mtDNA have found no evidence to suggest that Mesoamerican populations influenced the genetic composition of Southwestern populations. In contrast, studies by Turner (1987) and Niswander and colleagues (1970) supported genetic continuity between the two regions and a Central American origin of Uto-Aztecan. Although it seems that a Southwestern origin of Uto-Aztecan is the most accurate hypothesis, researchers do provide two notes of caution (Smith et al. 2000; Malhi et al. 2003; Kemp et al. 2005). The strongest evidence supporting a Southwestern origin comes from the lack of intrusive Central American mtDNA in the Southwest. Mitochondrial DNA corresponds to an individual’s matriline. Therefore, migratory movement by males alone will not be detected. If migration events leading the spread of Uto-Aztecan were linked to male relocation, investigations
of Y chromosome variation will be required. Additionally, it should be remembered that migration is not strictly required for the spread cultural traits, such as language, and that cultural diffusion could also explain the transference of Uto-Aztecan (Anthony 1990). This fact reiterates the necessity of integrating bioarchaeological data with other sources of information.

While studies of Uto-Aztecan expansion have sought to reconstruct population dynamics across North America and Central America, other researchers have addressed potential Toltec and Aztec migrations using biological distance approaches. For many decades, it has been hypothesized that the rise of the Toltec and Aztec states was preceded by great migratory events. Authors typically treated the potential migrations of the Toltecs and Aztecs as separate events, but Beekman and Christensen (2003) suggested that the arrival of the Nahuatl speaking Aztecs in Central Mexico was part of a long-term process that began during the Epiclassic period. Overall, these hypotheses are rooted in archaeological and ethnohistoric information, but bioarchaeologists have sought to evaluate these theories using biological data.

Two research groups, González-José and colleagues (2007) and Ragsdale and Edgar (2018, 2015, 2014) have used biological distance approaches to assess genetic continuity in the Central Highlands. González-José and colleagues (2007) analyzed the cranial metrics of over 330 crania from populations in Mexico, recovered primarily from the Highland Mexico. The crania were affiliated with archaeological sites ranging from the Preclassic period through the Colonial period, and a sample of modern individuals was also included. González-José and colleagues (2007) demonstrated that discontinuity events occurred during Central Mexican prehistory, suggesting significant migratory events that led to substantial genetic admixture. The most notable shift was observed during the Classic-Postclassic transition, as opposed to the period of Aztec migrations. Interestingly, all the facial variation observed in Preclassic, Classic, Epiclassic, and a number of northern populations can also be found in the Pericú from Baja California. The phenotypic pattern observed among the Pericú is very similar to the facial structure of Paleoamerican populations (González-José et al. 2003), which has led González-José and colleagues to suggest that the Pre-Mexica facial forms found in Central Mexico are ‘ancestral’, while the Postclassic form is somewhat ‘derived’ (González-José 2007:684). In addition to the work of González-José and colleagues, the analyses of Ragsdale and Edgar (2018, 2015, 2014) suggest that significant genetic shifts occurred in Central Mexico prior to the Colonial period. Using dental morphometric traits, Ragsdale and Edgar (2018, 2015, 2014) found that the most substantial change in the population structure of Highland Mexico occurred between Classic and Postclassic periods. This conclusion supports the hypothesis that populations from northern and western Mexico entered Central Mexico in significant numbers, changing both the cultural and biological landscape of the region. Ragsdale
and Edgar (2018) go on to suggest that these results support the Aztec claim of both Toltec and Chichimec heritage. While there is still much work to do regarding the bioarchaeology of the Classic-Postclassic transition, the work of González-José and colleagues (2007) and Ragsdale and Edgar (2018, 2015, 2014) provide the most comprehensive bioarchaeological investigations of these questions. Additionally, they have laid the groundwork for future studies in both the bioarchaeological and archaeological sciences regarding how populations adapt in times of social, economic, political, and environmental turmoil.

Finally, genetic studies at the urban center of Cholula, have been used to identify significant population shifts and to evaluate the validity of ethnohistoric narratives that detail large-scale migration events in the Epiclassic and Postclassic periods (McCafferty 2007b; McCafferty and Chiykowski 2016). In 1985, Suarez Cruz described a Late Classic period burial of a possible Maya individual, which McCafferty and Chiykowski (2016) used to argue for a Maya presence at Cholula during the Epiclassic. Additionally, a recent mitochondrial aDNA study (Morales-Arce et al. 2019) compared the haplogroups of individuals from Late Postclassic Tlatelolco and Early Postclassic Cholula. Four haplogroups (A, B, C, and D) were represented in the Tlatelolco sample, with Haplogroup A being the most common, a pattern not uncommon in Central Mexican samples (Morales-Arce et al. 2019). In contrast, at Cholula, only three haplogroups are represented (A, B, and C), but haplogroups A and B are equally frequent. Morales-Arce and colleagues hypothesized that the patterns observed at Cholula could be the result of migration, and that Gulf Coast Maya may have arrived at the site during the Epiclassic, as suggested by ethnohistoric documents. However, the absence of haplogroup D, a haplogroup associated with the Maya, at Cholula underpins the necessity for cautious interpretation. Ultimately, Morales-Arce and colleagues (2019) call for additional studies to clarify Cholula's ethnic makeup. Finally, Lopez Alonso and Salas Cuesta (1989) conducted an osteometric and morphological investigation, which also evaluated the possibility of a Postclassic migration to Cholula. Using skeletons recovered during the Proyecto Cholula, Lopez Alonso and Salas Cuesta (1989) demonstrated that the Postclassic individuals from this area are morphologically distinct from the Preclassic and Classic samples. The authors of the study also compare the Preclassic, Classic and Postclassic skeletal material from Cholula to skeletons from other regions, such as the Basin of Mexico. Lopez Alonso and Salas Cuesta (1989) suggest that the results of the study are consistent with a significant influx of a morphologically distinct population into Central Mexico during the Postclassic Period, although they caution that small sample sizes make further investigations necessary (Lopez Alonso and Salas Cuesta 1989).

Sacrifice

The topic of human sacrifice in Highland Mexico is briefly discussed in this final section.
Research surrounding human sacrifice in ancient Mesoamerica has focused heavily on the Post-Classic period, largely due to Spanish accounts of Aztec sacrificial practices and festivals. These early accounts were heavily exaggerated and led some early scholars to conclude that the Aztecs possessed “a maniacal obsession with blood and torture (Lévi-Strauss 1964:388)”. It is now generally accepted that the Aztecs were not endlessly blood thirsty, but the existence of sacrificial practices among Central Mexican populations and the importance of those practices for the maintenance of society should not be ignored. Emic explanations for Aztec sacrifice generally accept that “sacrificial victims were part of a cycle of sustenance which nourished the gods and ensured the continued existence of the world (Dodds Pennock 2012:286).” Additional etic explanations for sacrifice have also been proposed ranging from Cook’s (1946) theory that sacrifice was a response to overpopulation, that sacrificial victims were cannibalized to alleviate protein deficiencies (Harner 1977; Harris 1977), and that human sacrifice was a method of securing and maintaining social hierarchy (Carrasco 1999; Price 1978; Turner and Turner 1999; Watts et al. 2016). Of these three propositions, only the social control hypothesis is still widely accepted, leaving bioarchaeological investigations of sacrificial victims in Highland Mexico with compelling opportunities. In the study of human sacrifice, it is becoming increasingly important to (1) know who the victims were within society and (2) why they were chosen for sacrifice over their peers.

Human sacrifice provides a clear opportunity to apply Saul’s (1972) approach to the osteobiography. In the past, researchers analyzed the skeletal remains of sacrificial victims from Highland Mexico using a variety of methods. Spence, Pereira, and Sugiyama (Sugiyama 2005; Spence and Pereira 2007; Pereira et. al. 2011) provide descriptions and interpretations of the osteology and burial context of sacrificial victims from the Feathered Serpent Pyramid and Moon Pyramid, while Nado and colleagues (Nado 2017; Nado et al. 2017) used isotopic dietary reconstructions to address social distinctions between sacrificed persons and the general population of Teotihuacan. Additionally, White, Price, and colleagues have used a combination of isotopic approaches to assess the migration status of sacrificial victims (Price et al. 2007; White et al. 2007; White et al. 2002). Additionally, Lopez and colleagues (1976, 2002) analyzed the Postclassic ceremonial and sacrificial burials recovered from the Proyecto Cholula and documented practices of dismemberment and decapitation. Lagunas and Ocaña del Río (2013) also studied a small sample of Early Postclassic decapitations from Cholula. Elsewhere authors have drawn attention to case studies of sacrifice from smaller settlements and transitional periods (Fournier and Vargus Sanders 2002; González Sobrino et al. 2001; Meza Peñaloza 2010; Meza Peñaloza and Serran Sánchez 2009; Morehart et al. 2012), demonstrating that the practice occurred in locations other than urban capitols, which speaks to its ritual importance. Despite these important contributions, no researcher
has compiled complete osteobiographies that incorporate osteological and chemical (diet, immigration status, genetic heritage) data for pre-Aztec sacrificial victims. If these data were generated and compiled, it may be possible to identify new patterns among sacrificed persons that could explain why they were chosen for sacrifice. Furthermore, the identification of these trends may broaden our understanding of the function of sacrifice in Central Mexican society and assist our interpretations of how the practice of sacrifice changed through time (De Lucia 2014).

**Future Directions**

The Classic to Early Postclassic period was a dynamic and eventful epoch in the prehistory of the Central Highlands, with the rise and decline of regionally-important centers, increasing urbanization, and significant population movement. While Mexican bioarchaeology has attempted to explore many of the theoretical issues related to state formation, urbanism, and migration, it has been hampered by methodological challenges, which are experienced by the discipline as a whole. Additionally, with the exception of Teotihuacan and the Basin of Mexico, archaeological attention devoted to the Central Highlands has been comparatively limited. The lack of large, well-preserved, and well-documented skeletal samples, particularly from Classic and Epiclassic contexts in Central Mexico, has limited the inclusion of skeletal material from Highland sites into comparative, diachronic studies of cultural evolution.

Following the theoretical devastation wrought by "Farewell to Paleodemography" (Bocquet-Appel and Masset 1982) and the Osteological Paradox (Wood et al. 1992), bioarchaeology has been forced to reinvent itself by strengthening its methodological and theoretical underpinnings, while exploring new avenues of investigation. Over a decade ago, Spence and White (2009) recognized this shift and produced a survey of bioarchaeology in Mexico, identifying key research areas worthy of significant attention. Within the realm of theory, they called for an increase in studies that address how differential access to resources can generate health effects and how migrations and diasporas influenced the social and political landscape of Mexico. In Highland bioarchaeology, there has been increased interest in many of these research areas in the past ten years, but there is still much work to be done (see Willermet and Cucina 2018; Márquez Morfín and Hernández Espinoza 2019; Serrano Sánchez and Meza Peñaloza 2019). To address the areas of opportunity highlighted by Spence and White (2009), efforts have been made in Mexico to implement new theoretical orientations that more successfully integrate cultural and social data into interpretations of health. Efforts that address methodological challenges in bioarchaeology are currently ongoing (see below and DeWitte and Stojanowski 2015; Milner and Boldsen 2017; Wilson 2014; Wright and Yoder 2003), but researchers have also begun to pursue avenues of investigation that provide us with alternative ways of approaching theoretical questions relevant to
Highland bioarchaeology. Importantly, many of these perspectives do not demand the large, well-preserved collections required by the more traditional biocultural approach. Four current trends in the discipline could greatly advance Highland bioarchaeology: 1) the introduction of archeothanatology to funerary studies and an increasing focus on the taphonomic processes that have shaped the skeletal record; (2) the inclusion of social identity in bioarchaeological studies so that variation in life experiences can be explored, especially with respect to previously marginalized or underrepresented groups; (3) renewed interest in the theoretical underpinnings of ancient mobility and migration; and (4) an increased focus on the societal effects of interpersonal, socially sanctioned, and structural violence in ancient times (see Arnauld et al., in press; Duday 1997; Klaus 2012; Knudson and Stojanowski 2008; Knüsel 2014; Knüsel and Robb 2016; Martin and Frayer 1997; Martin and Harrod 2015; Márquez Morfín 2010; Martin et al. 2012; Pereira 2017; Tiesler 1997; Tiesler et al. 2010). Some of these new orientations are already being incorporated into bioarchaeological studies in the Central Highlands and elsewhere in Mexico, and they have the ability to transform how we approach studies of the Classic to Early Postclassic transition in the region. From the way we excavate skeletons, to the manner we approach studies of demography, health, and life experiences in urban environments, these theoretical perspectives allow us to see Mexican bioarchaeology in a promising new light.

While theoretical innovation is a critical component of bioarchaeological progress, methodological improvement is also of immense importance. In addition to the theoretical shift discussed above, we also advocate for four areas of methodological improvement are that essential for the advancement of Highland bioarchaeology: (1) the creation of isotopic baselines for less frequently studied subregions of Central Mexico; (2) increased AMS radiocarbon dating of burials; (3) unbiased “age-at-death” profiles; and (4) the analysis, especially chemical analysis, of larger samples and complete collections, especially using materials from underrepresented regions of Central Mexico.

Isotopic studies of migration in Mesoamerica have become increasingly common in the last decade, and these analyses rely upon environmental baseline data to distinguish migrants from locals. While efforts have been made to isotopically map large portions of the Maya region (Hodell et al. 2004; Sharpe et al. 2016), work in Central Mexico is far from complete (see Pacheco-Forés et al. 2020; Price et al. 2008 for review). If isotopic studies of migration in Central Mexico are to reach their full potential, an organized and highly-collaborative effort must be made to map the entirety of the region using multiple isotope systems, and to ensure that the full results of the analyses are available to all researchers. Additionally, it is likely that researchers will also need to account for the use of non-local lime in maize processing (Andreasen and Thomsen 2021; Frei et
al. 2020; Thomsen and Andreasen 2019). While a substantial undertaking, similar projects (Cavazzuti et al. 2019; Darling et al. 2003; Evans et al. 2010; Evans et al. 2012; Snoeck et al. 2020) have been successfully completed in other countries, or are underway, and have been of tremendous value to the archaeological, geological, and forensic communities. Similarly, bioarchaeological research in Highland Mexico would also benefit from increased AMS radiocarbon dating of burials. The reasons for this are two-fold. First, as Storey and colleagues (2019b) demonstrated, radiocarbon dating burials can allow researchers to assess change over time accurately and with increased precision. While alternative indicators of chronology can be useful, they are open to interpretive error, especially when researchers are in the early phases of unraveling chronologies in previously understudied areas. Second, consistent AMS radiocarbon dating of burials not only provides an important variable (time) for bioarchaeological analyses, it would also vastly improve archaeological chronologies in regions where direct dating has been limited. Developing accurate chronologies remains an important part of Mesoamerican archaeology, and mistakes within our temporal interpretations can have detrimental long-term effects (see Anderson et al. 2016; Healan 2012 for example).

Third, improved age-at-death profiles for individuals would open new doors in paleodemographic and paleopathological research in Highland Mexico. Death estimates in Mexico are faced with two problems (Bullock et al. 2013). The first issue is a lack of known age at death collections in Mexico that can be used to validate aging methods, though methods developed using an otherwise global sample should be applicable to Central Mexican populations. The second issue is reference sample mimicry within current skeletal aging methods and limitations in the total information that can be derived from cranial sutures, auricular surfaces, and pubic symphyses (see Bocquet-Appel and Masset 1982; Hoppa and Vaupel 2002; Konigsberg and Frankenber 1992). Specifically, Transition Analysis (Boldsen et al. 2012) has been shown to minimize or eliminate the reference mimicry present in traditional aging methods through the application of a Bayesian approach. While Transition Analysis-Version 1 has been in use for over a decade, Transition Analysis-Version 2 is under development (Milner et al. in press). Transition Analysis-Version 2 is also a Bayesian method, but it abandons the exclusive use of the cranium and pelvis as sources of age-related traits and incorporates data from all regions of the skeleton allowing for improved age estimates and more precise age estimates of poorly preserved remains. Finally, the method has been built using a global sample of known age at death skeletal collections, making the approach the most representative method ever created. It is only through improved age at death estimates in Highland bioarchaeology that researchers will be able to truly evaluate how risk factors such as sex, social standing, ethnic identity, migration status, and residential environment influence life
expectancy and health in Highland Mesoamerica.

Finally, pre-colonial Central Mexican bioarchaeology would benefit from research programs that seek to analyze larger samples and complete collections, especially within the realm of chemical approaches. When comparing ancient Mexico with other regions of the globe that have intensive bioarchaeological research programs, some challenges emerge. Skeletal preservation in Central Mexico can be notoriously poor, and excavating and housing skeletal materials in Mexico requires tremendous financial and temporal commitment. Large quantities of skeletal material have been excavated in Central Mexico, and although many collections have undergone osteological analyses, it would be worthwhile to revisit them, as analytical methods have improved over the past decades and new frameworks for assessing trends in ancient health have been developed. Additionally, isotopic and molecular methods of studying skeletal remains have improved dramatically in the past 50 years, as the cost per sample has been reduced significantly, the quantity of material need for analysis has decreased, and lab results have become more reliable. With this framework in mind, it would be fascinating to return to previously excavated collections with new research questions. Such an approach would provide new insights into Central Mexican population dynamics and an increase in the number of skeletons sampled and re-analyzed using current methods would bolster our ability to identify previously overlooked patterns and to assess research questions with greater statistical power.

Overall, improvements in age-at-death profiles, increased radiocarbon dating, and the chemical analysis and osteological re-analysis of excavated collections would facilitate further cross-cultural comparisons of communities in Highland Mexico and societies in other regions of the world. Central Mexico hosted three of the largest urban centers to thrive in the western hemisphere prior to the colonial period. Globally, there has been increased interest in ancient urbanism, population expansions and replacements, and the complex ways in which health and wellbeing intersect with issues such as inequality, life in ancient multicultural communities, and human resilience in times of social, political, and environmental turmoil. All of these topics are areas in which Mesoamerican bioarchaeology has much to offer and can provide important comparative New World examples to Old World case studies, which have received more attention within the literature. It is only through an outward facing view and dedication to collaboration that Central Mexican bioarchaeology will reach its full potential both within Mesoamerica and beyond.
CHAPTER 4: BIOARCHAEOLOGICAL CONSIDERATIONS FOR CERRO MAGONI AND LA MESA

Introduction
This chapter serves as a bridge between the reviews presented in Chapter 2 and Chapter 3 and the new data discussed in Chapter 5 and Chapter 6. Overall, this section addresses three topics. First, sources of bias in archaeological skeletal collections and paleodemographic studies are discussed. This discussion is not exhaustive, but does provide insight into the most common pitfalls associated materials from archaeological sites. Second, the mortuary contexts of the La Mesa and Cerro Magoni burials are described. Only limited information is available from both sites, but the general burial environment is addressed, as are some preliminary interpretations. Finally, the basic demographic characteristics of the La Mesa and Cerro Magoni collections are summarized.

Bias in Human Skeletal Collections
Studying human skeletal remains is fraught with difficulties. The ultimate goal of the endeavor is to reach one or more conclusions that reveal something about the population from which the skeletal collection is derived. Ideally, one would like to assume that the individuals available to bioarchaeologists are representative of a once living population. Unfortunately, this is never an accurate assumption. All skeletal collections have been subject to at least a few forms of selection bias, and in many cases a laundry-list of problems can be identified that degrade claims of representativeness even further. When working with human skeletal remains it is always important to consider how the collection housed on museum shelves came to exist and what sources of bias may influence the materials. Generally, these sources of bias can be divided into four categories, each of which affect skeletal collections in a different way. First, mortuary customs and cultural practices perhaps play one of the most significant roles in determining what skeletons can be recovered during archaeological exploration and what the broad defining characteristics of that collection will be. Second, taphonomic forces impact the preservation of the remains, while excavation techniques and research paradigms guide the recovery of skeletal materials. Third, the curation history of a collection can significantly impact what skeletons are actually available for analysis. Finally, theoretical and methodological paleodemographic challenges place limitations on how data derived from human skeletal remains can be interpreted. The remainder of this section explores each of these issues further.

Cultural Practices and Mortuary Tradition
Cross-culturally, mortuary patterns are highly variable, but every society needs a method (or methods) of disposing of the dead. Variation in these methods creates the first source of bias in archaeological collections. The canon of mortuary tradition used by a community determines where
in a settlement human skeletal remains can be found and the form those remains may take. For example, an individual who died during between 100 BC and AD 100 in ancient Rome was likely to have been cremated (Hope 2009), with the cremains being subsequently collected and interred in a designated cemetery or necropolis. In contrast, an individual of European descent in North America during the 17th century would likely be interred in a cemetery without undergoing any form of significant bodily modification (Lacy 2020). Finally, a non-elite individual living at the Central Mexican center of Teotihuacan was likely to have been placed in a tightly flexed position and buried within the domestic space they inhabited (Clayton 2011). In all three instances, archaeologists will find human remains in a different combination of contexts and forms. In the cases of Rome and colonial North America, remains were consolidated into a designated area, such as a cemetery or necropolis, but in the case of Rome, the cremation process will heavily limit the amount of information that can be gleaned from each individual. In contrast, researchers in the Central Mexican example may find relatively complete skeletons, but recovering the remains will require the excavation of domestic spaces. In this way, the most general attributes of a society’s mortuary tradition can dictate if there is the possibility of recovering human remains in a good state of preservation and if those remains are likely to be found given a researcher’s program of excavation.

Of course, the examples given above are highly simplified. Even within a single community, not every individual is treated the same in death. Some of the most common sources of variation in mortuary behavior within a society can be linked to gender, age-at-death, or social status. For example, sacrificial victims recovered from the Pyramid of the Sun at Teotihuacan were overwhelmingly male (n=96), and females (n=33) were only recovered from three specific deposits (Sugiyama 2005). Beyond the highly ritualized nature of interments from the Pyramid of the Sun, it would be a mistake to assume that the sample was representative of the gender dynamics at Teotihuacan. Similarly, researchers in the Mediterranean have long been forced to grapple with the effects of the differential treatment of individuals under the age of five at time-of-death in Etruscan society. In this instance, infants and young children who had not yet crossed into “personhood” were interred in separate cemeteries (Becker 2007). Again, assuming that either the “adult” or “juvenile” cemeteries were representative of Etruscan population dynamics would be a grave mistake yielding absurd demographic results. Again, returning the Roman example, during the same period in which cremation among Roman pagans was preferred, early Christian and Jewish communities within Rome interred their dead, illustrating how social differentiation, in this case religion, can result of differential burial treatment and preservation. As burials from the Pyramid of the Sun should not be considered representative of Teotihuacan’s gender dynamics, it would also
be incorrect to suggest that early Christian interments could be considered a proxy for all of Roman society, given that early Christians typically of low social status and also adhered to dietary practices that were inconsistent with the larger population (Rutgers et al. 2009). In all of these instances, basic knowledge of the culture and time period from which the skeletons were derived can be used to help mitigate sampling biases and misinterpretation at the society level.

Finally, some cultural processes can also lead to more gradual biases within the burial record. In the Maya region, there is a long-documented tradition of curating the bones of ancestors (Geller 2012; Guernsey and Reilly 2006), which is a process that can pull certain individuals, particularly mature adults from the burial record. Furthermore, over-crowding in community grave spaces can create unique challenges for bioarchaeologists. For example, even in modern Greece limited burial space has led to an intricate system in which individuals are buried for a period of time and are later exhumed so that the bones can be removed from the grave and placed in an ossuary, freeing the valuable grave plot (Blagojević 2013). Similarly, at the Teotihuacan barrio of Tlajinga, Storey (1992) observed that large quantities of human bone could be found in middens. Given the Central Mexican tradition of interring individuals below the floors of domestic spaces, Storey (1992) suggested that when burial spaces were in short supply, the grave space would be cleared and the bones of individuals who were no longer considered significant were added to the midden to create more room for the recently deceased. In the example of ancestor veneration among the Maya, specific types of individuals were more likely to be selected from the deceased population than others, while in the case of Tlajinga, removal of individuals from the burial record was more probably more random. Therefore, there can also be variation in the ways bias systematically (or unsystematically) influences the burial record.

Preservation and Excavation
While the mortuary patterns of a community perhaps play the most important role in determining which individuals have the potential to be recovered, preservation and excavation strategies also heavily influence the skeletal record. As illustrated by the differences between traditions that utilize cemeteries and those that inter individuals in domestic spaces, where archaeologists chose to excavate can heavily influence if skeletal materials are recovered and to whom those remains can be attributed. Additionally, excavation procedures themselves can introduce bias into the skeletal record. At some historic projects, if recovered skeletal remains were curated, only the skull of the individual was maintained as early researchers felt that the cranium must surely be the most informative part of the human skeleton. We now know that a cranium can only tell us so much about an individual, but nothing can be done to recover the lost post-cranial material. Errors in excavation can also have more nuanced, and perhaps more troubling, effects on
the skeletal collections. Particularly problematic is the recovery of remains from infants and young children. Depending upon the deposition environment, the skeletons of the very young can be preserved at different rates than adults. The bones of children are often small, fragile, and more porous than the bones of mature individuals. When preservation environments are less favorable (damp and acidic, for example), children’s skeletons suffer the most damage. Additionally, these bones are also smaller and make a tempting collectable for rodents and other burrowing animals, further deceasing the likelihood of recovering a skeleton intact. Especially in cases of poor preservation there is also no guarantee remains will be recognized as an intentional burial, or even identified as human. This is especially common with infant burials, where the rather odd appearance of the skeleton can lead excavators to mistake the remains as belonging to an animal. If researchers are not experienced in recovering infant burials and if soil is not sifted, there is a high likelihood that small bones and epiphyseal epiphyses will be missed. Together these factors often lead to a conspicuous absence of very young individuals from the burial record.

Regardless of the age-at-death of individuals, poor preservation and/or an unfamiliarity with human skeletons will always wreak havoc on skeletal collections. In cases of poor preservation, excavators may dig completely through a burial without even realizing their mistake. Additionally, without knowledge of human anatomy, excavators may stumble upon a small collection of articulated remains representing a poorly preserved burial and wrongly assume they have uncovered a sample of “miscellaneous” bone. The bones are then unceremoniously scooped up and stored with the rest of the unidentified bone fragments. Thus, another burial is lost from the record. The prevalence of this issue is thoroughly emphasized when bioarchaeologists ask to review the miscellaneous bone or unanalyzed faunal collections from an archaeological site of interest. With shocking regularity, huge quantities of previously unidentified human bone are frequently recovered. These bones may be linked to excavation errors like those described above, the disposal of remains during ancient times as in the case of Tlajinga’s middens, or to forces of taphonomic entropy such as rodent activity or flooding. Regardless of the proximate cause, the ultimate conclusion is that 1) many burials, especially those of the very young, are lost due to poor preservation, 2) a lack of interest in recovering skeletal remains can lead to wholesale losses of information, and 3) limited experience on the part of excavators can further introduce bias into an already dwindling record of the individuals who once inhabited a site. Even after all of these troubles some bioarchaeologists can consider themselves “lucky” enough to find a sizeable skeletal collection to study that has been well managed. In other instances, problematic curation means that troubles have only just begun.
Curation

A well organized and well cared for skeletal collection of considerable size is a rare resource, and the caregivers of these archives are rarely given the credit they deserve. Within curated skeletal collections sources of bias can generally be organized into two categories: 1) continued decay and 2) disorganization. In the case of continued decay, damage to collections can occur gradually or rapidly. In cases of rapid breakdown, cataclysmic events such as a burst pipes or laboratory fires can lead to immediate losses of whole collections. In contrast, slow decay over time is perhaps more insidious and this process frequently exacerbates already existing preservational difficulties. Materials that were already fragile degrade further, especially if they were not cleaned and dried properly. After only a few years, a bag once containing a long bone may only be recognizable by its label, more closely resembling a package of potting soil than part of a skeleton. Additionally, steps once taken to preserve the collection can also present challenges for modern analyses. For example, glue and lacquer haunt the dreams of every bioarchaeologist interested in bone chemistry.

Finally, disorganization perhaps leads to one of the most frustrating avenues for data loss in archaeological skeletal collections. Depending upon the thoroughness of the excavating archaeologists, skeletal remains may or may not be well documented. Even in stances when collections are recorded appropriately, there is no guarantee that the information will be deposited somewhere that allows others to access it. Some collections are immediately transferred to archives where they can be well managed and cared for, while others are abandoned at holding faculties, slowly succumbing to time and entropy. In the worst cases, interested researchers may have heard rumors of a collection existing, but have no way of knowing where the materials were last stored. Even when the location of collections is known, their organization can decline over time, which is especially problematic when the materials were already under documented. Finally, as collections more from facility to facility, portions of a collection can be lost or left-behind, further limiting what materials can be accessed by researchers. Based on the issues created by mortuary customs and cultural practices, differential preservation, excavator error, and curation difficulties it would be ludicrous to argue that any archaeological collection actually represents a once living population. With this said, some collections are likely to be more biased than others, but all skeletal materials are subject to several methodological and theoretical paleodemographic challenges.
Paleodemographic Challenges

**Age-at-Death Profiles**

As discussed briefly in Chapter 3, biased age-at-death profiles have been a thorn in the side of bioarchaeologists and paleodemographers for decades. Estimating the age of juvenile individuals is a relatively reliable process, especially when dental development is still underway. In contrast, working with adult individuals remains a more complicated endeavor, with age estimates being the worst among older persons (Milner et al. 2019, but see Boldsen et al. 2012). Because of this challenge, common age-at-death estimation methods like Todd (1920, 1921), Meindl et al. (1985), Brooks and Suchey (1990), McKern and Stewart (1957) and Lovejoy (1985) have been equipped with open ended final age-at-death categories that simply classify older individuals as being over 40 or 50 years old. While this classification may be technically correct, it leads to a tremendous loss of information and makes diligently studying life-expectancy and health among older individuals impossible. Additionally, many researchers seem to forget that these final age categories represent individuals who live beyond 40 or 50 years, not individuals who immediately died upon reaching their fourth or fifth decade. This misunderstanding, paired with the likelihood that a traditional age-at-death method will underestimate an adult’s age, has led to the pernicious assumption that everyone in the past died before reaching 40 or 50 years. Additionally, traditional age-at-death methods like those listed above are designed to group individuals into fairly broad age-at-death categories, even when assessing younger individuals. This leads to a situation in which little actionable demographic information can be derived (Milner et al. 2019).

Overall, these issues stem from two primary problems: sample mimicry and limitations of bony changes associated with the human cranium, auricular surfaces, and pubic symphyses. First, the samples used to develop popular age-at-death methods were biased. For example, the Hamann-Todd and Terry collections are composed of individuals of low socioeconomic status whose remains were sent to medical schools as dissection cadavers in the mid-1900s (Hunt and Albanese 2005; St. Hoyme and Iscan 1989). Other collections show a strong age and/or sex bias. The Korean War soldiers used by McKern and Stewart (1957) consisted almost entirely of young men. This age bias is perhaps the most problematic issue associated with aging methods, creating an effect commonly referred to as sample mimicry (Bocquet-Appel and Masset 1982; Konigsberg and Frankenberg 1992, 1994, 2002; Vaupel and Hoppa 2002). Sample mimicry does not imply that an age-at-death profile that exactly matches the reference sample will created when an estimation method is applied to a new collection, but that the resulting data will be biased towards the structure of the reference collection (Milner et al. 2019). Obviously, aging methods rely on bony changes to estimate age-at-death. When a trait is used as an indicator of age, its distribution in the reference sample is observed and tabulated. If the reference sample is biased, like the Korean War collection,
then the prevalence of various traits and their age associations will reflect the structure of the reference. Furthermore, it is impossible to use a biased reference collection to develop a method that can reliably detect individuals who were never part of the reference material. This leads to a situation where age estimates are pulled towards the structure of the reference materials and traits unique to older ages are not included in the final method. Finally, it is important to note that age characteristics are most commonly drawn from a limited set of skeletal regions, namely the suture closures of the cranium, the auricular surfaces, and the pubic symphyses. These areas have been systematically studied for a century now and researchers are arriving at the conclusion that there are limitations to the amount of information that can be derived from these regions (Milner et al. 2019). This means that researchers must look for new skeletal traits that can be used to address age-at-death, especially in older individuals. Of course, these traits must develop at a consistent rate over the life course (invariance) and occur in unidirectional manner (monotonicity). Naturally, estimating age-at-death in an accurate and precise manner is a critical part of studying life-expectancy and differences in risk of death and traditional approaches leave much to be desired. Fortunately, there are new approaches that seek to remedy, or at least improve, problems with age-at-death estimation.

As discussed in Chapter 3, one method that attempts to address the issues described above is Transition Analysis (Boldsen et al. 2012). At its most basic, Transition Analysis derives a transition function from logit or probit functions based on data from a known age-at-death sample. When paired with a Bayesian framework and associated estimated prior distribution, this function can then be used to calculate the probability that an individual has reached or surpassed a particular age. This prior distribution can be generated from a uniform distribution, historical data, or from a distribution created by a parametric mortality model. Transition Analysis is also engineered to account for potential non-independence among skeletal traits to minimize the likelihood of artificial minimization of standard errors in age estimates (Milner et al. 2019). Finally, as Transition Analysis continues to undergo further development, the sample used to generate the method has increased in size and continues to become more globally representative. Therefore, the currently available iteration of Transition Analysis, and the versions still in development, are the most likely of the currently available approaches to provide precise and unbiased estimates of age-at-death.

**Heterogenous Frailty and Selective Mortality**

Problems in age-at-death estimation are further compounded by issues of heterogenous frailty and selective mortality. These issues were highlighted by the Osteological Paradox (Wood et al. 1992) and continue to plague bioarchaeological research. The concept of heterogenous frailty draws attention to the fact that not everyone of a specific age in a population has an equal risk of
dying at that age. A variety of factors, some biologically pre-determined (i.e. carrying a BRCA gene that creates a predisposition to breast cancer) and others environmental (i.e. experiencing famine in early childhood), are combined throughout life to create variation in risk among individuals. The handmaiden of this effect is selective mortality. As a concept, selective mortality dictates that individuals who are at the greatest risk of dying at a specific age are usually the individuals who die at that age. This means that every skeletal collection is biased, no matter how complete it may appear. Skeletal collections can only provide one with a picture of the frailest individuals, those at the highest risk of dying, at each age category. For each person who died at 30 years, there is an unknown number of individuals from that population who potentially lived decades longer because they were at a lower risk of dying. Therefore, using a skeletal collection to estimate the “health” of an ancient population is a fraught endeavor. This issue is only complicated by another tenant of the Osteological paradox, which proposes that the relationship between the number of lesions a population has and the population’s health status is potentially counterintuitive. For decades researchers assumed that more lesions are synonymous with poorer health and higher frailty. Wood and colleagues (1992) instead proposed that in some cases lesions may actually be indicators of lesser frailty. This is because skeletal manifestations of illness develop over time. Even if a person died with active lesions, the fact that they survived long enough for the lesions to appear could indicate lower levels of frailty. Similarly, individuals who died without lesions could have been afflicted with the same ailment as the individual with lesions, but died quickly. This discussion becomes especially important when considering healed lesions, as lower overall frailty could have led to the healing process (as opposed to death). Alternatively, it is also possible that an individual survived the event that left them with the healed lesions, but experienced a higher risk of early death due to the event later in life (Boldsen et al. 2015). In the absence of accurate age-at-death estimates, heterogenous frailty leaves bioarchaeologists stuck in quite a quagmire. With this said, there are ways of addressing heterogenous frailty and even of viewing its effect as an important source of information (see below).

**Demographic Non-Stationarity**

If one has access to high quality age-at-death date, it is possible to mathematically assess if lesions or injuries are correlated with an increased risk of death. Calculating the crude risk of death (number of individuals in sample/life years included in sample) is the simplest way to proceed, but it is usually a methodologically unsound choice when historic or archaeological skeletal collections are involved, as the approach requires that researchers accurately define the study population and that population’s age structure (Milner and Boldsen 2017; Waldron 2007). Comparisons of crude risk are very sensitive to differences in population age structures, and false
variation in risk of death may be uncovered if populations have different age structures. In extreme cases, one population (Population A) may have a lower crude death rate than another population (Population B), but higher age-specific mortality. This may seem odd, but if Population A was composed of young individuals, then this discrepancy can occur mathematically. Therefore, crude risk is only helpful when all populations being studied resemble one another in age structure (Olsen et al. 2010). Similarly, crude risk can only be used in archaeological cases when a large sample exists and it can be assumed that the age composition of the population did not significantly change over time. If these criteria are met, it is possible that the skeletal collection reflects the actual age-at-death structure of the once living community. If a population is neither growing or shrinking and rates of birth and death remain constant, a population is considered stationary, and crude death rates may be of some use. It is also worth noting that life tables, which are still frequently applied in some paleodemographic circles, also assume that the population under analysis is stationary. While life tables and other forms of age-specific death rates provide more information than simple crude death rates, they are not without problems. First, they require large samples, which are frequently unavailable to bioarchaeologists. Second, the assumption of stationarity is problematic. In societies without written records, there are no methods currently available that can be used to directly calculate birth rates without issues of equifinality arising. Similarly, we now know that individuals and families frequently migrated in ancient times, but systematically assessing these movements is an expensive and time-consuming endeavor. Additionally, some demographic changes (like changing fertility rates) have a greater impact on the structure of a population than others (like death or migration rates) (Horowitz et al. 1988; Konigsberg and Frankenberg 1994; Stattenspiel and Harpending 1983). Therefore, stationarity is a difficult assumption to test. Finally, these age-specific methods of estimating risk of death usually fail to handle morbidity or comorbidity in a satisfactory manner.

As mentioned above in the section discussing heterogenous frailty, there are ways of addressing these issues, but they are completely reliant of high-quality age-at-death data. Specifically, survival analyses of age-specific mortality are a promising alternative (DeWitte 2014; Milner and Boldsen 2017; Milner et al. 2019), as they make fewer assumptions about the population undergoing study. Common and effective options include the Siler model, Kaplan-Meier survival analysis, and the Cox regression analysis. The Siler-model (Siler 1979, 1983) is a parametric model that calculates an individual’s risk of dying based on competing causes such as juvenile mortality, senescent (old-age) mortality, and age independent mortality. While parametric models, like the Siler model, do capture most human mortality distributions, they are less flexible than non-parametric or semi-parametric models. This may seem to be a draw-back, but this constraint can
actually be quite helpful when working with small sample sizes. With this said, researchers must ensure that their data actually fits the structure of the parametric models, but parametric models have the added benefit of being able to accommodate covariates. Non-parametric models, like a Kaplan-Meier survival analysis, are very flexible and do not assume that the data is parametric, but they are not without their shortcomings. First, it is difficult to add covariates directly into these non-parametric models. Usually, researchers assess covariates by fitting subpopulations to different models and comparing the results, but as the number of traits being included increases, this approach can become untenable. Additionally, when samples are small, non-parametric models do not generate smooth survival functions, which obviously fail to capture how risk actually functions in a population. Finally, semi-parametric approaches, like the Cox regression, combine the flexibility of the non-parametric approach with the ability to more easily address covariates. With this said, semi-parametric methods still do not generate smooth survival functions. Additionally, for semi-parametric conclusions to be accurate there must be a linear relationship between the covariates and the hazard and the proportional hazard assumption must be met. Because of their ability to incorporate covariates, semi-parametric and non-parametric methods can be used to compare how the presence of pathological lesions affects mortality distributions or how relative risk is affected by experiencing prior trauma. Overall, this approach allows researchers to more directly engage with issues like selective mortality and heterogeneous frailty and opens new avenues for research. Though heterogenous frailty, selective mortality, demographic non-stationarity, and risk are not explored in this dissertation it is good to note that they are important parts of the paleodemographic enterprise and should not be hastily swept under the proverbial rug.

**Sources of Bias among the Cerro Magoni and La Mesa Collections**

Because the new data presented in this dissertation primarily focuses on radiocarbon dating and paleodiet reconstruction, the sources of bias most likely to influence the results of this work are linked with cultural burial practices, excavation, preservation, and curation. For the purposes of this dissertation, samples from 12 individuals from Cerro Magoni and 52 individuals from La Mesa were exported for analysis. During sample collection in Mexico, 24 individuals from Cerro Magoni and 56 individuals from La Mesa were observed. The 24 individuals from Cerro Magoni are known to represent the complete excavated burial collection, but it is likely that a portion of the La Mesa collection is missing. The discrepancy between the number of individuals identified in the field and the number of samples exported is linked to two factors. First, very young individuals were not sampled. It is rare for the very young to be preserved in archaeological contexts in Mexico and sampling for radiocarbon dating was deemed too destructive. Second, approximately half of the samples from Cerro Magoni experienced exportation difficulties.
Though discussed in more detail below, from a cultural perspective it appears unlikely that the Cerro Magoni and La Mesa collections were systematically biased by mortuary practices. Individuals were primarily interred in domestic spaces at both sites. From the preliminary age-at-death distribution discussed below, it is apparent that no age category was intentionally excluded from the burial spaces at either site. As mentioned above, infants and very young children are the most likely to be systematically interred in areas separate from the rest of the population, but the presence of infants and children in the collections suggests that this was not the case at Cerro Magoni and La Mesa. With this said, one should not assume that the number of infants and children in the collections is representative of the age-at-death profile of the settlements. Given the lengthy occupation of the sites (see Chapter 5) and the small collection sizes it would be irresponsible to assume that a reliable mortality structure could be inferred from the samples. Though there was no systematic bias generated by mortuary traditions at the sites, there is some evidence of post-mortem manipulation of human remains and it appears to only be associated with adult individuals. For example, a bundle burial and a burial consisting of a cranium, articulated first vertebra, and articulated hands and feet were uncovered at Cerro Magoni. This suggests that not all individuals were simply interred at the sites and left undisturbed. Additionally, almost fifty percent of isolated bone recovered at Cerro Magoni was human. This ratio does not include any midden deposits, as none were ever found. Taken broadly, this suggests that bodies were being moved and/or manipulated at the site, but there are no discernable patterns to this process.

Regarding preservation, for Central Mexico and broader Mesoamerica, the burials from both sites are relatively well preserved. The positioning of the burials on porous bedrock likely aided preservation, and in many cases a high percentage of the original bone surface is still maintained, though some skeletons have suffered significant damage. In more moderate cases of damage, porous surfaces like the epiphyses of long bones, the pubic symphyses, and auricular surfaces are most commonly affected. The limited records from La Mesa make it difficult to comment on the excavation practices at the site. At Cerro Magoni, if a burial was recognized in the field, it was carefully collected, though no record of these excavations has been published. With this said, bioarchaeologists were not at the excavation site daily, so it is possibly that heavily disturbed burials or burials in very poor condition were not consistently recognized. It is also possible that some of the recovered isolated human bone from the site is the result of this process. Finally, the curation history of both collections has also affected the sample presented here. As mentioned above, the complete collection from Cerro Magoni (n=24) was evaluated during the course of this project, but only half of the selected samples were permitted to leave Mexico for analysis. While all available skeletons from La Mesa were observed and samples were successfully
exported, conversations with excavators have led to the conclusion that up to thirty to fifty percent of the collection could be missing. As discussed above, this has likely biased the data in this dissertation towards burials recovered from a small subset of buildings, but without knowing more about both the activity spaces at La Mesa and the potentially missing materials, it is impossible to determine how this might influence the collection. With this said, the radiocarbon and diet data presented in this dissertation appears quite internally consistent and there are no overt signs that the record has been severely biased. The remainder of this chapter provides a brief overview of the burial contexts of the La Mesa and Cerro Magoni collections, as they are currently understood and provides some basic demographic details of the burials.

The Cerro Magoni and La Mesa Collections

Mortuary Context

The burial contexts for Cerro Magoni and La Mesa have never been fully published. From La Mesa some limited information can be wrung from the available literature and comes from three sources. A book chapter by Bonfil Olivera (2005) provides a discussion of some activity areas at La Mesa, which subsequently contains a small amount of information about the burials recovered from the site. Additionally, an osteologically descriptive master’s thesis was completed by González Sánchez in 2017 and this document also includes some additional facts derived from Bonfil Olivera’s licenciatura thesis (bachelor’s thesis) from 1998. When comparing information in this dissertation to González Sánchez (2017) it is important to note that three burials studied by González Sánchez are not included in this dissertation and 16 burials included in this dissertation were not recorded by González Sánchez (2017). Despite this discrepancy, 42 of the La Mesa burials can be linked to an excavated building. These burials were recovered from three large excavation units (unidads) and six structures. This information is summarized in Tables 3 and 4, and it is important to note that three different structures are labeled “Estructura Circular #1”, but that they can be differentiated by their excavation unit number.

<table>
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<tr>
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<th>Note</th>
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</tr>
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</tr>
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<td>Estructura Circular #1</td>
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<td>La Mesa Burial 13</td>
<td>Unidad 99</td>
<td>Estructura Circular #1</td>
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Table 3. Burial contexts for La Mesa.
<table>
<thead>
<tr>
<th>Burial Excavation Unit and Structure</th>
<th>Number of Burials</th>
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<td>Unidad 31 Estructura Circular #1</td>
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<tr>
<td>Unidad 31 Platforma Rectangular #12</td>
<td>8</td>
</tr>
<tr>
<td>Unidad 33 Estructura Circular #1</td>
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</tr>
<tr>
<td>Unidad 99 Estructura Circular #1 (outside)</td>
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</tr>
<tr>
<td>Unidad 99 Estructura Circular X</td>
<td>4</td>
</tr>
<tr>
<td>Unidad 99 Estructura Circular Y</td>
<td>5</td>
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<tr>
<td>Looter’s Pits</td>
<td>3</td>
</tr>
<tr>
<td>Unknown</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 4. Number of burials per context at La Mesa.

According to Bonfil Olivera (Bonfil Olivera 1998 as cited by González Sánchez (2017); Bonfil Olivera 2005), all of the structures reported here were excavated in the western portion of the site and it has been suggested that this was the most residential area of the settlement. While Bonfil Olivera (1998, 2005) does make some suggestions as to the purpose of the circular structures at La Mesa, it seems that their function is not completely understood. It is also likely that different buildings were used for different things and that activity patterns may have changed over time. In sum, Bonfil Olivera (1998, 2005) suggests that the circular structures may have been used as storage spaces, areas for the manufacturing of household goods or processing maguey, kitchens, ritual spaces, and in later years middens. Bonfil Olivera does note that the majority of burials from La Mesa were recovered from these circular structures, and proposes that they may have served some specialized funerary function, but Mastache and Cobean (2002) note that households at La Mesa may have consisted of a rectangular structure and a few circular structures. Given that rectangular and circular structures were probably both integrated into a single household complex, it is perhaps more accurate to suggest that individuals at La Mesa were interred in domestic contexts, but that circular outbuildings were the preferred place of burial within these domestic units. Unidad 31 Platforma Rectangular #12 is the only rectangular structure reported here that contained burials, and Bonfil Olivera’s (1998, 2005) interpretations of this platform have changed over time. Initially it was suggested that the building was associated with ritual activity, but more recent interpretations propose it was a space where maguey fiber was processed. Even in 2005, Bonfil Olivera still suggested that the individuals who used this building were deeply important to the society of La Mesa and may have exerted some kind of ideological or economic authority, though this is a claim that should be explored fully before it is considered fact. Similarly, Bonfil
(1989) has also suggested that the individuals interred in Unidad 99 Estructura Circular #1 were potentially of higher status, but this should also be evaluated critically in the future.

Finally, 75 potential grave goods were recovered from the La Mesa burials, though many are quite humble in nature (bone fragments, ceramic sherds and vessels, groundstone tools, etc.). Additionally, not all individuals were interred with offerings and most other individuals received only one to three items. Sixteen of the burials discussed by González Sánchez (2017) did not have any grave goods, and the remaining individuals were interred with one to eight items. Furthermore, there do not appear to be any patterns in grave good allocation related to an individual’s sex, age-at-death, or burial location. For example, burials with larger numbers of grave goods are distributed throughout the excavated structures and both males and females can be found with four or more objects. Furthermore, even some juveniles were also buried with three to four offerings. Though Bonfil Olivera (1998, 2005) does propose that some of the individuals in the collection were higher status than others, it does not appear that these differences, if they existed at all, were based on age or sex. Additionally, there does not appear to be strong evidence that one structure was clearly higher status than the others.

While burial records from La Mesa are somewhat limited, results for Cerro Magoni are even more preliminary. No published records or reports have ever been completed for the full Cerro Magoni collection and many of the results discussed below are the direct result of personal familiarity with the Cerro Magoni project. As mentioned above, 24 individuals were recovered from what are hypothesized to be domestic spaces near at the summit of the site. None of these burials can be linked to individual buildings, but there is a record of each burial’s associated excavation unit. This information is summarized in Tables 5 and 6. Furthermore, there is no substantial evidence suggesting that there were overt status differences between the individuals.

<table>
<thead>
<tr>
<th>Burial Number</th>
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<td>Burial 1</td>
<td>U108C1740</td>
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<tr>
<td>Burial 2</td>
<td>U108C1740</td>
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<tr>
<td>Burial 3</td>
<td>U108C1740</td>
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<td>U108C1740</td>
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<td>Burial 7</td>
<td>U092C1778</td>
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<td>U092LC001</td>
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<td>Burial 9</td>
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<tr>
<td>Burial 10</td>
<td>U092LC001</td>
</tr>
</tbody>
</table>
Eighteen of the burials from Cerro Magoni were considered primary interments, meaning that the bodies were recovered in anatomical position and did not appear to have been disturbed after initial burial. Among the primary burials, almost all individuals were placed on their side in a tightly flexed position, though one adult individual was found lying on their back (dorsal) in a flexed position and an infant was found lying face down (ventral). In both cases, it is likely that the decomposition process caused the bodies to shift in situ. No patterns were observed in the orientation of the cranium among the primary interments, though this is not surprising given the potential for the skull to shift during decay. Additionally, three individuals (Cerro Magoni Burials 6, 7, and 18) were classified as secondary interments, which indicates that the bodies of the individuals were manipulated at least once after death and/or bodily elements were curated. Burial 6 is represented by the isolated cranium of a young adult woman, which was found lying among the other burials in U108C1740. Burial 7 is likely a bundle burial and it is the only example of this phenomenon.
recovered from Cerro Magoni. In the case of Burial 7, several long bones, ribs, and articulated vertebra were found neatly stacked with an obsidian projectile point balanced on the top of the burial, and no cutmarks were identified on the remains. Finally, Burial 18 contained the cranium, articulated first vertebra, and articulated hands and feet of an adolescent male. In this instance, the cranium was placed centrally with the feet placed on either side of the skull and the hands stacked on top of the feet. Again, no cut marks were identified on the elements, suggesting that the body was repositioned after decomposition began, but before it was complete. Finally, two burials were deemed too disturbed for any determination of primary versus secondary interment to be made.

As with La Mesa, grave goods from Cerro Magoni were relatively modest, and offerings were only observed in eight instances. In seven of these cases, burial items could be linked to specific individuals, but in the final case the overlapping contexts of Burials 20, 21, 22, and 24 made assigning the grave goods to a single individual impossible. Overall, there are fewer burial goods from Cerro Magoni than La Mesa, but this discrepancy may be related to differences in how grave goods were classified at each excavation, as opposed to actual cultural variation. At La Mesa small items like bone fragments and pottery sherds were considered offerings, while determinations at Cerro Magoni preference larger items like completed ceramic vessels. Unless very intentionally placed, items like ceramic sherds or single animal bones are unlikely to have been cataloged as grave goods at Cerro Magoni. With this said, burial goods at Cerro Magoni are typically utilitarian in nature and include items like obsidian projectile points, ceramic vessels, and groundstone tools. One exception to this pattern is a perforated conch shell associated with Burial 1, which is obviously an import from a coastal region (Figure 10). This item may suggest that this individual was of importance in the Cerro Magoni community, though it does not appear that they received any other specialized burial treatment.

Figure 10. Perforated shell from Burial 1.
Basic Demographic Information

In this final section, basic sex and age-at-death estimations are presented for both collections. When possible, Transition Analysis was used to estimate age-at-death for adult individuals. If neither the auricular surfaces or the pubic symphyses were present, the individual was simply categorized as an adult. For individuals too young for Transition Analysis to assess, age-at-death was estimated through dental eruption patterns (Al Qahtani et al. 2010). Unfortunately, an absence of dentition from juvenile individuals frequently coincided with overall poor preservation, which made estimating exact age challenging. Due to temporal limitations in the field, these individuals were simply classified as infants, subadults under six years old, and subadults over six years old. Though somewhat arbitrary, these cutoffs correspond to methodological needs and permitting requirements. Samples were not taken from individuals under one year of age and individuals under six years of age were excluded from the paleodiet study due to concerns over lingering isotopic weaning signatures. At La Mesa, to estimate if a juvenile individual without dentition was over or under six years old, the skeletal remains were compared to other individuals in the collection for whom dentition was available. At Cerro Magoni, one instance arose when estimating age-at-death for juvenile remains was not completed. Burial 20 and Burial 24, were uncovered in the same grave space and are in a poor state of preservation. It is clear that both burials correspond to juvenile individuals, but these remains were uncovered in the final days of the field season, so they were not fully analyzed with the expectation that the opportunity to return to them would occur the following year. This availability never materialized and it is unclear how many individuals are represented (between 2 and 3) by the remains and to what ages they correspond. With this said, it is clear that at least one infant and one older child are present. Samples from Burial 20 and Burial 24 were never exported and uncertainty concerning their composition has not influenced the results presented in Chapter 5 and Chapter 6. Finally, sex was estimated through an assessment of pelvic and cranial morphology (Buikstra and Ubelaker 1994). When available, the pelvis was preferred over the cranium. Sex estimation was not attempted for individuals who had not yet undergone puberty.

Age-at-death and sex estimates for Cerro Magoni and La Mesa are presented in Tables 7 and 8. For most adult individuals, all available Transition Analysis scores were used to calculate their age at death, but in three instances (La Mesa Burials 2, 5, and 8 bis) only the scores from the auricular surfaces and pubic symphyses were incorporated. In all of these cases, the cranial scores were highly divergent from the pelvic scores, with the cranial scores suggesting that the individuals were much younger. In some cases, this difference was so significant that it resulted in a poor agreement in the Transition Analysis model. The decision to exclude the cranial scores for these
individuals was based on two assessments. First, bioarchaeology has long been aware that cranial sutures can only provide limited information regardless of how they are assessed and that they typically only provide meaningful information during the first few decades of life (Lynnerup and Jacobsen 2003; Milner 2010; Milner and Boldsen 2012; Perizonius 1984). The pelvic scores for the individuals in question all suggest that they were older. Therefore, it is unlikely that the cranial scores contribute new information to the assessment of age. Finally, though no cranial warping or damage was noted at time of analysis, it is possible that taphonomic forces led to subtle changes in the crania. At Cerro Magoni, it was observed that burials were frequently deposited in shallow contexts. This meant that during excavation, researchers potentially spent days or weeks walking across the shallow burials before they were discovered. While working with the Cerro Magoni collection, it was observed that many skulls became warped, cracked, or began to take on a disc-like appearance. It is possible that a similar process may have caused some suture closures at La Mesa to appear more open than they were in actuality. Of course, in the future La Mesa Burials 2, 5, and 8 Bis should be reviewed to ensure that the conclusions presented here are accurate. Finally, Transition Analysis suggests that Burial 11 from Cerro Magoni was around 30 years old at time of death, with the auricular surface and crania supporting a younger age and the pubic symphysis suggesting an older age of around 40 years. Some potentially abnormal changes were observed on the left auricular surface and given lipping observed around the joint surfaces and overall dental wear, it is possible that Burial 11 is actually older than the estimate given by Transition Analysis.

As discussed above, the age-at-death data presented here should not be used to estimate the mortality patterns of either the La Mesa or the Cerro Magoni communities, but two important conclusions can be drawn from the data. First, no age group or sex is excluded from either site. Infants, children, and adults are present in both collections. Additionally, males and females are represented in roughly equal numbers as well. Second, the age-at-death estimated derived from Transition Analysis demonstrate that individuals over the age of 50 years are present in both communities, a conclusion that contradicts the popular narrative individuals in ancient communities almost always died before reaching their fifth decade.
<table>
<thead>
<tr>
<th>Burial Number</th>
<th>Sex</th>
<th>Age Estimate/Maximum Likelihood</th>
<th>Lower 95% Confidence Interval</th>
<th>Upper 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burial 1</td>
<td>M</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 2</td>
<td>I</td>
<td>9.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 3</td>
<td>M</td>
<td>17.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 4</td>
<td>M</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 5</td>
<td>F</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 6</td>
<td>F</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 7</td>
<td>I</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>F</td>
<td>29.4 ± 1 year</td>
<td>15.7</td>
<td>53.7</td>
</tr>
<tr>
<td>Burial 9</td>
<td>M</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 10</td>
<td>F</td>
<td>66.6 ± 1 year</td>
<td>40.3</td>
<td>85.6</td>
</tr>
<tr>
<td>Burial 11</td>
<td>F</td>
<td>31.3 ± 1 year</td>
<td>23.9</td>
<td>42.9</td>
</tr>
<tr>
<td>Burial 12</td>
<td>I</td>
<td>Birth ± 1 month</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 13</td>
<td>I</td>
<td>10 months ± 3 months</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 14</td>
<td>F</td>
<td>62.3 ± 1 year</td>
<td>29.4</td>
<td>86.8</td>
</tr>
<tr>
<td>Burial 15</td>
<td>F</td>
<td>39 ± 1 year</td>
<td>18.6</td>
<td>78.5</td>
</tr>
<tr>
<td>Burial 16</td>
<td>F</td>
<td>32.3 ± 1 year</td>
<td>18.6</td>
<td>55.4</td>
</tr>
<tr>
<td>Burial 17</td>
<td>M</td>
<td>18 ± 1.5 years</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Burial 18</td>
<td>I</td>
<td>1.5 months ± 2 months</td>
<td>-</td>
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<tr>
<td>Burial 19</td>
<td>I</td>
<td>11.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 20</td>
<td>I</td>
<td>Commingled subadults</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 21</td>
<td>F</td>
<td>69.9 ± 1 year</td>
<td>39.2</td>
<td>87.7</td>
</tr>
<tr>
<td>Burial 22</td>
<td>M</td>
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<td>27.6</td>
<td>58.9</td>
</tr>
<tr>
<td>Burial 23</td>
<td>F</td>
<td>29 ± 1 year</td>
<td>22.3</td>
<td>39.3</td>
</tr>
<tr>
<td>Burial 24</td>
<td>I</td>
<td>Subadult</td>
<td>-</td>
<td>-</td>
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Table 7. Age-at-death estimates for Cerro Magoni.
<table>
<thead>
<tr>
<th>Burial Number</th>
<th>Sex</th>
<th>Age Estimate/Maximum Likelihood</th>
<th>Lower 95% Confidence Interval</th>
<th>Upper 95% Confidence Interval</th>
</tr>
</thead>
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<td>F</td>
<td>23.3</td>
<td>23.3</td>
<td>45.1</td>
</tr>
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<td>Burial 2</td>
<td>F</td>
<td>71.8</td>
<td>45.8</td>
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<td>Burial 2 Bis</td>
<td>M</td>
<td>36.9</td>
<td>27.9</td>
<td>51.6</td>
</tr>
<tr>
<td>Burial 3</td>
<td>I</td>
<td>6.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 3 Bis</td>
<td>M</td>
<td>40</td>
<td>26.9</td>
<td>78.9</td>
</tr>
<tr>
<td>Burial 4</td>
<td>F</td>
<td>30.5</td>
<td>24.3</td>
<td>40</td>
</tr>
<tr>
<td>Burial 4 Bis</td>
<td>M</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 5</td>
<td>M</td>
<td>65.3</td>
<td>37.6</td>
<td>85.7</td>
</tr>
<tr>
<td>Burial 5 Bis</td>
<td>F</td>
<td>36.3</td>
<td>27.3</td>
<td>50.4</td>
</tr>
<tr>
<td>Burial 6</td>
<td>M</td>
<td>30.5</td>
<td>20.5</td>
<td>43.5</td>
</tr>
<tr>
<td>Burial 6A</td>
<td>F</td>
<td>33.3</td>
<td>18.3</td>
<td>56.9</td>
</tr>
<tr>
<td>Burial 6B</td>
<td>I</td>
<td>over 6 years</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 6 Bis</td>
<td>F</td>
<td>29.9</td>
<td>23</td>
<td>40</td>
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<tr>
<td>Burial 7</td>
<td>I</td>
<td>8.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 7 Bis</td>
<td>I</td>
<td>10.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 8</td>
<td>M</td>
<td>18 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 8 Bis</td>
<td>F</td>
<td>64.1</td>
<td>36</td>
<td>85</td>
</tr>
<tr>
<td>Burial 9</td>
<td>M</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 9 Bis</td>
<td>F</td>
<td>25.4</td>
<td>20.9</td>
<td>31.3</td>
</tr>
<tr>
<td>Burial 10</td>
<td>M</td>
<td>19.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 10 Bis</td>
<td>F</td>
<td>30.4</td>
<td>15.5</td>
<td>55.7</td>
</tr>
<tr>
<td>Burial 11</td>
<td>M</td>
<td>32.8</td>
<td>25.3</td>
<td>44.7</td>
</tr>
<tr>
<td>Burial 11A</td>
<td>F</td>
<td>15</td>
<td>15</td>
<td>28.3</td>
</tr>
<tr>
<td>Burial 11 Associado 1</td>
<td>I</td>
<td>5.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 12</td>
<td>I</td>
<td>8.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 12 Bis</td>
<td>M</td>
<td>55.4</td>
<td>33.5</td>
<td>81.3</td>
</tr>
<tr>
<td>Burial 13</td>
<td>M</td>
<td>Adult</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 13 Bis</td>
<td>I</td>
<td>under 6 years</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 14</td>
<td>I</td>
<td>5.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 14 Bis</td>
<td>I</td>
<td>5.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 15</td>
<td>M</td>
<td>16.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 15 Bis</td>
<td>F</td>
<td>12.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 16</td>
<td>M</td>
<td>30.2</td>
<td>24.5</td>
<td>37.8</td>
</tr>
<tr>
<td>Burial 16 Bis</td>
<td>I</td>
<td>5.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Burial 17</td>
<td>I</td>
<td>1.5 ± 1 year</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 8. Age-at-Death Estimates for La Mesa.

### Conclusion

This chapter has highlighted the sources of bias common to bioarchaeological collections and discussed how some of these processes may have affected the La Mesa and Cerro Magoni collections. Overall, the La Mesa and Cerro Magoni collections were likely influenced by common problems such as differential preservation and the potential under representation of infants. The prevalence of isolated bone and secondary burials at Cerro Magoni also demonstrates that some bodies were manipulated and moved after the individual had died and decomposition has at least begun. Finally, curation and exportation difficulties have limited the number of burials included in this dissertation. In addition to simply limiting sample size, this also means that some excavated areas of Cerro Magoni and La Mesa are probably more heavily represented than others. Without knowing more about both sites, it is difficult to assess the effect of this discrepancy. With this said, there are no signs that individuals were excluded from the burial environments because of their demographic characteristics, as males and females and the young and old are present in both
collections. Though Bonfil Olivera (1998, 2005) suggests that there may be some status differences among the individuals from La Mesa, this appears to be a rather preliminary conclusion that should be more fully evaluated in the future. Though the samples from both La Mesa and Cerro Magoni are limited, the data radiocarbon and diet data presented in the following chapters is internally consistent, suggesting that, despite the challenges laid out above, something meaningful can be learned from the La Mesa and Cerro Magoni collections.
CHAPTER 5: RADIOCARBON CHRONOLOGY AND THE TULA VALLEY OF MEXICO

Introduction

Tula Grande, located in the modern state of Hidalgo, was the heart of Central Mexico’s second expansionist state and the region’s third largest pre-Columbian urban center. Despite its importance for Highland prehistory, the site and surrounding valley have not been as intensively studied, when compared to other centers like Teotihuacan and Tenochtitlan. Even though research in the area began as early as the 1940s, progress has been relatively slow, especially with respect to both relative and absolute chronology development. The current ceramic chronology for Tula Grande was proposed in 1978 by Robert Cobean, but not released in its final form until 1990. Similarly, the first radiocarbon dates for the immediate Tula area were not generated until 1981. Though improvements have been made to the Tula ceramic chronology since 1990, absolute dating in the region remains minimal. As of 2012, Dan Healan was only able to identify 23 useable radiocarbon dates for the immediate Tula area in the published literature, some of which suffer from uncalibrated sigma ranges of over 100 years, and I am unaware of any useable radiocarbon dates other than those described by Healan (2012). This relative dearth of absolute dating has led to challenges in interpreting the archaeological record in the Tula region, making it impossible to validate long-standing hypotheses about sociopolitical development in the region, especially as it relates to Tula Grande’s rise to power.

The purpose of this study is to answer chronological questions involving a cultural period, known as the Epiclassic (AD 550-900), which immediately preceded the Toltec apogee. Overall, this work addresses three questions using radiocarbon ($^{14}$C) dates from the previously published literature and new $^{14}$C dates derived from burials recovered from two important La Mesa phase sites in the Tula region, La Mesa and Cerro Magoni. First, this study assesses if the La Mesa Phase Coyotlatelco hilltop settlements of Cerro Magoni and La Mesa were fully contemporaneous with one another. These communities were part of a collection of sites surrounding the Tula Valley that were potentially founded by migrant populations from the Bajio region of northwestern Mexico, and it is hypothesized that these social groups contributed significantly to Tula Grande’s rise (Beekman and Christensen 2003; Cowgill 2013; Healan 2012; Mastache et al. 2002; Mastache and Cobean 1989). Despite the importance of these communities, little is known about their absolute chronology and it remains impossible to assess their interactions until more is understood about their contemporaneity. Additionally, the founding of these hilltop settlements represents a stark break with the Classic period cultural traditions in Tula. Several hypotheses seek to explain why
populations chose to inhabit the rocky hilltops surrounding Tula. A popular proposal suggests that the hilltops were first inhabited at a time when the Tula bottomlands were still occupied by remnant Classic period populations. Scholars propose that the bottomlands were abandoned by AD 650. If crowding were the reason for the Epiclassic hilltop habitation, then Cerro Magoni and La Mesa should have been inhabited prior to AD 650.

Second, the occupation period of La Mesa and Cerro Magoni are estimated using the newly acquired radiocarbon dates from burial contexts to assess if the settlements were intensively occupied for a brief period, as has been previously hypothesized (Mastache and Cobean 1989; Mastache et al. 2002), or if they experienced a longer lifespan. Overall, the occupation of La Mesa phase sites in the Tula region has not been studied significantly using absolute chronology, and due to wide sigma ranges for published radiocarbon dates from the site of La Mesa, formal attempts to estimate the site’s use period yielded uninformative results. Due to this challenge, it has been impossible to address the longevity of the La Mesa phase sites and the timing of their use.

As discussed below, it is now understood that Tula Chico was contemporaneous with the La Mesa phase settlements. No new radiocarbon dates from Tula Chico are analyzed in this dissertation, but previously published $^{14}$C dates from the site of Tula Chico were re-calibrated and entered into a Bayesian model to assess if the resolution of Tula Chico’s occupation sequence could be refined to allow more informative comparisons with the data from La Mesa and Cerro Magoni. Current evidence suggests that Tula Chico was an important peer of La Mesa and Cerro Magoni, and the site was likely directly involved in the formation of Tula Grande in ~AD 900. Therefore, understanding how Tula Chico may have interacted with La Mesa and Cerro Magoni is an important part of reconstructing the culture history of the Tula Region. In conclusion, the manner in which new knowledge of Cerro Magoni’s, La Mesa’s, and Tula Chico’s absolute chronology influences our current understanding of Tula Grande’s rise to power is discussed and future directions for chronological research in the Tula region are suggested.

**Chronology in the Tula Valley: Past Interpretations and Current Understandings**

The first ceramic chronology for the Tula region was developed by Jorge Acosta (1945, 1956-1957), who conducted the earliest excavations at Tula Grande. Acosta identified two cultural complexes. The first was associated with the Aztec period, while the second was related to pre-Aztec occupations of the region. This second complex was referred to as “Tula-Mazapan” and was later revised to include two periods, known as Período Antiguo and Período Reciente, based on the presence of 17 ceramic types (Acosta 1945). Unfortunately, most of the ceramic types defined by Acosta can be found in both the Antiguo and Reciente periods, leaving the distinction largely
arbitrary. Additionally, Acosta’s use of the title “Mazapa” has been rightly referred to by Dan Healan (2012:57) as an “unfortunate and unending source of confusion.” Most current uses of Mazapan and Mazapa refer to a specific pottery and figurine type found in Central Mexico, but Acosta’s use of Mazapan is directly derived from Vaillant’s (1941) definition, which simply refers to pre-Aztec culture. Because of these challenges, Acosta’s chronological system has largely been abandoned in favor of the ceramic chronology developed by Robert Cobean (1978, 1990).

While slight differences exist between the ceramic chronology of Tula Grande and the broader Tula region, only the chronology of the complete region is used in this dissertation. In Tula, the Classic period corresponds with the Chingú phase, which is named after the preeminent center in the region. During the Epiclassic period, the La Mesa, Prado, Corral, and Terminal Corral phases are present (Healan 2012; Mastache et al. 2002). In the past, the La Mesa phase was most commonly viewed as preceding the Prado and Corral phases, but more recent analyses suggest that they are partially contemporaneous, if not fully overlapping (Anderson et al. 2016; Healan 2012). In Tula, Prado wares have only ever been recovered from Tula Chico and are often viewed as elite goods (Hernández and Healan 2019; Mastache et al. 2002). The following the Tollan phase (Bey 1986), which is associated with the Toltec State. The Tollan phase is then capped by three Aztec types, Fuego, Palacio, and Tesoro (not shown in Figure 11), which extend until the Spanish-Aztec War (AD 1519-21) (Cobean 1978, 1990).

Based on this sequence, archaeologists working in Tula originally proposed a four-step chronological model for Tula Grande’s rise to power. The first step simply consisted of the Classic period Chingú phase occupations, which were centered around the site of Chingú, on the valley floor of the Tula area. Chingú was likely a satellite polity of Teotihuacan and oversaw the exploitation of lime in the region and served at the empire’s northernmost outpost (Mastache et al. 2002). After Teotihuacan’s decline in approximately AD 550, populations living in and near Chingú may have dispersed, abandoning their settlements by the end of the Metepec phase in AD 650. This initiated the beginning of the La Mesa phase when settlement and cultural patterns in the area shift dramatically as new habitation areas were founded on the previously uninhabited hilltops surrounding the Tula valley floor. Nine of these settlements have been identified (Healan 2012; Mastache et al 2002), but only La Mesa and Cerro Magoni were explored in a substantial manner.
The other seven sites have since been destroyed by agriculture and land development. The available data indicate that all of these settlements contained a highly diverse red-on-buff ceramic ware known as Coyotlatelco. The origin of the Coyotlatelco ceramic complex is a highly debated issue in Central Mexican archaeology (see Chapter 2), but researchers generally agree that it is an intrusive ware that may have originated in the Bajío region of Mexico. This shift in settlement and ceramic style has led many scholars to suggest that the cultural changes that accompanied the La Mesa phase were the result of in-migration from northwestern Mexico, and that these immigrants played an important role in Tula Grande’s development. Based on excavation, surface survey, and preliminary ceramic analyses, Mastache and colleagues (Mastache et al. 2002:67-68; Mastache and Cobean 1989) hypothesized that the La Mesa phase sites of Tula were only in use for a limited period, perhaps under 100 years, noting that both La Mesa and Cerro Magoni contained

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**Figure 11.** General chronology of the Tula Region. 
Sources of chronological information: (1) Cowgill 2015; (2) Mastache et al. 2002; (3) Healan 2012.
uncomplicated stratigraphy. Based on this stratigraphy and a small number of radiocarbon dates, Mastache et al. (2002) suggested that La Mesa was occupied from AD 550 to AD 650 and was the earliest of the La Mesa phase settlements. Mastache et al. (2002:67-68) describe Cerro Magoni as “the most complex and extensive Coyotlatelco settlement in the Tula area” and “perhaps the direct antecedent of Tula Chico”. It was also proposed that Cerro Magoni represented a single occupation with limited complexity and longevity during the La Mesa period. Using only the ceramic record, researchers then suggested that a third stage of development occurred with the abandonment of the La Mesa phase hilltop settlements and the founding of a centralized settlement at Tula Chico, as a proto-Tula, during the Prado and Corral phases. The final stage of development then occurred when Tula Grande was founded. Overall, this narrative presented a relatively smooth, step-wise progression of social complexity in the Tula region. This chronological sequence was well reasoned and based on the ceramic evidence that researchers accepted for several decades until it was challenged by radiocarbon dating.

Figure 12. Radiocarbon dates from Tula without significant context or supporting data. Published as Figure 3 from Pardes Gudiño (2005:207). Image resolution result of original.
Though the ceramics of the Tula Valley have been actively studied for decades, the radiometric chronology of the area remains tenuous at best. Prior to this project, only 23 radiocarbon dates with adequate documentation have appeared in the published literature. Another 33 calibrated dates are presented in a chapter by Blanca Pardes Gudiño (2005), but very limited contextual background is available and key technical information such as the uncalibrated dates, their sigma range, and the sample processing and calibration methods are completely unrecorded, yielding the dates largely unusable, though they are presented here in their published form (Figure 12) with an associated map in Figure 13.

The 23 published and usable dates (Table 9) are from seven sites in the Tula region: La Mesa, Tula Chico, Tula Grande, El Canal, Vivero, Tepetitlan, and Vivero Aztec. These dates were originally published in several sources, but in 2012 Dan Healan presented them together for the first time. Given the established chronological narrative of Tula Grande’s rise described above, La Mesa should yield the earliest absolute dates, with Tula Chico generating later dates. These two sites should then be followed by the Toltec centers of Tula Grande, El Canal, Vivero, and Tepetitlan, with Vivero Aztec being the youngest of the sites. Generally, this pattern was followed
except for one important difference. The sites of La Mesa and Tula Chico appear to be contemporaneous with one another, as demonstrated by Figure 14. As discussed by Anderson et al. 2016, this revelation shifted interpretations of Tula Grande’s rise power, as it suggests that the La Mesa phase and the Prado/Corral phases should be collapsed into a single temporal space. Not only does this alter the convenient step-wise development process of Tula Grande, it also indicates that there were more large contemporary settlements in the region during the Epiclassic. Given the cultural differences observed between Epiclassic sites in the Tula Valley and recovered evidence of burning at the civic ceremonial precinct of Tula Chico, researchers have suggested that the period immediately preceding Tula Grande’s rise was highly contentious, with multiple, socially-distinct group vying for power within the region (Anderson et al. 2016). It is through this conflict that Tula Grande is hypothesized to have risen. This conclusion has led researchers to question the nature of relationships between the La Mesa phase hilltop settlements, and their association with Tula Chico. A key component of this inquiry is to assess the contemporaneity for the sites of La Mesa and Cerro Magoni.

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Table 9. All useable radiocarbon dates from the Tula area. Previously summarized by Healan (2012). Dates have been recalibrated using Oxcal v.4.4 using the IntCal20: Northern Hemisphere atmospheric curve. Calibrated date ranges are presented at both the 68% (1σ) and 95% (2σ) likelihood level.
Figure 14. All useable radiocarbon dates from the Tula area. Previously summarized by Healan (2012). Dates have been recalibrated using Oxcal v.4.4 using the IntCal20: Northern Hemisphere atmospheric curve. The red box notes contemporaneous dates from La Mesa and Tula Chico.
Materials and Methods

Sample Selection for La Mesa and Cerro Magoni

Bone samples for radiocarbon dating and stable isotope analysis were collected from the sites of Cerro Magoni and La Mesa and exported for analysis with permission from the Consejo de Arqueología de Mexico (permit 401.1S.3-2019/366). Samples were selected from bone free of visible pathology and material from the diaphyses of long bones was preferred. In the case of La Mesa, all individuals over one year old at time of death were sampled (n=52), and the collection is currently housed in the post-graduate osteology laboratory of the Escuela Nacional de Antropología e Historia (ENAH). Approximately one-half of the Cerro Magoni collection was sampled (n=12). Currently, the Cerro Magoni collection is split between the Instituto Nacional de Antropología e Historia (INAH), Hidalgo and the Zona Arqueológica de Tula. All samples were prepared for AMS dating in the Human Paleoecology and Isotope Geochemistry Laboratory at The Pennsylvania State University (Ebert et al. 2019). A summary of the samples processed and their quality control information can be found in Table 10.

Sample Preparation and Analysis of Samples from Cerro Magoni and La Mesa

Approximately 1.00g of bone was manually cleaned with scalpel treated with 70% methanol to remove surface contaminants and trabecular bone. The sample was then broken into fragments and placed in a scintillation vial. All samples from La Mesa were treated to remove potential contaminants resulting from museum conservation. Cerro Magoni was excluded from this treatment because those materials have been under the care of the first author since excavation and were known to be uncontaminated. To remove possible museum contaminants, the La Mesa samples were first treated with approximately 20mL of 100% methanol and sonicated without heat for 20 minutes. The methanol was then replaced with 20mL of 100% acetone, and the sample was sonicated again under the same conditions. Finally, the acetone was removed and the samples were sonicated in 20mL of 100% dichloromethane. The dichloromethane was removed and the samples were permitted to dry under ambient conditions in a fume hood.

Once dry, samples were demineralized in 0.5N hydrochloric acid at 5°C for two to seven days. The hydrochloric acid was changed every 24 hours. After demineralization, samples were rinsed with Nanopure (18MΩ) water to neutralize any remaining acid. Collagen was then gelatinized using the modified Login (1971) technique. Samples were submerged in 2mL of 0.01N hydrochloric acid for 12 hours at 60°C and the resulting gel was removed. This process was then repeated a second time. Gels frozen in liquid nitrogen and lyophilized until dry. The collagen was weighed and the crude percent yield was calculated (crude percent yield = collagen weight / starting sample weight).
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<th>D^{14}C (%)</th>
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Table 10. Laboratory data, quality control measures, and provenience for radiocarbon samples from Cerro Magoni and La Mesa.

Radiocarbon concentrations are provided as fractions of the Modern standard, D$^{14}$C, and conventional radiocarbon, following Stuiver and Polach (1977:355). All results have been corrected for isotopic fractionation following Stuiver and Polach (1977:355), with δ$^{13}$C values measured on prepared graphite using the AMS spectrometer. Sample preparation backgrounds have been subtracted based on measurements of $^{14}$C-free bone.
Samples with a collagen yield under one percent were discarded as they did not meet quality control standards (VanKlinken 1999). Samples that yielded between one and three percent collagen underwent XAD-2 resin (styrene-divinylbenzene) chromatography to remove humic and fulvic contaminants (Lohse et al. 2014; Stafford 1988, 1991). For chromatography samples, bone collagen was reduced to individual amino acids by treating the collagen with 2mL of 6N hydrochloric acid at 110°C for 22 hours. The collagen hydrolysate was then pipetted into a prepared Supelco ENVI-Chrom Solid Phase Extraction column with attached Millex Durapore filter. The sample was then flushed through the column with 10mL of 6N hydrochloric acid into a culture tube. The filtered hydrolysate was then placed on a heaterblock at 50°C under a stream of nitrogen gas for 12 hours until reduced to a thick syrup. Samples with yields over 3 percent underwent ultrafiltration (Brown et al. 1988). Samples were first hydrolyzed with Nanopure (18MΩ) water before being loaded into decontaminated Centriprep 30 ultrafilters (>30kDa molecular weight gelatin retention) (McClure et al. 2011). During ultrafiltration samples were centrifuged six times for 20 minutes and were diluted with Nanopure (18MΩ) water after the third cycle. The remaining fraction was frozen and re-lyophilized.

Prior to graphitization, carbon and nitrogen concentrations and ratios (δ 13C and δ 15N) for all samples were determined at the University of New Mexico Center for Stable Isotopes (UNM-CSI) and the Yale Analytical and Stable Isotope Center (YASIC). The location of analysis for each sample is noted in Table 10. Materials analyzed by UNM-CSI were processed using a Costech 4010 elemental analyzer equipped with a Confluo IV interface, and samples sent to YASIC were analyzed using a Costech ECS 4010 Elemental Analyzer with Confluo III interface. Overall, samples were assessed for quality by percent crude gelatin yield, percent carbon, percent nitrogen, and the atomic ratio of carbon and nitrogen (C:N). All final samples met the quality control measures suggested by Van Klinken (1999), namely the retention of a C:N ratio of between 3.1 and 3.5. One sample from La Mesa failed to produce collagen and no other samples failed to meet further quality control standards.

Approximately 2.5mg of collagen was then placed in a vacuum sealed quartz tube with CuO and Ag wire and combusted for 3 hours at 900°C. The resulting CO2 was then graphitized at 550°C using a H2 and Fe catalyst with reaction water draw off with C-9 Mg(ClO4)2 (Santos et al. 2014). Graphite samples were then pressed into targets in A1 cathodes and loaded on a target wheel with standards and backgrounds for AMS dating. Dates were analyzed in the PSU Radiocarbon 14C Laboratory using a modified National Electrostatics Corporation 500kV 1.55SDH-1 Compact Accelerator Mass Spectrometer. All dates have been corrected for isotope fractionation, with measured δ13C following Stuiver and Polach (1977).
Radiocarbon Calibration and Bayesian Modeling

Samples were calibrated in OxCal v.4.4 using the IntCal20: Northern Hemisphere atmospheric curve (Reimer et al. 2020), and all radiocarbon dates from the published literature were re-calibrated using OxCal v.4.4 to ensure consistent results. To answer the research questions discussed above, four simple models were formulated in Oxcal. First, using the “phase”, “boundary”, “span”, and “interval” functions, the use periods for La Mesa and Cerro Magoni were estimated separately. Using the Oxcal phase function, uncalibrated radiocarbon dates were entered into a basic Bayesian model that accepts a collection of dates as an unordered series of affiliated events. This single-phase model employs a uniform prior and is useful for estimating a site’s use period and start and end dates, or boundaries. Overall, it assumes that all events (i.e. single dates) are equally likely occur anywhere between the phase’s boundaries and favors neither long or short estimates of use period. Additionally, the model is capable of estimating the boundaries of a phase, meaning that these timepoints do not need to be previously defined (Bronk Ramsey 2009). This approach is actually favored over the calibration and plotting of dates as single events, as individual calibrations assume that events are independent and employ a constant prior, which is heavily biased towards longer time spans. The interval and span functions were used to succinctly estimate each site’s period of use in number of years occupied. Span is defined as the duration of a modeled phase from the first to last directly dated event, while the interval is calculated from the estimated boundaries. To assess the quality of the model, Oxcal generates a series of agreement indexes for each calibrated date (labeled A), estimated boundary, interval, and span (labeled A), and complete model (labeled Aoverall and Amodel) and convergence integrals for each date and boundary (labeled C). Agreement indexes for single samples and boundaries demonstrate if individual samples are in agreement with the larger model, while Aoverall and Amodel are generated from the individual agreement indexes and indicate if the model is likely given the included data. For all agreement measures, the typically accepted threshold is 60%. Finally, the convergence integrals demonstrate the level at which the Markov chain Monte Carlo sampling (MCMC) used by the model provides a representative set of posterior probability distributions. Generally, the model is only accepted if each convergence integral is over 95%. Of course, the existence of acceptable agreement indexes and convergence integrals does not indicate that the model is infallible, but simply that there is no reason to believe that the model contains an overt error.

To test the contemporaneity of La Mesa and Cerro Magoni the “phase” and “difference” functions were used to assess the synchronicity of the boundaries estimated by the models discussed above. Due to the uncertainties present in all radiocarbon dating, this model cannot definitively determine if sites are completely contemporaneous with one another, but instead provides the
statistical likelihood of boundaries being synchronous. To complete this test, separate models were run to compare the start and end boundaries of La Mesa and Cerro Magoni. In the first model, the probability distributions for the start boundaries for each site were entered into a single phase and the difference function was used to estimate the span of the phase in years. In the second model, the probability distributions for the end dates were used. If the estimated differences include zero years, it is possible for the start and end dates of the sites to be synchronous. If zero years was excluded from the span, then the dates are known to be diachronous. Oxcal also generates a probability distribution of the difference in dates, so that the likelihood of contemporaneity can be more fully discussed.

Finally, the $^{14}$C dates presented by Mastache et al. (2009) were entered into a Bayesian model that includes contextual information that has never been incorporated into the calibrations. Five $^{14}$C dates have been published for Tula Chico were analyzed at the University of Arizonan Geosciences laboratory. In the Bayesian model, these dates are groups into three sequential phases. The first phase contains a single date (A5039), which is derived from a carbonized maize cob that was recovered from the earliest occupation period of Tula Chico’s principal ballcourt. Mastache et al. (2002) suggest that this ballcourt’s construction began very early in Tula Chico’s occupation and that this date may reflect some of the earliest activity at the site. The other four dates were recovered from Platform 1 at Tula Chico. Recalling from Chapter 2, Platform 1 once hosted the civic-ceremonial structure that was burned, potentially prior to the founding of Tula Grande’s civic-ceremonial precinct. From Platform 1, one phase contains two carbonized wood samples (A5855 and A5856) from the second-to-last construction phases. The earliest phase included in this model contains the final two samples (A5852 and A5853). These materials are from the collapsed carbonized beams recovered from the burning event at Platform 1. While the beams are from the final construction phase of the building, the samples actually reflect the moment of carbonization, not construction. To indicate that to Oxcal that the samples were from the same event, the “combine” function was employed. Under the current interpretation of Tula Grande’s rise, this burning event marks the chronological moment directly prior to the founding of Tula Grande’s ceremonial precinct.

**Results**

As discussed above, the occupation of La Mesa and Cerro Magoni was assessed using single-phase models. The results of the La Mesa model can be found in Figure 15 and Table 11 and the outputs for the Cerro Magoni model are presented in Figure 16 and Table 12. Within the models, all agreement indexes and convergence integrals meet the standards described above. Deposition of burials at La Mesa has an estimated start date between 641 AD and 652 AD at the 68% likelihood
level. At the 95% level, the start date is estimated to be between AD 633 and AD 656. Burials have a 68% likelihood of halting at La Mesa between AD 790 and AD 871, and a 95% likelihood of ending deposition between AD 783 and AD 836. Using the first and last dated burials, the span of deposition is estimated to be between 138 and 168 years at the 68% level and 132 to 185 years at the 95% level. Using the estimated boundaries, the interval of deposition has a 68% likelihood of being between 143 and 175 years and a 95% likelihood of 134 to 195 years. The Cerro Magoni model estimates that deposition of the recovered burials from Cerro Magoni has a 68% probability of beginning between AD 624 and AD 658. At the 95% likelihood level, this date range is expanded to AD 577 to AD 667. Additionally, at the 68% level burials are estimated to have halted between AD 845 and AD 905. At the 95% level, this range is expanded to AD 815 to AD 953. The span of deposition is estimated to be between 191 and 233 years at the 68% likelihood level. This range is expanded to 150 to 249 years at the 95% level. Finally, the interval of deposition has a 68% likelihood of being between 203 and 279 years and a 95% likelihood of 164 to 343 years.

Based on a visual examination of the modeled dates, it appears likely that Cerro Magoni and La Mesa were contemporaneous. To investigate this further the start and end boundaries estimated by the single-phase models were compared. The start dates for La Mesa and Cerro Magoni overlap considerably, containing a potential difference of 0 years at both the 68% and 95% likelihood levels. At the 68% level a potential difference of -14 to 24 years was estimated and a difference of -25 to 70.5 years was calculated at the 95% level. Additionally, the peak of the probability distribution is strongly centered around 0 years of difference (Figure 17). In contrast, comparison of the estimated end boundaries did not yield a potential difference of 0 years, even at the 95% probability level. Potential differences ranged from -102 to -39 years at the 68% likelihood level and -148.5 to -1 years at the 95% level. Overall, this suggests that burial deposition at Cerro Magoni continued longer than deposition at La Mesa, with the highest peak of the probability distribution centering on 75 years of difference (Figure 18).
Figure 15. Results of the La Mesa Bayesian model. Dark grey peaks indicate calibrated modelled dates. Combined dark grey and light grey peaks indicate calibrated unmodelled date. Upper brackets indicate 68% likelihood and lower brackets indicate 95% likelihood. Parallel bars at AD 550 and AD 900 demarcate the Epiclassic period.
<table>
<thead>
<tr>
<th>Burial Number</th>
<th>Unmodelled (AD)</th>
<th>Modelled (AD)</th>
</tr>
</thead>
<tbody>
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<td>95%</td>
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<td>610-658</td>
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</tr>
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<td>La Mesa 29</td>
<td>650-665</td>
<td>641-757</td>
</tr>
<tr>
<td>La Mesa 22/22Bis</td>
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<td>643-758</td>
</tr>
<tr>
<td>La Mesa 21 Bis</td>
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</tr>
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<td>La Mesa 26</td>
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<td>651-774</td>
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<tr>
<td>La Mesa 12 Bis</td>
<td>657-759</td>
<td>652-774</td>
</tr>
<tr>
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</tr>
<tr>
<td>La Mesa 8</td>
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<td>655-774</td>
</tr>
<tr>
<td>La Mesa Saqueo Individual C</td>
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<td>655-774</td>
</tr>
<tr>
<td>La Mesa 10</td>
<td>661-772</td>
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</tr>
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</tr>
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<tr>
<td>La Mesa Span</td>
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<tr>
<td>La Mesa Interval</td>
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A Model 95.7
A Overall 94.2

Table 11. Results of single-phase model for La Mesa. Both modelled and unmodelled dates presented at 68% and 95% likelihood. Column “A” denotes agreement indexes and column “C” lists convergence integrals.
Figure 16. Results of the Cerro Magoni Bayesian model.
Dark grey peaks indicate calibrated modelled dates. Combined dark grey and light grey peaks indicate calibrated unmodelled date. Upper brackets indicate 68% likelihood and lower brackets indicate 95% likelihood. Parallel bars at AD 550 AD and AD 900 demarcate the Epiclassic period.
<table>
<thead>
<tr>
<th>Burial Number</th>
<th>Unmodelled (AD)</th>
<th>Modelled (AD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>95%</td>
</tr>
<tr>
<td><strong>Cerro Magoni Start</strong></td>
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<td>657-775</td>
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<tr>
<td><strong>Cerro Magoni 4</strong></td>
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<td>675-823</td>
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<td><strong>Cerro Magoni 2</strong></td>
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<tr>
<td><strong>Cerro Magoni Interval</strong></td>
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</table>

| A Model            | 101.0 |
| A Overall          | 100.4 |

Table 12. Results of the Cerro Magoni Bayesian model. Both modelled and unmodelled dates presented at 68% and 95% likelihood. Column “A” denotes agreement indexes and column “C” lists convergence integrals.
Finally, the modelled dates from Tula Chico are presented in Table 13. Prior to modelling, the average span of a calibrated date at the 68% likelihood level was 158.8 years and 262 years at the 95% likelihood level. After modelling, the average span was reduced to 131.75 years at the 68% likelihood level and 197.5 years at the 95% likelihood level. The greatest improvement was observed with samples UAZ/5856 and UAZ/5855, which correspond to the second to last construction phases of Platform 1 at Tula Chico. Unfortunately, only minimal improvements occurred in the calibration of samples UAZ/5852 and UAZ/5853, which correspond to the burning of Platform 1’s civic ceremonial structure. While the model only reduces the combined sample’s calibrated ranges by 24 years at the 68% level and 13 years at the 95% level, the timing of Tula Chico’s burning event is shifted slightly forward in time. The calibrated combined date is also
highly multi-modal, further complicating interpretation. To better summarized the modelled burning event, it is perhaps helpful to consider the probability of the date in relation to important temporal milestones. The Epiclassic period began in ~ AD 550 and ended in ~AD 900. Overall, there is a 14.7% chance that the burning of Platform 1 occurred before AD 725 AD, the midpoint of the Epiclassic period, and a 57% chance that it occurred prior to AD 800. Extrapolated further, this indicates that there is a 40% likelihood that the event occurred between AD 800 and AD 900. Furthermore, there is only a 13% chance that the destruction of Platform 1 happened in the final 50 years of the Epiclassic period. Overall, the burning event has the highest likelihood of occurring during the 50-year period between AD 786 and AD 836, with a probability of 43.5%.

<table>
<thead>
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<th>Sample Number</th>
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<th>Modelled (AD)</th>
</tr>
</thead>
<tbody>
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<td>95%</td>
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<td>UAZ/5855</td>
<td>681-874</td>
<td>660-938</td>
</tr>
<tr>
<td>UAZ/5852 and UAZ/5853 Combined</td>
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<td>675-866</td>
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<td>UAZ/5852</td>
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<tr>
<td>UAZ/5853</td>
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<td>677-882</td>
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</table>

Table 13. Modelled dates from Tula Chico.

**Discussion**

Using new data derived from burials, this chapter sought to assess if the La Mesa phase settlements of La Mesa and Cerro Magoni were fully contemporaneous with one another and if the sites were only used for a brief period, as was originally hypothesized. Additionally, previously published data from Tula Chico was modelled for the first time to assess if the chronology of the site could be refined and compared to that of La Mesa and Cerro Magoni. Based on the radiocarbon record generated by the intensive sampling of interred individuals and the resulting Bayesian models, it is likely that Cerro Magoni and La Mesa were founded very close in time to one another. Based on comparisons of the start boundaries estimated by Oxcal, there is a 55% likelihood that the sites were founded within 20 years of one another, probably during the 7th century. Because this analysis relies on the dating of skeletal material, as opposed to architectural elements or carbonized material, it should be noted that that data presented here represents the timing of the first burial at the site, not the actual founding events themselves. Interestingly, it is unlikely that burials at Cerro Magoni and La Mesa ceased at the same time, with interments at La Mesa ending sooner. At the 95% likelihood level, burials at La Mesa are estimated to have ended between AD 783 and AD 836.
and burials from Cerro Magoni likely ended between AD 845 and AD 905. Overall, there is a 68% likelihood that burials at Cerro Magoni continued 39 to 102 years longer than at La Mesa, with the peak of the distribution centered on 75 years of difference. This suggests that occupation at Cerro Magoni continued for a few more generations after La Mesa had been abandoned.

Based on the stratigraphy at La Mesa and surface collections of ceramics at Magoni, Mastache and Cobean (1989) suggested that both sites were only inhabited for a short period, perhaps a century or less. Though the previously published dates for La Mesa suggest the possibility of a longer habitation, their resolution and overall small number have made providing a sound projection troublesome. The dating of the burials from the site has made it possible to generate a sound estimate for the first time. The calculated interval of occupation at La Mesa at the 95% likelihood level is 134 years to 195 years, with the probability peaking at around 158 years of occupation. As expected based on the differing end boundaries for the sites, Cerro Magoni had a longer use interval of 164 years to 343 years at the 95% likelihood level, with the peak of probability centering on 233 years of habitation. The decreased precision in the Cerro Magoni estimate is likely the result of a reduced number of radiocarbon dates for the site. Together these interval estimates suggest that the La Mesa phase settlements in Tula were inhabited for a longer period than was originally suggested.

This refinement of our understanding of La Mesa and Cerro Magoni’s founding, occupation, and abandonment provides a few important insights into the Epiclassic in Tula. First, researchers have long questioned why populations chose to build communities on the hilltops surrounding the Tula Valley. Three hypotheses have been put forward. These are: 1) the hilltops served a defensive purpose, 2) hilltops were a matter of cultural or ideological preference, and 3) the La Mesa phase populations selected the hilltops because remnant Classic populations were still living on the Tula valley floor when sites like La Mesa and Cerro Magoni were founded. Under this paradigm, new comers to the region simply occupied the unoccupied hilltop spaces. Generally, researchers agree that the Classic period settlements in Tula were abandoned by the end of the Teotihuacan Metepec phase around AD 650. If the decision to inhabit the hilltops in Tula was motivated by crowding on the valley floor, La Mesa and Cerro Magoni should have been founded by AD 650. Based on the burial data presented here, there is a 87% likelihood that Cerro Magoni was founded before AD 650 and a 100% likelihood that it was inhabited before AD 700. At La Mesa, there is a 96% likelihood that settlement occurred before AD 650 and a 100% likelihood of habitation prior to AD 660. This indicates that there is a high probability that the La Mesa phase hilltop settlements did exist prior to the end of the Metepec period and that crowding on the valley floor may have motivated new populations to accept the hilltops as habitation zones.
Of course, this is a highly simplistic summary of both the chronology of late Classic/early Epiclassic Tula and of the motivations that made the hilltops an appealing residence. Even if the valley floor of Tula was de-populated by AD 650, we are still left with several important questions. When did the depopulation of the Chingú period settlements begin in earnest and what was the rate of depopulation? Essentially, when and how quickly did space become available on the valley floor? If the depopulation event was complete by AD 650, it is likely that arable land on the valley floor would have been available for newcomers in the years prior to AD 650. Even if the Chingú period settlements were depopulating in the years leading to AD 650, we have no way of ascertaining how agricultural land became available at the end of the Classic period. Additionally, archaeological evidence from northern Hidalgo, the Bajío, and the Basin of Mexico does suggest that the populations that utilized Coyotlatelco and Xajay ceramics demonstrate a broad preference for hilltop settlements. This observation is complimented by Anderson and colleague’s (2016) suggestion that the inhabitants of the La Mesa phase settlements brought a hybridized agricultural system with them from northwestern Mexico that combined maguey cultivation with maize agriculture. If this was true, then access to arable land may have been less economically valuable to the initial La Mesa phase populations. While, the potential overlap between the La Mesa phase populations and the remnant Classic period populations should not be used as a singular explanation for the Epiclassic cultural shift to hilltop settlements, it does suggest that the founders of the La Mesa phase communities were not deterred by the presence of the Teotihuacan affiliated Classic period populations.

Additionally, the longevity of La Mesa and Cerro Magoni suggest that populations were not highly motivated to abandon the hilltop settlements even after the valley floor was fully depopulated. These hilltop settlements are frequently discussed as brief and unstable occurrences in the Central Mexican prehistory, but it is possible that our perspective is clouded by our long-term view of the archaeological record. When compared to the temporal expanse of pre-colonial history, 150 to 300 years of occupation is not a shockingly long period, but from the perspective of the human lived experience, three centuries of legacy would be quite significant. Indeed, the modern countries of Mexico and the U.S.A have only existed in their current form for 210 years and 244 years, respectively. Putting this into further perspective, during the Aztec period males typically married between 20 and 22 years of age and females between 15 and 18 years of age. Assuming 20 years per generation and utilizing the 68% likelihood occupation interval, Cerro Magoni may have been inhabited for 10 to 14 generations. From this perspective, the occupation of the La Mesa phase settlements seems fairly stable.

As discussed in Chapter 2, the relationship between the La Mesa phase settlements and
Tula Chico has also been an important area of discussion. Prior to 2012, it was assumed that Tula Chico was not contemporaneous with the La Mesa phase settlements, but this is now known to be untrue. To improve the resolution of Tula Chico’s chronology, the existing radiocarbon dates were entered into a Bayesian model supplemented with contextual information. Unfortunately, models are only as precise as the entered data and the most important dates from Tula Chico were not significantly improved by the model, namely the earliest date from the sequence and the date representing the burning of Platform 1. The model still supports Healan’s (2012) observation that Tula Chico was contemporaneous with the La Mesa phase settlements, but provides little new information.

Given this limitation, it is perhaps more fruitful to discuss what scenarios are possible given the Tula Chico data. It is likely that the site was founded by AD 652, but this event may have also occurred as early as the 5th century. Like much of the Tula Chico data, the earliest date is highly multimodal with several probability peaks, but 68% of the probability is contained between AD 546 and AD 639. While it is possible for La Mesa and Cerro Magoni to have been founded before Tula Chico, it is much more probable that the sites were founded at the same time or that Tula Chico was founded first. The burning of Platform 1 has typically been viewed as the end of civic-ceremonial life at Tula Chico’s main precinct even though domestic life continued in the zones surrounding the platform. As discussed in Chapter 2, it is possible that Platform 1 was abandoned before the fire, but the radiocarbon date from the charred beams provides a terminus ante quem for ceremonial activity. Like the earliest date from Tula Chico, the combined radiocarbon date from the burning event is multimodal, but there is an 85% probability that the fire occurred between AD 700 and AD 835. Additionally, using the difference command in Oxcal to compare the end boundary of Cerro Magoni and the burning event at Platform 1 reveals that there is only a 4.8% probability that burials at Cerro Magoni ceased prior to the burning event and a 68% likelihood that burials continued at Cerro Magoni for 36 years to 158 years after the destruction of Platform 1 at Tula Chico. When the end boundary of La Mesa is compared with the burning of Platform 1, there is a 40% probability that burials at La Mesa ceased before the burning event at Tula Chico and an estimated difference of -28.5 years to 91.5 years at the 68% likelihood level. Though the comparison of data from La Mesa and Tula Chico is less definitive than that of Cerro Magoni and Tula Chico, it is also likely that burials at La Mesa continued after the burning of Platform 1. This comparison with Cerro Magoni and La Mesa suggests that the series of events that led to Platform 1’s destruction did not immediately disrupt daily life at La Mesa phase settlements, and it is possible that the burning event did not represent a final and cataclysmic event that marked the terminus of the Epiclassic.
In summary, through the comparison of new radiocarbon data derived from the burial records of La Mesa and Cerro Magoni and previously published dates from Tula Chico, four general conclusions can be reached. First, there is a high probability that the founding of Cerro Magoni and La Mesa were synchronous. This is significant because it suggests that the creation of the hilltop settlements was not a gradual process and that the widespread appearance of Coyotlatelco hilltop culture in Tula was a fairly sudden event. Additionally, if La Mesa phase settlements were founded at the same time, it can also be concluded that the initial inhabitants of those communities made the conscious decision not to cohabitate despite possessing a shared cultural tradition. If the hilltop settlements were founded by immigrants from the Bajío, perhaps large portions of pre-existing communities migrated together and the old community boundaries were maintained after emigration. This could also explain why differences in ceramic preference and access to the obsidian trade are observed between the sites. As discussed in Chapter 2, these differences should not automatically be viewed as evidence of conflict, as cultural variation and economic independence are not synonymous with animosity.

Second, it is probable that the La Mesa phase settlements were founded before the end of the Teotihuacan Metepec phase, after which the Chingú period settlements on the valley floor of Tula are thought to have been abandoned. This could suggest that crowding in the lowlands may have motivated immigrants to inhabit the hilltops surrounding Tula, but several important pieces of information suggest that dense population was not the primary reason for selecting elevated locales. Even in the Bajío and in northern Hidalgo, there is a strong cultural tradition of living on hilltops and mesas. If Anderson and colleagues (2016) are correct in suggesting that La Mesa phase populations brought an arid-adapted subsistence system with them from northwestern Mexico, there may have been little use for large expanses of arable land on the valley floor, and hilltops may have provided a cultural consistent and genuinely more desirable habitation area. Additionally, it is important to note that while the La Mesa phase populations and the remanent Classic period populations probably overlapped, any social tensions between the two groups were not strong enough to cause the La Mesa phase communities to live together. Instead, they occupied hilltops that were kilometers apart and not densely populated, suggesting that “safety-in-numbers” was not enough of a concern to override the desire of La Mesa phase communities to occupy separate spaces.

Third, the new data from Cerro Magoni and La Mesa empirically demonstrate that the La Mesa phase communities were inhabited longer than researchers initially hypothesized. The site of Cerro Magoni was especially long-lived, suggesting that the communities inhabiting the La Mesa hilltops were not highly motivated to abandon their settlements for the valley floor and that the
community structure of Epiclassic Tula may have been more stable than researchers have proposed. Comparisons of end boundaries show that burials at La Mesa ceased before those at Cerro Magoni, which could indicate that the abandonment of the hilltop settlements was a gradual process that occurred over several generations. This may suggest that the political processes that led to Tula Grande’s rise were less sudden and cataclysmic than the leading narratives indicate.

Finally, the modelling of the pre-existing Tula Chico radiocarbon dates most clearly demonstrates that more data is needed from Tula Chico before any strong conclusions can be reached about the site’s absolute chronology. Furthermore, Tula Chico’s relationship to the La Mesa phase sites requires higher resolution radiocarbon dates than those currently available in the published literature. With this said, the Tula Chico radiocarbon dates do raise important questions when put in conversation with the La Mesa and Cerro Magoni data. Primarily, the burning of Platform 1 has been considered one of the primary terminal markers of the Epiclassic period, after which Tula Grande is founded and the Toltec empire is born. Based on the estimates presented here, it is highly likely that habitation at Cerro Magoni continued after the burning of Platform 1 and it is also possible that daily life at La Mesa continued as well. Given this evidence, it is possible that the destruction of Platform 1 did not signal the end of the Epiclassic period. As discussed in Chapter 2, perhaps the fire was not viewed as a cataclysm by Epiclassic populations and archaeologists may be inferring too much from the destruction of the structure.

**Future Directions**

While the new data and conclusions presented here provide important insights into the prehistory of the Tula region, much work is still left uncompleted. Here, four areas of interest are highlighted that would benefit from further radiocarbon dating. First, the absolute chronology of Tula Chico requires significant refinement. Because of the nature of the radiocarbon calibration curve from 550 AD to 900 AD and the relatively short time span of the Epiclassic period, new dates from Tula Chico must be both high resolution and well provenienced so that tools, such as Bayesian models, can be effectively implemented. Fulfilling these parameters is the only way in which the chronology of Tula Chico’s civic-ceremonial structures can be refined. Specifically, it would be useful to better characterize the founding date of Tula Chico, so that it can be compared with data from La Mesa and Cerro Magoni. Additionally, there are no radiocarbon dates from residential contexts at Tula Chico, which leaves the nature and timing of domestic habitation at the site completely unexplored. Second, to reiterate the point made by Sterpone (2000-2001), far more attention should be given to the timing of the founding of Tula Grande’s civic ceremonial precinct. Currently, there are only two radiocarbon dates from the precinct and the interpretation of their provenience is far from precise. Because Tula Grande’s civic ceremonial precinct was likely built
on top of Corral phase structures, securing high resolution dates from early Tollan phase deposits would significantly influence interpretations of the end of the Epiclassic period and provide important context for characterizing the sequence of events that led to Tula Grande’s rise.

Third, the burial record of the La Mesa phase settlements of Cerro Magoni and La Mesa, would be complimented by a radiocarbon chronology of civic ceremonial building construction at the sites. While the burial record captures the length of time in which populations were simply living at the sites, an architectural record would potentially demonstrate when important socio-political changes occurred at the sites, as these events were commonly accompanied by building projects in Mesoamerica. Finally, household archaeology is frequently overlooked during the study of Epiclassic Coyotlatelco settlements. Reconstructing the timing and longevity of household life at Epiclassic communities in Tula and comparing the results between sites could provide valuable insight into the social dynamics and stability of these communities, and the speed of site and population growth. Overall, there is still much work to be done in Tula, but recent technical and analytical innovations in radiocarbon dating could help to clarify many long-standing questions.
CHAPTER 6: PALEODIET AMONG THE EPICLASSIC COYOTLATELCO CENTERS
OF CERRO MAGONI AND LA MESA

Introduction

Important social and economic facts about a society are imbedded in the food they consume. In some instances, large-scale variability between regions can reflect differences in regional ecology or culture. At times, the history of a place becomes evident in food, as events like migration, trade, and conquest all leave their mark on the dietary landscape. In other instances, trends in food are even more nuanced, with variability arising between closely linked settlements, or even within communities themselves. In many instances these smaller scale variances can be traced back to social differences, like those observed between genders and social classes. Other times, they are created when separate communities utilize the same landscape in different ways.

While studies of paleobotany and zooarchaeology can provide us with a record of the plants and animals exploited by a household or community, isotopic approaches to paleodiet are one of the only methods available to directly link dietary patterns to individuals in the ancient world. Isotopic approaches to diet in Central Mexico have been practiced since 1981 (Epstein and DeNiro 1981), but their application has largely been focused on the Basin of Mexico. To date, no isotopic studies have ever been completed for the Tula region, the heart of Mexico’s second expansionist state. The rise of Tula Grande has become a topic of interest in Mexican archaeology, with many scholars recognizing that understanding Tula Grande’s accumulation of power necessitates the study of the preceding cultural period (Clayton 2016, 2020; Cowgill 2013), known as the Epiclassic (AD 550-900). This study provides an isotopic study of diet for two Epiclassic Coyotlatelco hilltop centers from the Tula Region, La Mesa and Cerro Magoni.

In addition to simply providing a first glimpse into dietary practices at these important sites, this study also addresses three research questions. First, using carbon ($^{13}$C$_{collagen}$) and nitrogen ratios ($^{15}$N$_{collagen}$) from bone collagen, the dietary structure of Cerro Magoni and La Mesa are estimated and compared to one another. These data are also compared with dietary reconstructions from other Central Mexican communities to assess if Cerro Magoni and La Mesa exhibited differing dietary practices and if these sites were unique when compared to other Central Mexican examples. Second, differences in dietary status between males and females are analyzed for both sites. It is possible that men and women at Cerro Magoni and La Mesa had differential access to resources, a trend that can manifest in isotopic data. Finally, by pairing the isotopic data with the radiocarbon data from Chapter 5, it was possible to assess if dietary patterns in Tula exhibited any shifts during the Epiclassic period. This is of interest because some scholars (Anderson et al. 2016)
suggest that the inhabitants of the Tula Coyotlatelco centers brought a form of hybridized agriculture with them to Central Mexico. This subsistence practice may have paired cactus cultivation with maize agriculture and foraging activities and would have represented a break with the Classic period pattern of significant maize exploitation. Additionally, Anderson and colleagues (2016) also propose that maize exploitation may have increased near the end of the Epiclassic period and into the Postclassic period. Though differentiating maize exploitation from CAM plant usage is isotopically challenging (see below), shifts in dietary behavior may still be detectable.

Prior to addressing these areas of interest, this chapter will provide an overview of the ecology of the Tula region. The ecology of a region dictates what wild foods are available and what crops can be successfully grown. While the Tula hosts many of the same species as the Basin of Mexico, there are differences in climate and soil systems that can alter the productivity and viability of different subsistence systems. Additionally, our understanding of dietary practices in the Tula region will also be addressed, as botanical and faunal evidence can provide an important guiding framework for isotopic reconstructions of diet. Unfortunately, limited botanical and faunal evidence is only available for Tula Grande and associated sites, as Epiclassic dietary practices have never been studied in the Tula area. Finally, isotopic analyses of diet always benefit from comparisons to other human populations and to isotopic baseline samples from foods most commonly consumed in the region under study. To better contextualize the Cerro Magoni and La Mesa, a sample of faunal and botanical $\delta^{13}C_{\text{collagen}}$ and $\delta^{15}N_{\text{collagen}}$ values from the Basin of Mexico are also presented here, as are a few examples of human populations from Central Mexico. A more thorough (but still relatively brief) review of the application of isotopic approaches to paleodiet in Central Mexico can be found in Chapter 3. Finally, note that laboratory methods for the collagen samples are not included here because they are discussed at length in Chapter 5, as various collagen attributes serve as important quality control measures for radiocarbon dates derived from human remains.

**Background**

In this section, the basic ecology and geography of the Tula region is discussed to provide context for the remainder of the chapter. Additionally, botanical and faunal data for Postclassic period Tula is also addressed, as no botanical or faunal data has ever been generated for an Epiclassic site in Tula. Finally, some comparative isotopic faunal, botanical, and human data from the Basin of Mexico are also presented, so that tentative comparisons between the regions can be addressed.
Ecology of Tula

The Tula region is bounded by the Basin of Mexico to the south and the Mezquital Valley to the south, covering approximately 1,000 sq. km. Overall, the climate is dry and geographically divided into steppe and temperate zones (Mastache et al. 2002). In the steppe, temperatures average 18°C (64.4°F) and annual rainfall reaches 450-600 millimeters. Temperate zones have an average temperature of 12º-17.5ºC (53.6º-63.5°F) with an annual rainfall of 700 millimeters (Garcia 1966). In both areas, rain mostly falls between June and September. Tula is also part of the Tula River hydrographic sub-basin, which is part of the larger Pánuco River system (Mastache et al. 2002). In the region, the Pánuco River has four main tributaries, which shaped life during ancient times. The Tula River and Salado River run from south to north, meeting at the northern periphery of Tula. The Coscomate River and Rosas River run from west to east. Tula Grande was founded at the junction of the Rosas and Tula Rivers, which would have provided important resources during ancient times. To date, no water sources have been identified on the hilltop centers of Cerro Magoni and La Mesa.

Much of the Tula region is characterized by low mountain ranges and their foothills. These mountains typically extend from southwest to northeast and the highest peaks reach 3,050 meters above sea level. The most readily arable land in the region, an alluvial plain created by the Tula River, can be found in the north, while sedimentary foothills dominate the south. The western portion of the region hosts a series of mountains (2,050-2,650 meters), foothills, and intermountain valleys. Finally, to the east the area is bounded by another mountain range with peaks reaching up to 2,800 meters in elevation (Mastache et al. 2002). In Tula, the soil quality varies considerably. In more elevated mountainous areas, erosion is rampant and some hilltops and peaks completely lack topsoil. Alternatively, along steep slopes that host limestone deposits, soils are present, but they are of very poor nutrient quality. The alluvial plains provide the best agricultural soil, which is a mix of volcanic materials, silt, and clay and are very nutrient dense (Mastache et al. 2002, Ortiz and Ortiz 1990). Unfortunately, areas that experienced seasonal flooding, either during ancient times or in the deep geologic past, are prone to elevated salinity. Over time, irrigation practices may have slowly exacerbated this problem and gradually stripped soils of nutrients (Márquez 1986). Overall, soils naturally located at the base of foothills provide the most sustainable and fertile soils in the region, and Figure 19 provides visual record of the soil conditions in Tula, as zones are ranked based on their agricultural potential. The defining characteristics of each land class are presented in Table 14. Eight land classes are present on the map (Ortiz and Ortiz 1990). The lower the categorization, the more productive the land, or the more easily it can be managed. Each subsequent class represents increasing challenges related to soil depth, erosion, nutrient
content, salinity, and water content. Class V is an exception to this general categorization, as it highlights areas with significant problems associated with flooding and waterlogging. According to Ortiz and Ortiz (1990), land classes I-IV are considered to have varying agricultural potential, while classes V-VIII are without agricultural use. Mastache and colleagues (2002) note that at least 50% of land in Tula falls into categories V-VIII. Classes III-IV account for an additional 30% to 40% of land, and only 15% to 20% of land falls into categories I and II. Together, this provides a picture of a somewhat agriculturally tenuous landscape that would have require significant investment and constant management. In ancient times, especially from the Epiclassic period onwards, these restraints may have led to innovation subsistence strategies that relied less on maize agriculture and incorporated foraged items and cactus cultivation. Though no faunal or botanical data exists for Tula during the Epiclassic, some information is available for the Postclassic period and later.

Figure 19. Soil type distribution in the Tula Region. Land classifications from Ortiz and Ortiz (1990). Red rectangle denotes area where Cerro Magoni, Tula Chico, and Tula Grande were located.
Table 14. Land classes in Tula.
Descriptions from Ortíz and Ortíz (1990).

Dietary Practices in Tula

Archaeological botanical data from the Tula region is derived from four Postclassic excavations: the rural household complex of Tepetitlán (Cobean and Mastache 1999), the urban habitation areas of El Canal and El Corral (Diehl 1989) and from Units 27-28 (Cobean and Mastache 1999), a domestic area near Tula’s civic ceremonial center. In total, the analysis of plant remains from these contexts identified four plant species, maize (Zea mays), amaranth (Amaranthus sp.), beans (Phaseolus vulgaris), and maguey (Maguey sp.), as potential primary sources of nutrition during the Postclassic period, a trend that has continued into modern times.

Maize is perhaps the most important crop grown in Mexico, and it is certainly the most famous. Among the Postclassic excavations in Tula botanical remains were scarce, but cobs samples were available for analysis by Benz (1999). Benz (1999) was able to identify nine probable types of maize in the collection and concluded that the types recovered from the urban zone of Tula Grande were fairly homogenous and very similar to the types found in the Basin of Mexico. With this said, the diversity of maize types grown in the Tula region during the Postclassic speaks to an interesting method of risk mitigation. As mentioned in Chapter 2, maize agriculture in Tula is frequently unreliable, as the region is prone to unpredictable rainfall and frost. Indeed, some scholars (Figueroa n.d. as cited by Mastache et al. 2002) suggest that in unirrigated areas of Tula, maize crops fail up to five years in every six-year cycle. Given this risk (Sanders 1993) and the variable soil conditions of the area, the high variability of maize types grown in ancient Tula may have alleviated some risk, as Benz (1999) suggests that each type has different growth characteristics. Some grow quickly, while others mature more slowly. There is also variability in
the temperature and moisture requirements of the maize types, and different varieties would have been ideal for different culinary purposes.

Overall, Mastache and colleagues (2002) note that given the limited botanical evidence from Tula, it is difficult to determine what proportion of the Postclassic diet consisted of maize, but it seems unlikely that the ecology of the Tula region could have fully supported the population of Tula Grande (60,000 urban + 25,000 hinterland) using maize agriculture alone. Estimates of ecological carrying capacity are linked to projected crop yields, the nutritional value of the crop, and the proportion of the crop consumed in comparison to the whole diet. Therefore, calculations can be highly variable, but Mastache and colleagues (2002) have suggested that at least 235-286 sq. km. of land in Tula would have been needed to feed Tula Grande’s population, assuming a maize dominant diet. If 50% to 66% of the land were allowed to lay fallow (Mastache et al. 2002; Sanders 2000, but see Charlton 1970), the required arable land may have been expanded to 470-858 sq. km. Given that Figueroa (n.d.) estimates that only 418 km$^2$. of land was available for agriculture in ancient times, it is unlikely that the Tula region could have supported the whole Toltec population using maize as the only staple crop. This has led researchers to pursue hypotheses concerning alternative or hybridized subsistence strategies (Anderson et al. 2016; Mastache and Cobean 2002; Parsons and Darling 2000).

In addition to maize agriculture, amaranth may have also served as an important staple crop in Tula, though evidence is not definitive. Amaranth is still grown in northern, northwestern, and Central Mexico, and was important in ancient times. While amaranth was produced as a subsistence crop, it also held important ritual significance as well (Orítz 1997; Rojas Rabiela 1985; Torres 1985). In some ways, amaranth is a more desirable crop than maize, especially in the Tula region. While early frosts can mean disaster for maize, amaranth plants are relatively unaffected. Leaves may be destroyed, but the grain remains unaltered (Sánchez Marroquín 1980). Additionally, amaranth is very rich in protein, minerals, and carbohydrates, and the protein in amaranth contains significant quantities of essential amino acids (Sánchez Marroquín 1980). Unfortunately, amaranth does require high quality soil and is prone to outstripping nutrients, much like maize.

The most significant domestic deposit of amaranth remains was recovered from Tepetitlán, potentially in a ritual household context, and amaranth was also observed at El Canal, though the frequency and context are unknown. Additionally, a pollen analysis derived from a soil core from El Salitre in Tula (González Quintero and Montúfar 1980), suggests a cyclical relationship between maize and amaranth agriculture in Tula. In periods when one crop is significantly represented, the other is minimally present. The sequence begins with amaranth agriculture, which was replaced by maize. There are then two more bouts of amaranth growth that are capped by a period of maize agriculture.
persistence. Unfortunately, there is no absolute chronology available for the soil core, so no patterns can be linked to actual cultural horizons. Despite the temporal challenges associated with the soil core study, it is evident that both maize and amaranth were important crops in the Tula region, though preferences for each plant may have shifted through time. While maize is usually considered dominant in Mexico, amaranth should not be underestimated. Still, amaranth has similar soil requirements to maize, which leaves the problems surrounding subsistence patterns at Tula Grande unaddressed. To that end, beans and maguey may have provided an important source of nutrition.

Typically, beans are viewed as a tremendously important stable crop in North and Central America, second only to maize. Beans are revered for their adaptability, nutritional qualities, and ability to grow among other staple foods without jeopardizing the yield of either crop (Rojas Rabiela 1985). They are also prodigious nitrogen fixers, which make them ideal companions for crops like maize. At Tula, the majority of bean remains were recovered from Tepetitlán and were studied by Kaplan (1999). Interestingly, Kaplan found that between 66% and 75% of the samples recovered were wild species. The fact that wild species were the most common is very interesting, but the coexistence of wild and domesticated types, even in elite contexts, is more intriguing. Kaplan (1999) proposed that the presence of both wild and domesticated types was suggestive of an integrated cultivation system that did not rely solely on domesticated plants (for a discussion on the modern applicability see Beebe et al. 2012; Díaz-Batalla et al. 2006; Espinosa-Alonso et al. 2006; Porch et al. 2013), even at Tula Grande’s height, supporting the hypothesis that subsistence practices in the Tula region were not rigid and were adapted to utilize the unique ecology of the area.

In addition to wild and domesticated beans, communities in Tula also likely cultivated maguey and other cacti, like nopal. Maguey has never ceased to be an important crop in Central Mexico, but Parsons and Darling (2000) noted that the plant is frequently excluded from conversations surrounding subsistence practices in Mexico. In Mexico, there are upwards of 150 (Sanders 1993) species of maguey, and each is adapted to a slightly different climate. Most importantly, many of these varietals are unaffected by high elevations, heat, and low rainfall. There are approximately nine maguey species that are actively used to produce pulque, a popular fermented beverage common to Central Mexico (Escalante et al. 2016; Parsons and Parsons 1990). These species are especially well adapted for growing in the climate of Tula and thrive in soil compositions that are impossible for other staple crops. In addition to producing pulque, a calorie rich fermented beverage, maguey plants also provide a plethora of other resources. Portions of the plant can be used as fiber, animal fodder and fuel. The leaves can be used to wrap other foods for
cooking. Aquamiel from the plants can be turned into honey and stored for long periods of time, and many portions of the plant are edible when roasted, though some are rather unpleasant to eat (Mastache et al. 2002). Though the versatility of maguey is impressive, it is important to note that a single plant cannot fulfill all of the needs listed above, especially regarding food production. If one wishes to directly consume the edible parts of a maguey plant, the plant will not be able to simultaneously provide aquamiel, and by default, pulque.

While maguey is not intermixed with other crops, it is frequently grown along the edges of fields because the plants help to limit erosion. Additionally, maguey grows well on terraces and in shallow rocky soil, making it an ideal plant for area where other crops are doomed to fail. Despite the obvious value of maguey, there is some question regarding the caloric value of each maguey plant. Sanders (1993) argues that when the calories produced by a hectare of maize and a hectare of maguey are compared, maize generates more caloric value. This means that it is unlikely that maize would have been replaced by maguey in zones where grain crops could be successfully grown. In contrast, Parsons and Darling (2000) propose that maguey is more productive, though their study fails to take into account maguey’s inability to simultaneously produce directly consumable plant portions and aquamiel/pulque. While maguey was unlikely to replace seed agriculture in Tula, the plants were likely grown alongside other staple crops and in zones where seed crops could not survive.

Two ethnographic studies further emphasize the importance of maguey in Hidalgo. Both examples come from the Mezquital Valley. In 1946, Anderson and colleagues published an article about four unnamed Otomi communities in the southern valley and in 1971 Young studied another Otomi population from Ixmiquilpan. Young (1971) specifically notes that Ixmiquilpan did not contain irrigable land, and Anderson and colleagues suggest that their study communities were minimally impacted by irrigation. Despite the 25-year separation between the studies, they tell a very similar narrative. In Ixmiquilpan, beans provided the primary source of dietary protein and meat was rarely eaten. When consumed, meat was almost exclusively from hunted game. In the area studied by Anderson and colleagues, meat often came from goats or sheep, though usually only blood and off-cuts are consumed, as more prime items were sold. Additionally, Anderson and colleagues (1946) note that the communities they studied were so impoverished that even beans were considered too expensive to purchase in large quantities. Unsurprisingly, maize was an important staple food in both studies. Perhaps more unexpected is the importance of maguey in both contexts.

Both Anderson and colleagues (1946) and Young (1971) noted that pulque was consumed in huge quantities, and in many instances replaced water. Indeed, Young (1971) found that pulque
was even used in place of water in the making of tortillas and tamales, and households could consume several gallons a day. Many men interviewed by Anderson and colleagues (1946) claimed they could not work without a steady supply of pulque and that pulque replaced meat in their diets. Both studies remark on pulque’s importance as a source of vitamin B, and Anderson and colleagues (1946) note the importance of vitamin C as well. While Young does not provide a proportional estimate of pulque’s presence in the diet, Anderson and colleagues (1946) identified pulque as the second most calorically important food item, with maize tortillas being the most important. Overall, these two studies make two important points. Even in the 1970s, maguey was still an important crop that was frequently grown alongside other plants, like maize and beans. Second, in marginal landscapes and during lean years, resources derived from maguey meant the difference between starvation and survival. Depending on age category, individuals in the study by Anderson and colleagues (1946) only received between 55% and 82% of recommended daily calories and pulque supplied an average of 22% of these calories. Removing maguey resources from the diet would have wielded a catastrophic blow to community diet. While it is unlikely that populations at Tula were impoverished as the communities observed by Anderson and colleagues (1946), Parson and Darling’s (1993) suggestion that cactus horticulture played an important part in the development of communities north of the Basin of Mexico is well founded.

In addition to agriculture and horticulture, hunting and gathering activities were also important in Tula. Both Young (1971) and Granados Sánchez (1995) note the importance of foraging wild plant species and hunting game among ethnographically studied Otomi populations. A study by González Quintero (1999) conducted using plant remains from Tepetitlán also confirms that wild foraged plants were important during ancient times, even at Tula Grande’s apogee. In addition to foraged fruits and vegetables, a wide variety of animal species were also used. In the excavations at Tula, freshwater mollusks, dogs, (*Canis*), and deer (*Odocoileus virginianus*) were the most common, though hares (*Lepus sp.*), rabbits (*Sylvilagus sp.*), and turkeys (*Meleagris sp.*) were also recovered. Overall, deer were the most common species recovered and it is notable that only a few turkey bones were found (Diehl 1981; Polaco 1999). This is surprising considering that turkeys were a Mexican domesticate and are considered a staple of the Central Mexican diet (Manin et al. 2018; Thornton and Emery 2017), though issues of recovery or preservation could affect these results.

Interestingly, some differences in hunting behavior between contexts at Tula have been observed. More animal remains were recovered from El Canal and El Corral than Tepetitlán (Diehl 1981; Mastache et al. 2002; Polaco 1999), which could suggest that individuals in more urban areas actually consumed more meat than individuals in rural settlements (Mastache et al. 2002).

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differences may reflect variation in actual consumption practices, Manin and Lefèvre (2016) also bring attention to the cultural differences between “hunting” and “garden-hunting” in northern Mesoamerica (Katz 2006; Neusius 2008; Linares 1976). Under these traditions, garden-hunting consists of capturing and consuming animals that are from cultivated areas or culturally altered environments. Garden-hunting can be undertaken by any member of society, and animals that are typically drawn to areas of cultivated crops are most commonly killed. In contrast, hunting is a highly ritualized activity only undertaken by specific members of society, and it only occurs outside of altered or cultivated spaces (Brown and Emery 2008; Hémond 1996; Szuter 1991). While many of the same species are targeted by hunting and garden-hunting, the unused remains of the animals must be treated differently. Bones of garden-hunted animals can be placed in the household midden, while the bones of hunted animals must be returned to the animal guardian/diety (Brown and Emery 2008; Olivier 2011). If this practice was undertaken in Tula, it has the potential to significantly impact the faunal record. Mastache and colleagues (2002) remark that it is odd that more rural contexts in Postclassic Tula have fewer animal bones than urban contexts, as more rural populations should have had easier access to animals. A practice of returning the bones of hunted animals to the landscape may explain this discrepancy. Rural communities may have had more access to unmodified landscapes. Therefore, animals acquired there would have been considered hunted, not garden-hunted.

Finally, insects and river animals may have also contributed to the Tula diet. As noted above, freshwater mollusks have been recovered in Tula, and their unworked shells were recovered in considerable number from Cerro Magoni. Additionally, mud turtle (Kinosternon sp.) is commonly found in deposits in northern Mexico, and some examples were found at Cerro Magoni. Manin and Lefèvre (2016) also note that boney fish were probably important to populations living near river environments, but that their remains are infrequently found due to the need for specialized recovery methods. Finally, insects were potentially an important seasonal source of nutrition, though no archaeological traces of their use can be recovered. There is ethnographic evidence of insect collecting in northern Mexico (Hémond 1996; Katz 2006), and in Tula, modern communities still collect and eat red maguey worms, ant eggs, ants, maize cob worms, and crickets with considerable gusto. Spiced fried crickets are so popular that they are often sold to visitors as snacks at archaeological zones.

While Tula may not be the ideal environment for intensive maize agriculture, the area is a space of relative abundance in an otherwise marginal landscape. As noted above, the region is ecologically diverse, which provides a range of habitats where various plant and animal species thrive. While maize may have not been as dominant in Tula as it was in other areas of Mexico, the
region certainly would have yielded diverse dietary options for innovative populations, especially those who were already accustomed to living in northwestern Mexico. In the next section of this chapter, the mechanics of δ\textsuperscript{13}C and δ\textsuperscript{15}N isotopic systems will be discussed, and some comparative examples from the Basin of Mexico will also be presented.

\textbf{δ\textsuperscript{13}C and δ\textsuperscript{15}N Isotope Mechanics}

δ\textsuperscript{13}C values represent a ratio of 13\textsuperscript{C} to 12\textsuperscript{C}, and is expressed in parts per thousand (per mil, ‰) relative to the VPDB (Vienna Pee Dee Belemnite) international standard. δ\textsuperscript{15}N values follow the same notation, but represent the ratio of 15\textsuperscript{N} to 14\textsuperscript{N} and are calculated relative to AIR (atmospheric N\textsubscript{2}). Variation in δ\textsuperscript{13}C and δ\textsuperscript{15}N values are driven by differences in the photosynthetic pathways used by plants, the trophic level of the organism under analysis, an organism’s relationship to terrestrial, lacustrine, or marine environments, and climate (Ambrose 1991; Dawson et al. 2002; Farquhar et al. 1989; Kohn and Cerling 2002; Lee-Thorp 2008). Stable carbon ratios in plants are the result of the photosynthetic pathways utilized by the plant, and plants can be divided into three categories: C\textsubscript{3}, C\textsubscript{4}, and CAM types. Most plants (fruits, vegetables, grasses, trees) fall into the C\textsubscript{3} category, using the Calvin-Benson photosynthetic pathway. This pathway favors 12\textsuperscript{C} incorporation and yields very negative δ\textsuperscript{13}C values (DeNiro and Epstein 1978). In modern contexts C\textsubscript{3} plants generate values with a mean of -27‰ and a range of -35‰ to -20‰ (Dawson et al. 2002).

In contrast, C\textsubscript{4} plants, like maize and amaranth, use the Hatch-Slack cycle and produce more positive δ\textsuperscript{13}C results (DeNiro and Epstein 1978). In modern environments, C\textsubscript{4} plants have a δ\textsuperscript{13}C mean of -12‰ and a range of -15‰ to -11‰ (Dawson et al. 2002). In Central Mexico, the dichotomy between C\textsubscript{3} and C\textsubscript{4} plants is complicated by the presence of CAM plants. Because CAM plants employ alternating photosynthetic pathways, they produce δ\textsuperscript{13}C values intermediate to C\textsubscript{3} and C\textsubscript{4} plants (O’Leary 1988). CAM plants are most commonly found among desert and cactus species, such as maguey and nopal. Modern CAM plants produce a δ\textsuperscript{13}C range of -27‰ to -12‰ (O’Leary 1988). Because of their overlap, C\textsubscript{4} and CAM plants are commonly grouped together when isotopically describing diets in archaeological contexts. Overall, δ\textsuperscript{13}C values cannot be used to assess aquatic plant use because the δ\textsuperscript{13}C values of aquatic plants are determined by differences in the boundary layer effects between littoral and pelagic species, and not differences in photosynthetic pathways (Casey and Post 2011).

A δ\textsuperscript{13}C signature is incorporated into an organism when the individual consumes C\textsubscript{3}, C\textsubscript{4}, or CAM plants, and this signature is maintained through the food-chain. In this way, a carnivore feeding on small animals who consumed C\textsubscript{3} plants would also produce a δ\textsuperscript{13}C signature reflective of a C\textsubscript{3} diet. With this said, δ\textsuperscript{13}C\textsubscript{collagen} values are prone to isotopic fractionation (the separation of
a quantity of an isotope during a phase transition), and an individual’s signature will typically be enriched 1‰ – 5‰ when compared to diet (Ambrose and Norr 1993; Keegan and DeNiro 1988; DeNiro and Epstein 1978; van der Merwe 1982). To ease comparisons between human δ¹³C values and dietary inputs, δ¹³C results can be adjusted by reducing the value by 5‰, so that δ¹³C reflects the isotopic signature of the foods consumed (δ¹³C = δ¹³Ccollagen - 5‰) (DeNiro and Epstein 1978; Keegan and DeNiro 1988).

While δ¹³C values are linked to photosynthetic pathways, δ¹⁵N values are primarily guided by an organism’s trophic level and connection to aquatic and terrestrial environments. The higher the trophic level of an organism, the higher their δ¹⁵N values. Plants typically have a δ¹⁵N range of -3‰ – 6‰ (Ambrose 1993; DeNiro and Epstein 1981). With each trophic level increase δ¹⁵N values are increased 2‰ – 6‰ (DeNiro and Epstein 1981; Schoeninger and DeNiro 1984; Schoeninger et al. 1983). A human consuming a vegetarian diet will typically generate a low δ¹⁵Ncollagen value of 3‰ to 9‰ (DeNiro and Epstein 1981; Nado et al. 2017), while humans consuming an omnivorous diet have δ¹⁵Ncollagen values above 9‰ (DeNiro and Epstein 1981; Nado et al. 2017). Marine ecosystems have many more trophic levels, so δ¹⁵N becomes significantly enriched. A human who has a diet heavy in marine resources can generate a δ¹⁵Ncollagen value between 14‰ and 17‰ (DeNiro and Epstein 1981; Nado et al. 2017). As noted above, freshwater ecosystems are highly variable, but foods from these environments typically produce δ¹⁵Ncollagen values intermediate to those of terrestrial and marine ecosystems (DeNiro and Epstein 1981; Nado et al. 2017; Moreiras Reynaga 2020). δ¹⁵N values can also be affected by environmental, climatic, and health factors, though these are unlikely to have whole communities in Tula. Similar to adjustments made to δ¹³C values to account for fractionation, δ¹⁵Ncollagen results can also be adapted to reflect the nitrogen signature of the diet. Typically, δ¹⁵Ncollagen values are reduced by 3‰ to account for fractionation (δ¹⁵N = δ¹⁵Ncollagen - 3‰) (DeNiro and Epstein 1981).

Finally, δ¹³C and δ¹⁵N values can be influenced by an individual’s developmental age. Most notably, nursing infants and children generate δ¹⁵N results that are enriched by 2‰ – 3‰ when compared to women of reproductive age in the same community (Fogel et al. 1989; Fuller et al. 2006; White et al. 2001; Wright and Schwarcz 1999). This is because the nursing child is essentially one trophic level above their mother. This pattern is very easy to identify in the very young, but is more troublesome when older children are considered. Bone, which contains collagen, is a living tissue that regenerates through the life course. During early development, bone turnover is rapid and slows as an individual reaches adulthood. The exact rate of turnover at each age is not known, but researchers generally suggest that infants may experience 100% turnover per year and
children exhibiting 70-50% turnover. In contrast, adults are only expected to experience 0.3-3% turnover per year (Cox and Sealy 1997; Martin et al. 2015). Rates of turnover also differ between types of bones and between cortical and trabecular bone. This means infants will almost certainly generate isotopic values reflective of breastfeeding, while bulk collagen results from adults homogenizes the past 10+ years of life. Interpreting the collagen results from children is more complex because the timing of weaning and the rate of bone turnover both determine if an earlier breastfeeding signal could be hybridized with a non-breastfeeding signature from later in life. Because of this challenge, only individuals over the age of 6 years were the focus of this study.

Comparative Data from the Basin of Mexico

A more complete (though still brief) review of paleodiet studies from Central Mexico can be found in Chapter 3, but a few useful examples are highlighted here and used as comparative data for the La Mesa and Cerro Magoni collections (summarized in Table 15). As noted in Chapter 3, most isotopic diet studies in Central Mexico focus on Teotihuacan, though there are a few important exceptions. This section summarizes a selection of paleodietary studies from Central Mexico and collates plant and faunal isotopic baseline materials from Central Mexico. Comparing the Cerro Magoni and La Mesa data to environmental materials from Hidalgo would be ideal, but no such information exists for the Tula region. Human comparative samples were included in this study if they were from individuals over the age of six, so that no breastfeeding/weaning effects would be present. Finally, only samples with both \( \delta^{13}C \) and \( \delta^{15}N \) values from bone or dentine from second or third adult molars were considered. Because of these restrictions, the descriptive statistics for sites may vary slightly from values published in the literature.

To date there are only two isotopic studies from Central Mexico that address diet prior to the Classic period. In 2003, Gonzalez and colleagues (Gonzalez et al. 2003) produced dietary profiles for four individuals dated to the Mexican pre-ceramic period. In this study, \( \delta^{13}C_{\text{collagen}} \) values ranged from -15.5‰ to -11.6‰ with a mean of -14.0‰ and a standard deviation of 1.7. \( \delta^{15}N_{\text{collagen}} \) values ranged from 9.7‰ to 13.6‰ with a mean of 11.2‰ and a standard deviation of 1.7. Overall, Gonzalez and colleagues suggested that this signature indicated a diet rich in \( \text{C}_4 \) resources, though maize was not domesticated yet. Alternatively, it was proposed that the study individuals consumed graving animals that fed on \( \text{C}_4 \) grasses.

While Gonzalez and colleagues (2003) provides us with an image of ancient foodways during the pre-ceramic period, Storey and colleagues (2019a) generated a “first glimpse” of early agricultural populations from Altica, a site that provides the earliest known evidence of maize cultivation in the Teotihuacan Valley. Though \( \delta^{13}C_{\text{collagen}} \) \((n=4; \text{ range } -9.0‰ - 8.4‰, \text{ mean } -8.7‰, \text{ s.d. } 0.3) \) and \( \delta^{15}N_{\text{collagen}} \) \((n=4; \text{ range } 8.9‰ - 9.7‰, \text{ mean } 9.3, \text{ s.d. } 0.5) \) data was only available from four
Early Formative individuals, the authors were able to concluded that the populations of Altica were likely already reliant on C₄ plants such as maize, a supposition that is supported by paloethnobotanical analyses conducted by McClung de Tapia et al. (2019). In addition to the presence of maize remains at the site, McClung et al. (2019) also detected the use of other wild and cultivated plant species. Overall, this subsistence profile was interpreted as evidence of a milpa-based agroecological system, which may have included the exploitation of both foraged and cultivated resources.

Over the past two decades, many diet studies have been completed at Teotihuacan. Here only a few examples are discussed. First, materials from Tlajinga 17, 18, and 33 were analyzed by Storey and colleagues (2019b) to address potential dietary variation between inhabitants at the different compounds. Tlajinga was a Classic period barrio whose inhabitants were involved in the production of lapidary pieces and San Martin Orange ceramic wares. Generally, the inhabitants of Tlajinga are thought to have been of modest means, with families living in Tlajinga 17 and 18 being slightly wealthier than their neighbors (Storey 2019). Overall, Storey and colleagues found that diets were analogous across the compounds (n=12; ₁³C collagen range -9.9‰ - -6.6‰, mean -8.49‰, s.d. 0.9; ₁⁵N collagen range 7.8‰ – 10.2‰, mean 9.35, s.d. 0.6) at Tlajinga, though individuals from compounds 17 and 18 likely supplemented their diets with more C₃ or CAM plants than those at Tlajinga 33. A heavy reliance on C₄ plants, likely maize or amaranth, was observed, and no differences in terrestrial protein consumption were identified between Tlajinga 17 and 18 and Tlajinga 33.

Analyses have also been conducted at the Classic period barrio of Tlailotlcan. Tlailotlcan is unique because it hosted an Zapotec enclave that housed migrants from Oaxaca and Teotihuacan natives of Oaxacan ethnicity, though other groups may have lived in the neighborhood as well. In their study, White and colleagues (2004b) assessed if migrants consumed different foods than non-migrants, and if social status influence diet. Overall, no significant differences between migrants and non-migrants or between individuals of differing status were identified. Like Tlajinga, the ₁³C collagen (n=6; range -7.9‰ - -7.3‰, mean -7.7‰, s.d. 0.2) and ₁⁵N collagen (n=6; range 8.1‰ – 9.8‰, mean 8.9, s.d. 0.6) results from Tlailotlcan suggest a diet high in C₄ plants, like maize, accompanied by terrestrial animal consumption. Interestingly, of the comparative samples presented here, Tlailotlcan has the most enriched ₁³C average.

In addition to examples from the Mexican pre-ceramic period, Altica, and Teotihuacan, one isotopic study containing samples from the Postclassic/Aztec period (Mazapa AD 800-1150/Aztec 1430-1521) has been published (Moreiras Reynaga et al. 2020). The study includes individuals from a single household at the site of San Cristobal Ecatepec in the Basin of Mexico,
near the Texcoco and Xaltocan lakes. Inhabitants at the site may have specialized in textile and salt production, paying tribute to Tenochtitlan during Aztec times. In addition to the fact that this study is the first to provide isotopic data from an Aztec context, it is also unique because the inhabitants of Ecatepec were well positioned to exploit lacustrine resources. Overall, Moreiras and colleagues found that the residents of Ecatepec primarily consumed C_4 and CAM resources (n=11; \(\delta^{13}C_{\text{collagen}}\) range -9.2‰ - -7.2‰, mean -8.2‰, s.d. 0.6), but concluded that lacustrine foods were also included in the diet (n=11; \(\delta^{15}N_{\text{collagen}}\) range 9.0‰ – 12.2‰, mean 11.3‰, s.d. 0.9). Though no statistically significant differences were identified between the sexes, slightly enriched \(\delta^{13}C\) values were observed among males, and Moreiras and colleagues suggest that this may have been linked to higher pulque consumption.

<table>
<thead>
<tr>
<th>Site</th>
<th>N</th>
<th>Mean (\delta^{13}C_{\text{collagen}})</th>
<th>S.D.</th>
<th>Range</th>
<th>Mean (\delta^{15}N_{\text{collagen}})</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleoindian</td>
<td>4</td>
<td>-14.0‰</td>
<td>1.7</td>
<td>-15.4 to -11.6‰</td>
<td>11.2‰</td>
<td>1.7</td>
<td>9.7 to 13.6‰</td>
</tr>
<tr>
<td>Altica</td>
<td>4</td>
<td>-8.7‰</td>
<td>0.3</td>
<td>-9.0 to -8.4‰</td>
<td>9.3‰</td>
<td>0.5</td>
<td>8.9 to 9.7‰</td>
</tr>
<tr>
<td>Tlajinga</td>
<td>12</td>
<td>-8.5‰</td>
<td>0.9</td>
<td>-9.9 to -6.6‰</td>
<td>9.4‰</td>
<td>0.6</td>
<td>7.8 to 10.2‰</td>
</tr>
<tr>
<td>Tlailotlacan</td>
<td>6</td>
<td>-7.7‰</td>
<td>0.2</td>
<td>-7.9 to -7.3‰</td>
<td>8.9‰</td>
<td>0.6</td>
<td>8.1 to 9.8‰</td>
</tr>
<tr>
<td>Ecatepec</td>
<td>11</td>
<td>-8.2‰</td>
<td>0.6</td>
<td>-9.2 to -7.2‰</td>
<td>11.3‰</td>
<td>0.6</td>
<td>9.0 to 12.2‰</td>
</tr>
</tbody>
</table>

Table 15. Summary table of comparative human examples from the Basin of Mexico.

While it is not currently possible to provide \(\delta^{13}C\) and \(\delta^{15}N\) estimates for plants and animals from Tula, materials from the Basin of Mexico provide a functional proxy. Following Moreiras Reynaga and colleagues (2020), a potential diet space for Central Mexico can be formulated by collating the results of analyses conducted by Casar et al. (2017), Lounejeva-Baturina et al. (2006), Manin et al. (2018), Morales-Puente et al. (2012), Somerville et al. (2017), and Warinner (2010). Together, these papers provide \(\delta^{13}C\) and \(\delta^{15}N\) estimates for the following foods: mezquite, squash, green tomo, tejocote, huauhtzontle, epazote, catlin fruit, huizache, zapote, calabaza, chilacayote, red tomato, beans, maize, amaranth, nopal, tuna fruit, xoconostle, maguey, biznaga, chilies, rabbits, hares, opossums, turkeys, dogs, insects, bobo mullet fish, red snapper, gray pompano, and blue runner. When broken into appropriate categories, these results generate estimated isotopic ranges for C_3, C_4, and CAM plants, terrestrial faunal species, insects derived from C_3 environments, insects derived from C_4/CAM environments, fish from riverine environments, and fish from ocean environments. These results, in addition to the scientific name for each plant or animal species, can be found in Table 16.
Methods

As mentioned above, detailed methods for the collagen extraction process can be found in Chapter 5. Values for $\delta^{13}C_{\text{collagen}}$, $\delta^{15}N_{\text{collagen}}$, $\delta^{13}C_{\text{diet}}$, and $\delta^{15}N_{\text{diet}}$ results for Cerro Magoni and La Mesa are presented in Table 17. Sex estimates for these sites were conducted by the author using the practices outlined in *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). Age estimation was conducted on juvenile individuals to determine if they were old enough to reflect a post-weaning diet. Only individuals over the age of six were included in this analysis, and juvenile age was estimated using dental development and skeletal fusion (AlQahtani et al. 2010; Scheuer and Black 2000). All demographic data for the comparative cases (Paleoindian, Altica, Teotihuacan, and Ecaetpec) was drawn from the published literature, though some classificatory systems were simplified.

$\delta^{13}C_{\text{collagen}}$ values are presented relative to VDPD and AIR, while diet values are adjusted to account fractionation. $\delta^{13}C_{\text{diet}}$ values were calculated reducing the $\delta^{13}C_{\text{collagen}}$ value by 5‰, so that $\delta^{13}C_{\text{diet}}$ reflects the isotopic signature of the foods consumed ($\delta^{13}C_{\text{diet}} = \delta^{13}C_{\text{collagen}} - 5‰$). $\delta^{15}N_{\text{collagen}}$ results were also adapted to reflect the nitrogen signature of the diet by reducing the value by 3‰ to account for enrichment ($\delta^{15}N_{\text{diet}} = \delta^{15}N_{\text{collagen}} - 3‰$). $\delta^{13}C_{\text{diet}}$ and $\delta^{15}N_{\text{diet}}$ values were only used to compare data from Cerro Magoni and La Mesa to potential food sources. In all other instances, $\delta^{13}C_{\text{collagen}}$ and $\delta^{15}N_{\text{collagen}}$ values were used to make comparisons.

Environmental baseline samples are visually presented in Figures 29 and 30 and summarized in Table 16 (Casar et al. 2017a, 2017b, Lounjeva-Baturina et al. 200, Manin et al. 2018, Morales-Puente et al. 2012, Somerville et al. 2017, and Warinner 2010). To ensure compatibility with the ancient human collagen results, botanical and faunal $\delta^{13}C$ values from modern contexts were increased by 1.5‰ to account for the seuss effect (Wahlen 1994). Additionally, $\delta^{13}C$ faunal values derived from bone were reduced by 2‰ to reflect differences between meat and bone (DeNiro and Epstein 1981). Statistical analyses were conducted in IBM SPSS Statistics Version 27 and Graphpad Prism Version 9.0.0 (86). Tests were considered statistically significant when p-values were below a threshold of 0.05. Each statistical test conducted is described below with the results of the test.
<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Plant Type/ Habitat</th>
<th>Modern/Archaeological</th>
<th>Native/Exotic to Basin of Mexico</th>
<th>δ13C N</th>
<th>Mean</th>
<th>SD</th>
<th>Lower Range</th>
<th>Upper Range</th>
<th>δ15N N</th>
<th>Mean</th>
<th>SD</th>
<th>Lower Range</th>
<th>Upper Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mezquite, Squash, Green Tomato, Tejocote, Huauhtzontle, Epazote, Capulin Fruit, Huizache, Zapote, Calabaza, Chilacayote, Red Tomato</td>
<td>Prosopis, Cucurbita sp., Physalis ixocarpa, Crataegus mexicana, Chenopodium sp., Acacia pennatula, Cassimiroa edulis, Solanum lycopersicum</td>
<td>C3</td>
<td>Modern</td>
<td>Native</td>
<td>18</td>
<td>-24.0</td>
<td>1.9</td>
<td>-26.8</td>
<td>-18.3</td>
<td>18.0</td>
<td>3.7</td>
<td>3.1</td>
<td>-1.0</td>
<td>8.4</td>
</tr>
<tr>
<td>Bean</td>
<td>Phaseolus vulgaris</td>
<td>C3</td>
<td>Modern</td>
<td>Native</td>
<td>19</td>
<td>-24.0</td>
<td>1.9</td>
<td>-</td>
<td>-</td>
<td>19.0</td>
<td>3.4</td>
<td>3.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C3 Plant Combined</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>Zea mays</td>
<td>C4</td>
<td>Modern</td>
<td>Native</td>
<td>6</td>
<td>-10.2</td>
<td>0.4</td>
<td>-10.9</td>
<td>-9.9</td>
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<td>0.5</td>
<td>1.0</td>
<td>-0.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Amaranth</td>
<td>Amaranthus sp.</td>
<td>C4</td>
<td>Modern</td>
<td>Native</td>
<td>4</td>
<td>-12.6</td>
<td>1.2</td>
<td>-13.6</td>
<td>-10.9</td>
<td>4.0</td>
<td>4.5</td>
<td>2.2</td>
<td>2.8</td>
<td>7.6</td>
</tr>
<tr>
<td>Nopal, Tuna Fruit, Xoxonostle, Maguey, Biznaga, Chilies</td>
<td>Opuntia, Agave sp., Echinocactus sp.</td>
<td>CAM</td>
<td>Modern</td>
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<td>1.0</td>
<td>-2.0</td>
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<tr>
<td>C3/CAM Combined</td>
<td></td>
<td></td>
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<tr>
<td>Rabbit and Hare</td>
<td>Sylvilagus floridanus, Lepus sp.</td>
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<td>Archaeological</td>
<td>Native</td>
<td>67</td>
<td>-17.4</td>
<td>2.8</td>
<td>-24.3</td>
<td>-12.2</td>
<td>67.0</td>
<td>5.6</td>
<td>2.2</td>
<td>0.3</td>
<td>13.7</td>
</tr>
<tr>
<td>Opossum</td>
<td>Didelphidae</td>
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<td>Archaeological</td>
<td>Native</td>
<td>1</td>
<td>-14.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
<td>8.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Turkey</td>
<td>Melagrís gallopavo</td>
<td>Terrestrial</td>
<td>Archaeological</td>
<td>Native</td>
<td>18</td>
<td>-14.0</td>
<td>3.3</td>
<td>-20.7</td>
<td>-10.4</td>
<td>18.0</td>
<td>6.6</td>
<td>1.7</td>
<td>3.5</td>
<td>8.9</td>
</tr>
<tr>
<td>Dog</td>
<td>Canis familiaris</td>
<td>Terrestrial</td>
<td>Archaeological</td>
<td>Native</td>
<td>3</td>
<td>-9.7</td>
<td>0.3</td>
<td>-10.0</td>
<td>-9.5</td>
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<td>0.9</td>
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</tbody>
</table>
Insects (C3)  | Liometopum apiculatum, Hypopta agavis, Sphenarium sp. | Terrestrial | Modern | Exotic (Oaxaca Valley) | 7 | -24.2 | 3.5 | -26.9 | -17.0 | 7.0 | 6.1 | 1.6 | 4.2 | 8.6

Insects (C4/CAM)  | Acenotrems hesperiaris, Hypopta agavis | Terrestrial | Modern | Exotic (Oaxaca Valley) | 3 | -9.9 | 0.5 | -10.4 | -9.5 | 3.0 | 5.5 | 1.0 | 4.8 | 6.7

Bobo Mullet Fish  | Joturus pichardi | Riverine | Modern | Exotic | 2 | -21.0 | N/A | -22.1 | -19.8 | 2.0 | 9.1 | 7.7 | 10.5 | 6.7

Red Snapper, Gray Pampano, Blue Runner  | Lutjanus campechanus, Trachinotus carolinus, Caranx crysos | Marine | Modern | Exotic | 4 | -15.2 | 1.2 | -16.6 | -13.7 | 4.0 | 12.3 | 0.3 | 12.2 | 12.7

Table 16. Faunal and botanical samples from the Basin of Mexico. Modern plants and animal values were corrected by +1.5‰ to account for the sue's effect. Carbon values from archaeological fauna were adjusted -2.0‰ to reflect the difference collagen from tissue and bone.
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<th>Bone Type</th>
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<th>Yale/UNM Code</th>
<th>ε</th>
<th>δ</th>
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<td>La Mesa Burial 22/22 Bis</td>
<td>M</td>
<td>Post pubescent</td>
<td>Ulna</td>
<td>Ultrafilter</td>
<td>UNM LM41</td>
<td>-9.52</td>
<td>9.11</td>
<td>-14.52</td>
<td>6.11</td>
<td>45.6</td>
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<tr>
<td>La Mesa Burial 23</td>
<td>F</td>
<td>Post pubescent</td>
<td>Ulna</td>
<td>Ultrafilter</td>
<td>UNM LM42</td>
<td>-8.24</td>
<td>8.94</td>
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<td>I</td>
<td>6.5± 1 years</td>
<td>Humerus</td>
<td>Ultrafilter</td>
<td>UNM LM43</td>
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<td>8.89</td>
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<td>F</td>
<td>Post pubescent</td>
<td>Fibula</td>
<td>Ultrafilter</td>
<td>UNM LM44</td>
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<td>8.73</td>
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<td>Ulna</td>
<td>XAD</td>
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<td>Ultrafilter</td>
<td>UNM LM47</td>
<td>-7.79</td>
<td>9.5</td>
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<td>Mandible</td>
<td>Ultrafilter</td>
<td>UNM LM49</td>
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<td>10.63</td>
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<td>Mandible</td>
<td>Ultrafilter</td>
<td>UNM LM51</td>
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Table 17. Laboratory data for $\delta^{13}$C$_{\text{collagen}}$ and $\delta^{15}$N$_{\text{collagen}}$ analyses. $\delta^{15}$N$_{\text{diet}} = \delta^{15}$N$_{\text{collagen}} - 3‰$ and $\delta^{13}$C$_{\text{diet}} = \delta^{13}$C$_{\text{collagen}} - 5‰$.  

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Results
Differences Between Cerro Magoni and La Mesa

At Cerro Magoni \((n = 12)\), the mean \(\delta^{13}C_{\text{collagen}}\) value was -7.6‰ with a range of -8.5‰ to -6.80‰ and a standard deviation of 0.5 (Figure 20). A Shapiro-Wilk test confirms that the \(\delta^{13}C_{\text{collagen}}\) data from Cerro Magoni is normally distributed (Shapiro-Wilk \(df = 12, W = 0.96, p = 0.80\)), and no statistical outliers were detected. For La Mesa \((n = 44)\), the mean \(\delta^{13}C_{\text{collagen}}\) value is -8.6‰ with a range of -9.52‰ to -7.73‰ and a standard deviation of 0.4 (Figure 20). \(\delta^{13}C_{\text{collagen}}\) results from La Mesa were also normally distributed (Shapiro-Wilk \(df = 44, W = 0.97, p = 0.35\)). Again, no \(\delta^{13}C_{\text{collagen}}\) outliers were identified. \(\delta^{15}N_{\text{collagen}}\) values from Cerro Magoni have a mean of 9.3‰ with a range of 8.8‰ to 10.9‰ and a standard deviation of 0.54 (Figure 21). At La Mesa, the \(\delta^{15}N_{\text{collagen}}\) mean was 9.1‰ with a range of 8.16‰ to 11.1‰ and a standard deviation of 0.52 (Figure 21). Neither data set was normally distributed (Cerro Magoni Shapiro-Wilk \(df = 12, W = 0.76, p = 0.003\); La Mesa Shapiro-Wilk \(df = 44, W = 0.90, p = 0.001\)), and statistical outliers were identified in both cases. At Cerro Magoni, Burial 7 was the only outlier, but at La Mesa both Burial 17 and Saqueo Adult Individual C were outliers. Both Burial 7 and Burial 17 identified as an extreme outlier (outside the 1st and 3rd quartile range). All three individuals present enriched \(\delta^{15}N_{\text{collagen}}\) values when compared to the rest of the population.

To test if there are dietary differences between the sites of Cerro Magoni and La Mesa, a Mann-Whitney U test was used because non-normality and outliers are present in many of the data sets. The distributions of the La Mesa and Cerro Magoni \(\delta^{15}N_{\text{collagen}}\) values were considered similar, as determined by visual examination. The median \(\delta^{15}N_{\text{collagen}}\) values for Cerro Magoni (median =9.30) and La Mesa (median =9.13) were not statistically significantly different \((U = 200.0, z = -1.3, p = 0.20)\). The distributions of the La Mesa and Cerro Magoni \(\delta^{13}C_{\text{collagen}}\) were not considered similar as determined by visual examination, but the \(\delta^{13}C_{\text{collagen}}\) values from La Mesa (mean rank= 23.56) and Cerro Magoni (mean rank= 46.63) were statistically significantly different \((U = 46.50, z = -4.3, p <0.001)\).
Figure 20. $\delta^{13}$C$_{\text{collagen}}$ values for Cerro Magoni and La Mesa. The bolded line represents the median value. The second and the third quartile are contained by the red box, and the outer whiskers define the maximum and minimum values.

Figure 21. $\delta^{15}$N$_{\text{collagen}}$ values for Cerro Magoni and La Mesa. The bolded line represents the median value. The second and the third quartile are contained by the red box, and the outer whiskers define the first and fourth quartiles. Outliers are denoted by circles and extreme outliers are marked by asterisks.
Differences Based on Sex

At Cerro Magoni, $\delta^{13}$C$_{\text{collagen}}$ values for males ($n = 4$) have a mean of $-7.5\%_o$, a range $-8.0\%_o$-$-6.8\%_o$ and a standard deviation of 0.53. Females ($n = 6$) have a mean $-8.0\%_o$, range $-8.5\%_o$-$-7.3\%_o$ and standard deviation of 0.5 (Figure 22). Both of these variables are normally distributed and no statistical outliers were observed ($\delta^{13}$C$_{\text{collagen}}$ Cerro Magoni males Shapiro-Wilk df = 4, $W = 0.95, p = 0.69$; $\delta^{13}$C$_{\text{collagen}}$ Cerro Magoni females Shapiro-Wilk df = 6, $W = 0.89, p = 0.31$). Additionally, the $\delta^{15}$N$_{\text{collagen}}$ values of males at Cerro Magoni have mean of $9.2\%_o$, range $8.8 - 9.4\%_o$, and standard deviation of 0.3. Females have a mean of $9.2\%_o$, range $8.9\%_o - 9.7\%_o$, and standard deviation of 0.27 (Figure 23). Both variables were normally distributed ($\delta^{15}$N$_{\text{collagen}}$ Cerro Magoni males Shapiro-Wilk df = 4, $W = 0.85, p = 0.22$; $\delta^{13}$C$_{\text{collagen}}$ Cerro Magoni females Shapiro-Wilk df = 6, $W = 0.92, p = 0.56$), but one statistical outlier, Burial 10, was identified among the females.

Figure 22. $\delta^{13}$C$_{\text{collagen}}$ values for Cerro Magoni by sex. The bolded line represents the median value. The second and the third quartile are contained by the red box, and the outer whiskers define the maximum and minimum values.
Figure 23. $\delta^{15}$N$_{\text{collagen}}$ values for Cerro Magoni by sex. The bolded line represents the median value. The second and the third quartile are contained by the red box, and the lower whiskers define the first quartiles. Outliers are denoted by circles.

At La Mesa, $\delta^{13}$C$_{\text{collagen}}$ values for males ($n = 17$) had a mean of $-8.7\%$, a range of $-9.1\%$ to $-7.7\%$, and a standard deviation 0.4. Females ($n = 17$) had a mean of $-8.5\%$, range of $-9.1\%$ to $-7.7\%$, and a standard deviation of 0.4 (Figure 24). In both instances, the $\delta^{13}$C$_{\text{collagen}}$ values were normally distributed ($\delta^{13}$C$_{\text{collagen}}$ La Mesa males Shapiro Wilk df = 17, $W=0.97$, $p=0.75$; $\delta^{13}$C$_{\text{collagen}}$ La Mesa females Shapiro Wilk df = 17, $W=0.94$, $p=0.30$). Two outliers were identified among the females, Burials 15 bis and 32, and Burial 22/22 bis was identified as an outlier among the males. The $\delta^{15}$N$_{\text{collagen}}$ values of males at La Mesa have a mean of $9.2\%$, a range of $8.5\%$ to $9.67\%$, and a standard deviation of 0.3. Females have a mean of $9.1\%$, a range of $8.65\%$ to $10.36\%$, and a standard deviation of 0.5 (Figure 25). $\delta^{15}$N$_{\text{collagen}}$ results from males were normally distributed ($\delta^{15}$N$_{\text{collagen}}$ La Mesa males Shapiro-Wilk df 17, $W=0.11$, $p=0.36$), but Burial 20 bis was identified as an outlier. In contrast, results from females were not normally distributed ($\delta^{15}$N$_{\text{collagen}}$ La Mesa females Shapiro-Wilk df = 17, $W=0.01$, $p= <0.001$), and Saqueo Adult Individual C was again identified as an outlier.
Figure 24. $\delta^{13}C_{\text{collagen}}$ values for La Mesa by sex. The bolded line represents the median value. The second and the third quartile are contained by the red box, and the outer whiskers define the maximum and minimum values. Outliers are denoted by circles and extreme outliers are marked by asterisks.

Figure 25. $\delta^{15}N_{\text{collagen}}$ values for La Mesa by sex. The bolded line represents the median value. The second and the third quartile are contained by the red box, and the whiskers define the first and fourth quartiles. Outliers are denoted by circles and extreme outliers are marked by asterisks.
To test if there are dietary differences between males and females at each site a Mann-Whitney U test was used because non-normality and outliers are present in many of the data sets. At La Mesa, the distributions of both $\delta^{13}$C$_{\text{collagen}}$ and $\delta^{15}$N$_{\text{collagen}}$ values for males and females were considered similar, as determined by visual examination. The median $\delta^{13}$C$_{\text{collagen}}$ values for males (median = -8.67) and females (median = -8.50) were not statistically significantly different ($U = 174.0, z = 1.02, p = 0.31$). Additionally, the median $\delta^{15}$N$_{\text{collagen}}$ values for males (median = 9.2) and females (median = 9.0) at La Mesa were also not statistically significantly different ($U = 116.5, z = -0.97, p = 0.34$). At Cerro Magoni, the distributions of both $\delta^{13}$C$_{\text{collagen}}$ and $\delta^{15}$N$_{\text{collagen}}$ values for males and females were not considered similar, as determined by visual examination. $\delta^{13}$C$_{\text{collagen}}$ values for males (mean rank = 4.33) and females (mean rank 7.25) were not statistically significantly different ($U = 5.0, z = -1.5, p = 0.17$). With this said, the $\delta^{13}$C$_{\text{collagen}}$ values of females at Cerro Magoni were typically lower than those of males. $\delta^{15}$N$_{\text{collagen}}$ values for males (mean rank = 5.67) and females (mean rank = 5.25) were also not statistically significantly different ($U = 13.0, z = 0.22, p = 1.0$). Overall, results comparing male and female diets should be considered cautiously considering the small sample size of individuals for whom sex could be estimated. Overall, these results suggest that there are no overt differences between the diets of male and females at both Cerro Magoni and La Mesa.

The Effect of Time

To test if trends in $\delta^{13}$C$_{\text{collagen}}$ and $\delta^{15}$N$_{\text{collagen}}$ values at Cerro Magoni and La Mesa changed significantly over time, Spearman’s rank-order correlation test was conducted. Samples from both sites were chronologically ordered based on their uncalibrated radiocarbon dates (see Chapter 5). Based on the results of the Spearman’s test, $\delta^{13}$C$_{\text{collagen}}$ values at Cerro Magoni ($n = 12$) show a strong negative relationship to time, which was statistically significant ($r_s = -0.87, p = <0.001$). This trend is visualized in Figure 26. Overall, $\delta^{13}$C$_{\text{collagen}}$ values at Cerro Magoni were higher earlier in time then quickly decreased before reaching a plateau. The relationship between $\delta^{15}$N$_{\text{collagen}}$ values at Cerro Magoni and time was not statistically significant ($r_s = 0.12, p = 0.72$). Additionally, there was no statistically significant relationship between time and the $\delta^{13}$C$_{\text{collagen}}$ ($r_s = -0.08, p = 0.61$) or $\delta^{15}$N$_{\text{collagen}}$ ($r_s = 0.04, p = 0.82$) values from La Mesa ($n = 44$).
Transmission of information from Cerro Magoni.
Burial 14 is the oldest date in the sequence with a modelled 95% likelihood range of AD 615-672. Burial 9 is the youngest date with a modelled 95% likelihood range of AD 771-892. Details of modelled dates can be found in Chapter 5.

Discussion
What did the Inhabitants of Cerro Magoni and La Mesa Eat and How did the Sites Differ?
As discussed above, variation in $\delta^{13}\text{C}_{\text{collagen}}$ values was the only statistically significant difference between diets at Cerro Magoni and La Mesa. When the two sites were compared, no $\delta^{13}\text{C}_{\text{collagen}}$ outliers were identified, indicating that the trend is not driven by a few extreme cases. Overall, $\delta^{13}\text{C}_{\text{collagen}}$ values at Cerro Magoni are more enriched than those at La Mesa. This suggests a higher reliance on resources derived from a C$_4$/CAM food chain among the inhabitants of Cerro Magoni. In contrast, the inhabitants of La Mesa likely consumed more resources from C$_3$ sources. No statistically significant differences were observed in the $\delta^{15}\text{N}_{\text{collagen}}$ values of the two sites, but visual examination of the data does show that results from La Mesa were more widely dispersed than those from Cerro Magoni. Additionally, $\delta^{15}\text{N}_{\text{collagen}}$ enriched outliers were identified in both cases (Cerro Magoni Burial 7; La Mesa Burial 17 and Saqueo Individual C).

When compared to the inhabitants of other sites from the Basin of Mexico (Figures 27 and Figure 28), a few important observations can be made. Unsurprisingly, individuals from Cerro Magoni and La Mesa are very dissimilar to the Paleoindian samples. Even though the Paleoindian
individuals did probably rely on C₄ foods, their δ¹³C<sub>collagen</sub> values are more depleted than any other comparative example included in this study, and their δ¹⁵N<sub>collagen</sub> values are higher than samples from Altica or Teotihuacan. Additionally, the δ¹⁵N<sub>collagen</sub> values from Cerro Magoni and La Mesa do not overlap with those from the Aztec site of Ecatepec, though the Ecatepec δ¹³C<sub>collagen</sub> values are very comparable to those observed at Cerro Magoni and La Mesa. Overall, the Cerro Magoni and La Mesa results fit most closely with data from Altica and Teotihuacan. While La Mesa is slightly more nitrogen depleted than the inhabitants of Altica and Tlajinga, the mean δ¹³C<sub>collagen</sub> values for the three sites are almost identical. In contrast, Cerro Magoni shows δ¹⁵N<sub>collagen</sub> values very similar to those from Tlajinga and Altica, but δ¹³C<sub>collagen</sub> results more closely related to those from Tlailotlacan. With this said, Cerro Magoni has the most enriched δ¹³C<sub>collagen</sub> results of any sample presented here.

It is impossible to precisely estimate diet using the available data, but by plotting δ¹³C<sub>diet</sub> and δ¹⁵N<sub>diet</sub> values from Cerro Magoni (Figure 29) and La Mesa (Figure 30) with the carbon and nitrogen values of various foods from Central Mexico some suggestions can be made. Generally, δ¹⁵N<sub>diet</sub> values from both Cerro Magoni and La Mesa are suggestive of an omnivorous diet in which terrestrial animals were consumed in limited quantities. Based on the comparative faunal data from the literature, it appears that animals with δ¹⁵N values similar turkeys, rabbits, and hares were likely consumed. Insects may have also been eaten, but many of the species consumed in Central Mexico are seasonal, so it seems unlikely that they would be the driving force behind the Cerro Magoni and La Mesa diets. Given the availability of river resources in Tula, it is somewhat surprising that the δ¹⁵N<sub>diet</sub> values from Cerro Magoni and La Mesa do not reflect the consumption of significant quantities of riverine fish, even though the shells of fresh water mussels were recovered from Cerro Magoni, though it is possible that the δ¹⁵N<sub>diet</sub> enriched outliers from Cerro Magoni and La Mesa were consuming more riverine resources. Alternatively, increased consumption of terrestrial protein could explain the enrichment. While no mortuary data is available for La Mesa, the elevated nitrogen value of Burial 7 is of interest. Chronologically, Burial 7 is situated in the middle of the temporal distribution, but the burial was the only bundle burial recovered from Cerro Magoni. Typically, bundle burials are used when the bones of an important individual are preserved as a form of ancestor veneration. Perhaps this individual was a higher ranking member of the community and had access to a more protein rich diet than others, though there is little evidence of social stratification at Cerro Magoni.

When interpreting isotopic results, it is important to remember that statistically significant variation is not immediately indicative of dramatic dietary differences. Overall, the differences in
\[ \delta^{13}C_{\text{collagen}} \] values between Cerro Magoni and La Mesa likely reflect subtle variation in foodways between the sites, as opposed to completely divergent diets. The \[ \delta^{13}C_{\text{collagen}} \] results from both sites are indicative of a diet heavy in \( C_4 \)/CAM resources, though the inhabitants of Cerro Magoni appear to have consumed more \( C_4 \)/CAM foods. The inhabitants of Cerro Magoni may have consumed more \( C_4 \) cultigens, like maize or amaranth, but increased maguey and cactus cultivation could also explain the carbon enrichment. Pulque production and consumption may have been more common at Cerro Magoni than at La Mesa. This hypothesis is especially interesting given that Cerro Magoni generated the highest \[ \delta^{13}C_{\text{collagen}} \] values of any site reviewed in this study, though they are closest to the ethnically Oaxacan barrio at Teotihuacan. Interestingly, Oaxaca has long been known for maguey cultivation and mezcal production. Perhaps the \[ \delta^{13}C_{\text{collagen}} \] values from Cerro Magoni and Tlailotlcan reflect a shared interest in maguey and pulque. As noted above, the \[ \delta^{13}C_{\text{collagen}} \] values from La Mesa most closely reflect results from Tlajinga and Altica. In both of these contexts, \( C_4 \) plants have been described as the primary dietary input, suggesting the heavy use of maize or amaranth with supplementation from \( C_3 \) resources like beans, which may have been cultivated or wild.

![Basin of Mexico Comparisons](image)

Figure 27. \[ \delta^{13}C_{\text{collagen}} \] and \[ \delta^{15}N_{\text{collagen}} \] values from Cerro Magoni and La Mesa plotted with comparative examples from Central Mexico. Central points represent means and whiskers denote range of data from each site for individuals over the age of six years. Lower right box reflects space depicted in Figure 28.
Figure 28. $^{13}$C$_{collagen}$ and $^{15}$N$_{collagen}$ values from Cerro Magoni and La Mesa plotted with select comparative examples from Central Mexico. Central points represent means and whiskers denote range of data from each site for individuals over the age of six years.

Figure 29. $^{13}$C$_{diet}$ and $^{15}$N$_{diet}$ values from Cerro Magoni plotted with the isotopic composition of potential dietary inputs from the Basin of Mexico. Central points depict the mean value for each food class and whiskers show 95% confidence range.
Did Diets Differ between Males and Females?

Statistical tests showed no significant differences in diet among males and females at Cerro Magoni or La Mesa. This unsurprising, as high isotopic variation between the sexes has rarely been identified in Central Mexican communities. With this said, visual examination of the data does provide some interesting observations. Though differences in $\delta^{13}C_{\text{collagen}}$ values between males and females at Cerro Magoni are not statistically significant, males display slightly higher ratios than females. A similar pattern was also observed at the Aztec site of Ecatepec (Moreiras-Reynaga 2020), and researchers suggested that this trend might have been the result of higher pulque intake among men. This hypothesis is consistent with the ethnographic observations made by and Anderson and colleagues (1946). In these examples, pulque was consumed by individuals of both sexes and all ages, but adult men drank more pulque than other cohorts. At La Mesa, there is even a smaller difference between the sexes. Overall, this may suggest that the difference in $\delta^{13}C_{\text{collagen}}$ values between Cerro Magoni and La Mesa are driven by variation in pulque practices and that the variation also has a gendered component, despite the lack of statistical significance.

Did Diets Change over Time?

In addition to assessing differences between Cerro Magoni and La Mesa and between males and females from both sites, the effect of time was also addressed. Overall, no statistically significant or visually notable changes were observed at La Mesa, and no shifts were apparent in

Figure 30. $\delta^{13}C_{\text{diet}}$ and $\delta^{15}N_{\text{diet}}$ values from La Mesa plotted with the isotopic composition of potential dietary inputs from the Basin of Mexico. Central points depict the mean value for each food class and whiskers show 95% confidence range.
the nitrogen values at Cerro Magoni. In contrast, changes in $\delta^{13}C_{\text{collagen}}$ at Cerro Magoni were significantly and strongly correlated to time. The oldest sample from Cerro Magoni (modelled 95% likelihood AD 615-672) has a moderate $\delta^{13}C_{\text{collagen}}$ value. The $\delta^{13}C_{\text{collagen}}$ values then continued to decrease for approximately 100 years, but rise steeply after 150 years, reaching a peak with the youngest sample in the sequence (modelled 95% likelihood AD 771-892). While males do typically display higher $\delta^{13}C_{\text{collagen}}$ values at Cerro Magoni, it is unlikely that sex is biasing the temporal change, as males are represented in the trough of the curve and females are present in the late peak. Though the Cerro Magoni sample is small, evidence suggests that the carbon enrichment observed over time does reflect a real dietary trend. Isotopically, this increase in $\delta^{13}C_{\text{collagen}}$ values (and lack of change in $\delta^{15}N_{\text{collagen}}$) suggests $C_4$ or CAM resources became an even more important part of the Cerro Magoni diet. This could be related to the increased consumption of grains, like maize or amaranth, or to elevated consumption of cactus and maguey products.

The question of maize/amaranth intensification versus maguey/pulque consumption is a difficult question to answer isotopically. If it is scientifically possible to address this issue using carbon and nitrogen ratios, more baseline samples from Hidalgo would be required. An increase in CAM plant consumption could account for the increase in $\delta^{13}C_{\text{collagen}}$ values at Cerro Magoni, and if CAM consumption increased, it was likely in the form of pulque. There has been a long-standing hypothesis that the founders of the Epiclassic hilltop centers in Tula were migrants from northwestern Mexico (Armillas 1969; Beekman 2015; Beekman and Christensen 2003; Diehl and Berlo 1989; Anderson et al. 2016) and that populations in northern Mexico were more likely to use CAM resources as an important part of the daily diet. Additionally, researchers have also suggested that pulque consumption leads to carbon enrichment. If the early inhabitants of Cerro Magoni were from CAM exploiting populations in northern Mexico, we would expect them to have enriched carbon values. Instead, carbon enrichment occurs near the end of the Epiclassic. If this change in $\delta^{13}C_{\text{collagen}}$ values was the result of increased CAM exploitation, the question of why it manifests later is difficult to answer.

If maize or amaranth consumption increased near the end of Cerro Magoni’s use, it is possible that the social and political maneuvering that led to Tula Grande’s rise was linked to revitalization of the seed agriculture in the region and reopening of the Classic period irrigation systems. Typically, authors (Anderson et al. 2016) suggest that such a change would have been led by political heads at Tula Chico who then received surplus maize as tribute. If this was the case, we are left with the question of how tribute to Tula Chico led to increased consumption at Cerro Magoni. If maize consumption increased throughout the region, change would be expected in the La Mesa material as well. It is possible that Cerro Magoni instead led efforts to revitalize the maize
agriculture systems in Tula, or that both Tula Chico and Cerro Magoni contributed. Unfortunately, it will be impossible to assess this question until data is available from Tula Chico, but the fact that subsistence patterns shifted at the end of the Epiclassic period does support the hypothesis that changes in agricultural practice may have played an important part in the sociopolitical events that led to Tula Grande’s, especially if these changes were linked to an increase in seed agriculture.

While it is difficult to assess the exact cause of the dietary shift at Cerro Magoni, the timing of the event does tell us something very important about the timing of the sociopolitical changes that led Tula Grande’s rise. If Anderson and colleagues are correct in suggesting that changes in agricultural practice were deeply intertwined with Tula Grande’s culmination of power, the timing of the subsistence shifts at Cerro Magoni indicate when sociopolitical changes began to take place. When modelled, the latest burials from Cerro Magoni cluster around AD 775 – 890 (95% likelihood; AD 775-860 at the 65% likelihood level) (see Chapter 5). Given that collagen values from adults give a homogenized signature for up to the last ten years of life, it is reasonable to suggest that important ecological shifts in Tula began to occur between AD 765 and AD 880.

Conclusion

In summary, this study addressed three questions. First, isotopic differences were identified between the Epiclassic hilltop centers of Cerro Magoni and La Mesa. While the sites do not differ in their $\delta^{15}$N<sub>collagen</sub> values, statistically significant variability was identified in $\delta^{13}$C<sub>collagen</sub> values. The inhabitants of Cerro Magoni likely consumed more C<sub>4</sub> or CAM resources than the population of La Mesa. Given the ecology of Tula, this difference suggests that Cerro Magoni was more reliant on maize, amaranth, or pulque produced from maguey, while diets at La Mesa included more C<sub>3</sub> resources, which may have been cultivated or foraged. No statistically significant differences in diet between the sexes were identified at either site, but males at Cerro Magoni do have more enriched $\delta^{13}$C<sub>collagen</sub> values, when compared to females. One possible explanation for this difference is higher pulque consumption among males. A similar phenomenon was observed at the Aztec site of Ecatepec. Finally, $\delta^{13}$C<sub>collagen</sub> values were found to be highly correlated to time. Overall, carbon values became more enriched over time, suggesting a shift in agricultural practice, but it is impossible to determine if this change was linked to increased maguey reliance or increased consumption of seed cultigens like maize or amaranth. If Anderson and colleagues (2016) are correct in suggesting that shifts in agricultural practice played an important role in Tula Grande’s rise to power, the timing of the carbon enrichment at Cerro Magoni does suggest that significant changes began to occur between AD 765 and AD 880.
CHAPTER 7: CONCLUSION

Introduction

This study sought to highlight ways human skeletal collections can be used in Central Mexico to answer archaeological questions that extend beyond issues of population health. Specifically, this approach was applied to remains from the Epiclassic (AD 550-900) Coyotlatelco hilltop settlements from the Tula region of Hidalgo. Though the site of Tula Grande was the heart of Central Mexico’s second expansionist state, it has been studied less than other important settlements. Overall, research in the region has been stalled by a myriad of factors, including missing and damaged collections, variable data quality, and unpublished reports, but the destruction of archaeological sites in the region poses the most significant threat to future work. While this loss is unfortunate, it stems from economic and political realities that are unlikely to change in the near future. Therefore, it becomes increasingly important for archaeologists to recognize the value of the collections that have already been excavated and the potential to derive new information from previously studied material. The pursuit of this dissertation has also drawn into focus the importance of caring for collections once they have been excavated. At minimum, archaeologists have a responsibility to know where materials they excavate are curated, to show an interest in how they are cared for, and to ensure that they are fully documented in a manner that makes the collections accessible to others. Only if these criteria are met, will researchers be able to think in an innovative manner about how lingering questions can be answered using old collections paired with new methods. Thinking creatively about how skeletal remains are studied is an important step in this process. Burial collections can provide information about basic demographic characteristics of a community and health, but they can also be used to generate new data on chronological patterns, dietary trends, migration, and community interaction, providing an important supplement to more traditional analyses of settlement patterning, ceramics, and lithics.

This dissertation’s form shifted many times during its completion, but it was always an exercise in using what was available to learn something new. To that end, this dissertation presented two review chapters and two chapters containing original laboratory data. Chapter 2 summarized archaeological research in Tula, while Chapter 3 presented a review of bioarchaeological work in Central Mexico. Chapter 4 served as a bridging chapter between the reviews in Chapters 1 and 2 and the new data presented in Chapters 5 and 6 by discussing potential sources of bias in archaeological skeletal collections and the available contextual information for the La Mesa and Cerro Magoni collections. Using skeletal remains from the sites of Cerro Magoni and La Mesa, Chapter 5, provided an assessment of the chronology of Coyotlatelco hilltop settlements in the Tula region. Finally, Chapter 6 discussed the results of isotopic diet analyses from both sites. The final
few pages of this dissertation summarize the conclusions and findings of Chapter 2 through Chapter 5, note some limitations of the analyses from Chapters 4 and 5, and propose directions for future work.

**Summary of Findings**

**Chapter 2: Regional Archaeology in Tula**

Chapter 2 reviewed the archaeology of the Tula region. Specifically, the chapter discussed the history of archaeological work in Tula, the current narrative used to explain Tula Grande’s rise to power, and explanations for the cultural shifts observed during the Classic (AD 300-600) - Epiclassic (AD 550-900) period transition and the Epiclassic – Postclassic development of Tula Grande (AD 900-1,200). Though archaeology has been practiced in Tula since the 1940s, the current ceramic chronology for the region was not published until 1990 (Cobean 1990), and radiocarbon dates, especially high-resolution dates, are relatively rare. Issues of chronology have been a major stumbling block in addressing Tula Grande’s rise to power. With this said, researchers have long suggested that populations from the Bajío region of northern Mexico arrived in Tula during the Epiclassic, founded the La Mesa phase hilltop settlements, and eventually contributed to Tula Grande’s culmination (Anderson et al. 2016; Beekman and Christensen 2003; Braniff Conejo 1972; Jiménez Moreno 1966; Mastache and Cobean 1989, 1990; Mastache et al. 2002). It was not until 2012 (Healan 2012), that researchers first realized that the La Mesa phase hilltop sites of Tula and the site of Tula Chico were actually contemporaneous. Previously, it had been assumed that the La Mesa phase centers were predecessors of Tula Chico and that Tula Grande had developed from a step-wise sequence of consolidation. Revealing the contemporaneity of the La Mesa phase centers and Tula Chico emphasized that more settlements were present on the Epiclassic landscape of Tula, suggesting that social and political relationships during this transitional time were more complex than researchers previously hypothesized. In the past decade, this has led to questions about how La Mesa phase communities, like Cerro Magoni and La Mesa, and Tula Chico interacted throughout the Epiclassic and how these interactions somehow culminated in the Tula Grande’s rise.

Anderson and colleagues (2016) provide the most recent series of hypotheses that seek to explain how Tula Grande came to power in the Postclassic period. Overall, they make six suggestions, emphasizing that multiple strategies may have been used. Potential strategies include (1) the consolidation of bottomland populations to develop surplus agricultural goods, (2) the composite cultivation of seed and cactus species, (3) the importation of a pre-existing complex social structure from the Bajío, (4) the conquest of smaller settlements by Tula Chico, (5) the functioning of Tula Chico as a disembedded capital (Blanton 1978), and (6) the merging of populations and ideologies to create the Toltec state. Overall, some of these hypotheses are more
likely than others, and the theories are varied in their scientific testability, but they do highlight areas in Tula archaeology where there is work to be done. As is emphasized in Chapter 5, Tula would benefit greatly from an intensive program of radiocarbon dating that significantly incorporates Bayesian modelling. Additionally, many of Anderson and colleagues’ hypotheses focus on food production as an important consolidation strategy, but there is very little dietary data available for Tula. Currently, limited information is only published for Postclassic contexts, and Chapter 6 of this dissertation contains the only data ever produced for Epiclassic communities in the area. Assessments of ideological shift will require significant investments in excavation in the ceremonial precincts of Tula Chico and Cerro Magoni as well, but these efforts should only be undertaken if adequate resources are available to care for the uncovered structures. Finally, archaeology from Tula would also likely benefit from a reassessment of previously excavated materials. Even in the past 10 years, the capabilities of archaeological science have expanded considerably, and old collections from Tula may provide new insights if approached correctly.

Chapter 3- Bioarchaeology in Highland Mexico

Chapter 3 discussed the study of bioarchaeology in Highland Mexico from the Early Classic period (AD 300-600) to the end of the Toltec period (AD 1,200). While this chapter was not an exhaustive summary of all studies, it highlighted four areas of interest in Central Mexico bioarchaeology: (1) paleodemography, paleopathology, and ancient health, (2) paleodiet reconstructions, (3) migration, and (4) sacrifice. Additionally, this chapter provided theoretical and methodological suggestions for future work in Highland Mexico. In the area of theory, four trends were identified from which Highland bioarchaeology would benefit. First, the introduction of archaeoanatology and an increased interest in how taphonomic processes influence the burial record would aide Central Mexican studies of funerary customs. Second, the study of social identity should be included in bioarchaeological projects so that variation in lived experiences can be explored across time and regions, especially with regard to understudied and marginalized communities. Third, a renewed interest in the theoretical underpinnings of migration and ancient mobility would greatly aide in our interpretations of demographic redistributions in the past, their effect on the social landscape, and the social dynamics of multiethnic centers like Teotihuacan. Finally, bioarchaeology in Highland Mexico would benefit from an increased focus on the nature and effects of interpersonal, socially sanctioned, and structural violence in past communities.

Additionally, four areas of methodological interest were also identified. First, Mexico would benefit from the development of isotopic baselines for areas that are less frequently studied, which could be used to improve studies of both diet and migration. Second, increased AMS radiocarbon dating of burials would contribute significantly to the refinement of chronology in
Mexico, but would also permit greater temporal control for studies of ancient health, diet, and population movement. Third, higher resolution “age-at-death” profiles that lend themselves well to various forms of mortality modeling have the potential to increase the amount of information that can be derived from previously excavated collections. Finally, the chemical analysis of larger samples and complete collections would greatly expand our understanding of communities currently under study and would generate a foundation of comparative data to be used in the future. Central Mexico hosted three of the largest ancient urban centers to ever thrive in the western hemisphere, and throughout the global bioarchaeological community, there is increasing interest in urbanism, migration, and the ways health intersects with issues like inequality, multiculturalism, and resilience in times of environmental and political turmoil. All of these topics are areas where Mexican bioarchaeology has much to offer and has the potential to impact international discourse in a significant way.

Chapter 4 - Bioarchaeological Considerations for Cerro Magoni and La Mesa

Chapter 4 discussed potential sources of bias inherent to bioarchaeological collections and how these issues may have affected the Cerro Magoni and La Mesa samples. Though limited, the available contextual information for each collection was also presented, as was some basic bioarchaeological data. Bias in archaeological skeletal collections can typically be divided into four categories: 1) cultural practices and mortuary traditions, 2) preservation and excavation, and 3) curation, and 4) paleodemographic and paleoepidemiological challenges. With respect to cultural practices and mortuary traditions, all communities must find ways to dispose of their dead, but the manner in which this disposal takes place can directly influence the archaeological record. Some cultures prefer to bury the dead in cemeteries, while others may place deceased individuals in domestic spaces. This directly affects where archaeologists might recover human remains. Additionally, the way in which the body is manipulated prior to final disposal can also bias the record. For example, cremations are less likely to be recovered than complete interments. This becomes especially complex when subsets of a population are treated differently in death, or trends change over time. Of course, some burial environments are more likely to preserve human remains than others and when conditions are poor, the most fragile remains, usually those of the very young, are the first to disappear from the record. This problem can be exacerbated by excavation techniques that do not emphasize careful collection of skeletal remains, excavator errors, and misinterpretations that lead to further loss. Improper or disorganized curation can lead to the further degradation of fragile materials and the outright loss of skeletons if collections are not properly organized and monitored. Once skeletons finally make their way to the osteologists table, researchers are faced with a series of theoretical and methodological dilemmas, including poor age-
at-death estimates, heterogenous frailty and selective mortality, assumptions of demographic stationarity, and the osteological paradox.

As discussed in the limitations section below, it would be absurd to assume that the skeletal collections from La Mesa and Cerro Magoni were completely representative of lived experiences at each settlement. Given the lifespan of the sites themselves, the samples presented here are simply too small and bioarchaeological conclusions drawn from them should be interpreted cautiously. This is especially important in the case of Cerro Magoni. With this said, it does appear that excavation and curation errors are the most likely sources of bias for both collections. Compared to other sites in Mesoamerica, the skeletons from Cerro Magoni and La Mesa are relatively well-preserved. Therefore, it seems unlikely that a significant number of skeletons were lost completely due to issues of preservation. Additionally, both males and females are represented at the site in generally equal numbers, and members of all age categories, including individuals over the age of 40 years and infants are present at both sites, indicating that all age groups are represented in the collections and that no group was systematically excluded from the sample. With this said, it should not be assumed that the age-at-death ratios present in this dissertation are representative of the age-at-death profiles of the sites. Finally, the limited contextual information from the burials included in this dissertation do not suggest that there was a strong social hierarchy at the sites, though some differences may exist between a few individuals and the remainder of the collections.

**Chapter 5 - Radiocarbon Dating in Tula**

In Chapter 5, the published radiocarbon record for the Tula region was reviewed, as was the current chronology. As of 2012, only 23 usable radiocarbon dates were available in Tula, and to the author’s knowledge, no new dates have been produced since. Many of these dates are unfortunately plagued by large standard errors, which limit the usefulness of the data. While these data do highlight the contemporaneity of the La Mesa phase sites and Tula Chico, they cannot be used to estimate other parameters. To address this issue, 52 radiocarbon samples from La Mesa and 12 samples from Cerro Magoni were analyzed to improve our understanding of Epiclassic temporal dynamics. These data were then used to answer three research questions. First, the contemporaneity of the La Mesa phase settlements was assessed. The communities were part of a series of sites surrounding the Tula Valley that were potentially founded by migrants from the Bajío region in northern Mexico, and researchers hypothesize that these individuals played an important part in Tula Grande’s consolidation of power in approximately AD 900. Despite the importance of these communities, very little is known about their absolute chronology and it remains impossible to assess the interaction of these sites. Second, the occupation periods of Cerro Magoni and La Mesa were estimated to test if the sites were ephemeral, or if they were in use for a longer amount of
time. Initial estimates suggested that the La Mesa phase sites were occupied for under 100 years, but it has been difficult to test that hypothesis with the data previously published. Finally, previously published radiocarbon data from Tula Chico was entered into a Bayesian model to evaluate if our current understanding of the site’s use and abandonment could be refined.

Based on the results of these analyses, it is likely that Cerro Magoni and La Mesa were founded very close in time to one another, prior to the end of the Metepec (AD 650) period. The founding of the sites prior to AD 650 is significant because the bottomlands of the Tula Valley may have still been inhabited by Classic period remnant populations. Overcrowding may have been one reason why the La Mesa phase settlements were placed on the inhospitable hilltops surrounding the valley, but the nearly simultaneous founding of centers on nine separate hilltops suggests that any animosity between the Coyotlateco populations and the Classic period communities was not great enough to encourage the La Mesa phase households to live together in a large settlement. Though the La Mesa phase sites were founded at the same time, the site of La Mesa was abandoned earlier than Cerro Magoni. This suggests that the transition from the hilltop centers to the lowlands was a gradual process, or that hilltop populations eventually merged. Additionally, the La Mesa phase communities existed for longer than researchers initially projected, suggesting that life in these settlements was actually more stable than the literature suggests. Unfortunately, the radiocarbon dates from Tula Chico were not significantly improved by the Bayesian model, but it is likely that Tula Chico was founded at the same time or before Cerro Magoni and La Mesa. The burning of Platform 1 at Tula Chico has long been considered one of the final events of the Epiclassic period in Tula, but the evidence presented in Chapter 5 suggests that daily life at Cerro Magoni continued for at least several decades after the event. This may mean that the burning of Platform 1 does not symbolize a great societal shift or struggle that immediately led to Tula Grande’s rise, and it may be prudent to reassess narratives that propose the Toltec state was born from violence and conflict.

Overall, the results of Chapter 5 show how a well-executed radiocarbon program in Tula could help to answer longstanding questions, but the chapter also highlights how much work remains to be done. While the analyses conducted here were exclusively using material from human skeletal remains, pairing burial record with architectural radiocarbon dates would help to clarify the rate of community development and nature of household stability in Tula. Additionally, higher resolution radiocarbon dates from Tula Chico would allow for closer comparisons between the site and the La Mesa phase settlements. Finally, no secure radiocarbon record exists for the civic ceremonial precinct at Tula Grande. Therefore, it is impossible to triangulate how the founding and abandonment of the La Mesa phase settlements and Tula Chico corresponds with Tula Grande’s development. If these areas could be addressed, archaeology in Tula could be propelled forward.
Chapter 6- Paleodiet at Cerro Magoni and La Mesa

Finally, in Chapter 6 $\delta^{13}$C$_{collagen}$ and $\delta^{15}$N$_{collagen}$ data was used to characterize paleodietary patterns at Cerro Magoni and La Mesa. This chapter provides the first isotopic paleodiet data ever analyzed for an Epiclassic hilltop center in Tula. In addition to providing a first glimpse of dietary trends at La Mesa phase settlements, three research questions were addressed. First, the diets of the Cerro Magoni and La Mesa populations were compared to one another to assess if the inhabitants of the sites displayed divergent trends. This information was also compared to other populations from the Basin of Mexico to determine if Cerro Magoni and La Mesa are unique, or if they display patterns similar to previously studied populations. Second, differences in dietary trends between males and females were studied for both sites, as men and women can have differential access to resources. Third, by combining the isotopic data with the radiocarbon dates from Chapter 5, it was possible to assess if diets changed over time at Cerro Magoni or La Mesa. This is important because innovations in agricultural practice may have allowed Tula Grande’s population to be effectively supported even in the somewhat marginal landscape of Hidalgo.

Overall, it is likely that the inhabitants of Cerro Magoni and La Mesa both heavily exploited C$_4$/CAM resources and consumed terrestrial fauna. No differences in $\delta^{15}$N$_{collagen}$ values were observed between Cerro Magoni and La Mesa, but there was a statistically significant difference in $\delta^{13}$C$_{collagen}$ values. Comparatively, the $\delta^{13}$C$_{collagen}$ results from La Mesa closely correspond to those observed at the Basin of Mexico communities of Altica and Tlajinga, but Cerro Magoni is more similar to the Oaxaca barrio of Teotihuacan. Additionally, the Cerro Magoni samples produced the most enriched $\delta^{13}$C$_{collagen}$ values of any site included in the study. While a few individuals from the sites display elevated $\delta^{15}$N$_{collagen}$ values, there is little isotopic evidence to suggest intensive exploitation of river resources, though they would have been available to populations in Tula. No statistically significant differences were identified between the diets of males and females at Cerro Magoni and La Mesa, but the $\delta^{13}$C$_{collagen}$ values of males at Cerro Magoni are slightly more enriched than females. This enrichment may be the result of higher pulque consumption among males, as suggested by ethnographic evidence. Even during the 1970s pulque was an important dietary supplement among all ages and sexes in rural Hidalgo, but that men typically consumed more than women and children. Finally, a statistically significant correlation was observed between time and $\delta^{13}$C$_{collagen}$ values at Cerro Magoni, with carbon enrichment occurring as the Epiclassic period progressed. This shift may have been the result of either increased CAM or C$_4$ resource exploitation. Anderson and colleagues (2016) suggest that Tula Grande’s rise to power was facilitated by shifts in agricultural practice, and populations may have revitalized the irrigation systems built during the
Chingú period to allow for increased maize or amaranth production. Alternatively, following the work of Parsons and Darling (2000), Anderson and colleagues also note that maguey cultivation may have also greatly expanded the horticultural capacity of the Tula region. Either hypothesis, or a combination of the two, could account for the isotopic shift observed at Cerro Magoni. Though the exact source of the enrichment cannot be identified, it is likely that the associated ecological shift occurred between AD 765 and AD 880. This change was almost certainly paired with a sociopolitical transition that may be directly related to Tula Grande’s rise to power in AD 900.

**Limitations**

Though several important conclusions were reached in Chapter 5 and Chapter 6, this work does have limitations. One of the most significant sources of bias comes from the skeletal collections themselves. There is no evidence that the skeletal remains of specific classes of individuals (the very young, males or females, individuals of high status, etc.) were excluded from the excavated burial environments at Cerro Magoni and La Mesa, but the collections themselves still remain very small. It would be ludicrous to assume that the limited number of skeletons included in this dissertation were completely representative of all individuals who lived at Cerro Magoni and La Mesa. The samples, especially the sample from Cerro Magoni, is simply too limited. It is highly unlikely that 250 years of lived experience at Cerro Magoni will be accurately captured by 12 individuals. Additionally, it is important to note that the sample included in this dissertation does not reflect the complete excavated collections from Cerro Magoni and La Mesa. Burials are commonly numbered as they are found, and skeletons buried together are usually recovered at the same time making them more likely to be stored together. When skeletons are missing, whole boxes of remains are usually excluded. Because burial number is loosely linked to burial and storage location, the portions of a skeletal collection that remain are usually from a smaller subset of the total number of excavation units or areas. Therefore, the available collection becomes biased towards certain areas within an archaeological site. This process has likely affected both collections included in this dissertation, but because the excavation records for Cerro Magoni and La Mesa are so incomplete it is difficult to estimate what biases have been introduced into the study due to curation error. With this said, many of the conclusions derived from this dissertation are quite general and there is no evidence that this process has skewed the results of the radiocarbon and diet studies. It is also important to note that Cerro Magoni and La Mesa only represent two of approximately nine La Mesa phase hilltop centers from Tula. As noted previously, it is likely that each of these sites had its own life history, though in much of the literature they are discussed as a singular group. Therefore, we should be cautious is assuming that discoveries related to one site will be applicable to all of the La Mesa phase settlements.
Additionally, there are a few limitations in the radiocarbon results presented in this dissertation. As is discussed in Chapter 5, all new radiocarbon dates in this dissertation are derived from burials. Therefore, the dates ultimately reflect when burials began and ceased at the sites. In theory, this range should closely mirror the length of each site’s occupation. This could be problematic if early burials were removed from graves to make room for later interments. There is currently no evidence to suggest that this practice is biasing current estimates, but it should be kept in mind. Second, as mentioned above, the record presented here only describes the occupation of the structures from which the skeletons were excavated and does not provide information on the construction sequences at the site. While the radiocarbon dates from burials could be used to estimate when structures were inhabited, the lack of stratigraphic differentiation in the interments means that the timing of construction sequences cannot be addressed, if they occurred. Additionally, most of the burials included in this dissertation likely come from domestic spaces, so they cannot inform our interpretations of the timing of civic-ceremonial building at either site. The dating of construction events, both domestic and ceremonial, could be very important in unravelling the life history of each site and the sequence of events that led to Tula Grande’s rise in AD 900.

Finally, some limitations can be found in the paleodiet reconstructions in Chapter 6. First, it is important to remember that isotopic reconstructions from bone collagen reflect the food-chain associated with the protein component of the diet, while analyses of bioapatite are thought to reflect the complete diet space. Therefore, it would be ideal to pair the collagen data from Chapter 6 with bioapatite analyses, so that a more complete understanding of diets at Cerro Magoni and La Mesa can be reached, and this work is already underway. Though the sample size from La Mesa is substantial, the sample from Cerro Magoni is small. Because of this, conclusions derived from the Cerro Magoni data should be considered preliminary and should be tested more fully in the future, if possible. This is an especially important when considering the potential carbon enrichment among males at Cerro Magoni. The difference is not statistically significant and is derived from a total sample of only 10 individuals. This observation should not be taken as proven fact, but should instead be viewed as an invitation to conduct further tests at Cerro Magoni and at other sites throughout Central Mexico. Finally, the analysis of paleodiet presented in Chapter 6 would be improved by region specific baseline data from local plants and animals. For the analyses presented here, data from the Basin of Mexico was largely relied upon. There is no reason to believe that the isotopic carbon and nitrogen signatures of plants and animals from the Basin of Mexico would differ wildly from those in Tula, but it would still be worthwhile to investigate the issue further, especially in the case of CAM plants and products. Clearly, there is much room for expansion in the bioarchaeology of Tula and some suggestions for future directions are presented below.
**Future Directions**

One of the central takeaways from Chapter 2 is that there is much work to be done in Tula. Given the rate of site destruction and development in the region, the window to learn more about the Epiclassic period in the region is closing. Though plans for this dissertation changed many times, new high-quality datasets for the Tula region were successfully produced. The number of usable radiocarbon dates for Epiclassic centers in the region was increased from 10 to 74. While previously published radiocarbon dates for Tula Chico and La Mesa have an average standard error of around 63 years, dates generated in this dissertation are of much higher resolution with an average error of around 20 years. Not only does this increase in precision improve the resolution of the individual dates, the dates also lend themselves better to Bayesian modelling. Because the Epiclassic period was relatively short, modeling is probably the only way in which the chronology of the area can be truly refined, but the effectiveness of a model is directly correlated with the quality of the entered data.

The new dates from Cerro Magoni and La Mesa should encourage researchers to reconsider the longevity and stability of the La Mesa phase settlements in Tula, and differences between the two study sites remind us that the La Mesa phase communities were not a homogenous entity. Each site likely had its own narrative, and the key to understanding Tula Grande’s rise could come from understanding these individual stories. In the future, it will be necessary to construct a more refined radiocarbon record for Tula Chico and for Tula Grande. Once these projects are completed, it will be possible to more fruitfully compare Tula Chico’s longevity and chronology with that of the La Mesa phase settlements. While the published radiocarbon dates from Tula Grande are of high resolution, their provenience is somewhat problematic, as researchers are unsure if the materials dated are culturally associated with early Toltec times, or if they are linked to Corral phase occupations. Until a sequence of well-provenienced dates with established affiliations to Epiclassic or Toltec cultural horizons can be generated for the early construction phases of Tula Grande it will be impossible to establish how Tula Grande’s early development corresponded with the occupation and eventual abandonment of the La Mesa phase settlements and Tula Chico.

Unfortunately, the radiocarbon dates presented in Chapter 5 only inform our understanding of residential life at Cerro Magoni and La Mesa, and because of burial practices in Central Mexico it is possible that some of the earliest burials are missing from the sequence. Therefore, it would be beneficial to develop a corresponding radiocarbon chronology that directly dates the residential spaces at both sites. Because burials from the La Mesa phase settlements are universally placed along the bedrock layer, interments from the site do not lend themselves well to Bayesian models because no stratigraphic levels separate older burials from younger burials. Therefore, domestic
architectural sequences are probably the best choice for creating refined chronologies for habitation spaces among the hilltop centers. Additionally, data from this dissertation does little to refine our understanding of civic ceremonial structures at Cerro Magoni and La Mesa. Developing a separate sequence of dates from these structures would help to clarify the timing of key sociopolitical developments during the Epiclassic.

While Chapter 6 presents the first isotopic paleodiet data ever produced for Tula, the issue should be explored more fully. Tula would benefit significantly from the analysis of more zooarchaeological and botanical collections, especially from Epiclassic contexts. Additionally, these materials should also undergo isotopic analysis so that dietary baselines can be generated specifically for Tula. Even a limited study would help to confirm if plant and animal data from the Basin of Mexico are an appropriate proxy for diets in Hidalgo. Hopefully in the coming years isotopic data will also become available for populations from the Bajío region. Currently, the isotopic “signature” of these communities is completely unknown. Given the relationship between δ13C values and time at Cerro Magoni, researchers should be prepared to conduct radiocarbon dating on a significant proportion of the burials being studied. Regarding individuals from Cerro Magoni and La Mesa, bioapatite (δ13Capatite) analyses are currently underway for all study individuals. When combined with the collagen data, it will be possible to quantify the ratio of C₃ to C₄/CAM resources at both sites and to interrogate the potential use of river resources further.

Given the theories of Parsons and Darling (2000) and Anderson and colleagues (2016) and the relationship between time and diet at Cerro Magoni, it is likely that shifting subsistence strategies contributed significantly to Tula Grande’s rise to power. Moving forward more attention should be given to any data (faunal, botanical, ceramic, or isotopic) that could further our understanding of dietary practices at the La Mesa phase sites, Tula Chico, and Tula Grande. Additionally, it would be very interesting to compare an isotopic record from Tula Chico to that of the La Mesa phase sites. Such a comparison may have the potential to elucidate questions related Tula Chico’s dominance during the late Epiclassic.

Conclusion

Osvaldo Sterpone has referred to Tula as a chimera, an entity made of seemingly non-corresponding and at times contradictory parts. As an area of study, scholarship on Tula has significant room for advancement, but working in the region can also be a frustrating affair. As Michael Smith (2007) eloquently notes, the literature from Tula is scattered, many important studies are unpublished, and key data is missing from others. Overall, a lack of basic information about Tula Grande and the surrounding sites greatly limits attempts at progress, but this does provide significant opportunity for researchers who are willing to wrestle the chimera. Even small
quantities of new data have the potential to dramatically impact how Tula Grande is perceived. In the future researchers should focus on letting empirical data, not grand theories, lead discussions. Tula would also benefit from a renewed focus on archaeological stewardship. Given the rate of site destruction in the region, it is imperative that previously excavated collections are actively managed and that adequate resources are in place to care for newly uncovered material. This dissertation shows that new information can be derived from previously studied materials. The archaeological sciences continue to rapidly develop and more advances will undoubtedly come in the next decades. It is the responsibility of current researchers to ensure that at least some part of Tula is available for future generations to study.
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Kennett D.J. and N. Marwan

Klaus, H. D.

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Knüsel, C. J.

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APPENDIX A: OXCAL CODE FOR BAYESIAN MODELS

Cerro Magoni Model

Plot()
{
  Sequence()
  {
    Boundary("Start 1");
    Phase("1")
    {
      R_Date("CM25", 1390, 20);
      R_Date("CM11", 1320, 25);
      R_Date("CM08", 1310, 25);
      R_Date("CM04", 1260, 20);
      R_Date("CM05", 1245, 20);
      R_Date("CM01", 1230, 20);
      R_Date("CM07", 1210, 25);
      R_Date("CM02B", 1195, 20);
      R_Date("CM06", 1195, 20);
      R_Date("CM03", 1190, 25);
      R_Date("CM10", 1190, 20);
      R_Date("CM09", 1185, 30);
      Span("CERRO MAGONI SPAN");
      Interval("CERRO MAGONI INTERVAL");
    }
    Boundary("End 1");
  };
}
La Mesa Single Phase Model

Plot()
{
  Sequence()
  {
    Boundary(“Start 1”);
    Phase(“1”)
    {
      R_Date(“LM21”, 1410, 20);
      R_Date(“LM19”, 1400, 20);
      R_Date(“LM51”, 1390, 20);
      R_Date(“LM10”, 1370, 20);
      R_Date(“LM48”, 1365, 20);
      R_Date(“LM41”, 1360, 20);
      R_Date(“LM40”, 1340, 20);
      R_Date(“LM44”, 1335, 20);
      R_Date(“LM26”, 1330, 20);
      R_Date(“LM47”, 1330, 20);
      R_Date(“LM16”, 1325, 20);
      R_Date(“LM49”, 1325, 20);
      R_Date(“LM20”, 1320, 20);
      R_Date(“LM27”, 1320, 20);
      R_Date(“LM32”, 1320, 20);
      R_Date(“LM33”, 1310, 20);
      R_Date(“LM14”, 1305, 20);
      R_Date(“LM29”, 1305, 20);
      R_Date(“LM06”, 1300, 20);
      R_Date(“LM23”, 1300, 20);
      R_Date(“LM25”, 1300, 20);
      R_Date(“LM45”, 1300, 20);
      R_Date(“LM17”, 1295, 20);
      R_Date(“LM31”, 1295, 20);
      R_Date(“LM39”, 1295, 20);
      R_Date(“LM36”, 1285, 20);
      R_Date(“LM38”, 1285, 25);
      R_Date(“LM05”, 1275, 20);
      R_Date(“LM13”, 1270, 20);
      R_Date(“LM18”, 1270, 20);
      R_Date(“LM28”, 1270, 20);
      R_Date(“LM3”, 1270, 20);
      R_Date(“LM30”, 1270, 20);
      R_Date(“LM35”, 1270, 20);
      R_Date(“LM52”, 1270, 20);
      R_Date(“LM43”, 1265, 20);
      R_Date(“LM04”, 1255, 20);
      R_Date(“LM09”, 1250, 20);
      R_Date(“LM24”, 1250, 25);
      R_Date(“LM22”, 1245, 15);
      R_Date(“LM37”, 1245, 20);
      R_Date(“LM11”, 1230, 20);
R_Date("LM34", 1230, 20);
R_Date("LM07", 1220, 20);
R_Date("LM08", 1220, 20);
R_Date("LM46", 1220, 15);
R_Date("LM15", 1205, 20);
R_Date("LM02", 1200, 20);
R_Date("LM50", 1195, 15);
R_Date("LM42", 1185, 20);
R_Date("LM12", 1175, 20);
Span("LA MESA SPAN");
Interval("LA MESA INTERVAL");
);
Boundary("End 1");


Cerro Magoni/La Mesa Start Boundary Difference

Plot()
{
Prior("Start_1_La_Mesa_","Start_1_La_Mesa_.prior");
Prior("Start_1_Magoni_","Start_1_Magoni_.prior");
Difference("Start Diff", "Start_1_La_Mesa_", "Start_1_Magoni_"ollider);
};

Cerro Magoni/La Mesa End Boundary Difference

Plot()
{
Prior("End_1_La_Mesa","End_1_La_Mesa.prior");
Prior("End_1_Cerro_Magoni","End_1_Cerro_Magoni.prior");
Difference("Difference End ", "End_1_La_Mesa", "End_1_Cerro_Magoni");
};
Tula Chico Model

Plot()
{
  Sequence("Tula Chico")
  {
    Phase("Early Ball Court")
    {
      R_Date("5039", 1490, 50);
    };
    Phase("Prior to Burning")
    {
      R_Date("5856", 1260, 130);
      R_Date("5855", 1245, 55);
    };
    Phase("Burning")
    {
      Combine("Burning")
      {
        R_Date("5852", 1265, 30);
        R_Date("5853", 1240, 35);
      };
    };
  };
};
APPENDIX B: BIOARCHAEOLOGICAL OBSERVATIONS FROM CERRO MAGONI

Photos of burials in situ were collected by the Tula Region Interaction and Migration Project and laboratory photos were collected by Kate.

Burial 1

Archaeological Information
Excavation Year: 2012
Provenience: U108C1740
Capa: VI
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Cranium Direction: North
Grave Goods: Present, Perforated Conch Shell

Demographic Information
Age: Adult
Sex: Male
Dental Pathology: Present
Skeletal Pathology: Present

Osteological Discussion
Burial 1 is estimated to be a male in their middle to late adulthood. Sex was estimated through an assessment of cranial morphology, as the os coxae were not recovered. The cranium was found to be very masculine. Additionally, the long bones of Burial 1 are quite robust. Only one sign of postcranial pathology was observed. Eburnation was present on the articular facet of the left tibia. Significant dental wear was also observed. The maxillary dentition shows significant wear along the occlusal surfaces. Carious lesions are present in the molars and several teeth were lost antemortem, as evidenced by the partial filling of the alveolar cavities with bone. The maxillary incisors were also lost antemortem. It is possible the individual used their incisors as tools, leading to escalated wear and eventual tooth loss in the years preceding death.
Field Photos

Burial 1 in situ.
Laboratory Photos

Note resorption of the alveolar cavities of the central incisors.

Eburnation of the proximal left tibia.
Maxillary dentition of Burial 1.
Burial 2

Archaeological Information
Excavation Year: 2012
Provenience: U108C1740
Capa: VI
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Cranium Direction: South
Grave Goods: Absent

Demographic Information
Age: 9.5 ± 1 year
Sex: N/A
Dental Pathology: Present
Skeletal Pathology: Absent

Osteological Discussion
Burial 2 is estimated to be 9.5 ± 1 year. This consensus was reached through the evaluation of the dental development and eruption patterns. Some pinpoint carious lesions were observed on the occlusal surfaces of the molars, but no other pathological conditions were noted.

Additional Associated Material
In addition to the skeletal elements attributed to Burial 2, skeletal elements associated with at least one additional individual were also recovered, including cranial fragments, long bones, scapula fragments, os coxa fragments, vertebra, and ribs. These elements are from an adult (or adults) individual. Among this collection the only notable sign of pathology is a healed rib fracture.
Field Photos

Cranium of Burial 2 in situ.

Long bones of Burial 2 in situ.
Vertebrae and ribs of Burial 2 in situ.
Laboratory Photos

Note incompleteness of root development.

Note unerupted permanent mandibular canines.
Note presence of deciduous molars and unerupted permanent molar.
Burial 3

Archaeological Information
Excavation Year: 2012
Provenience: U108C1740
Capa: VI
Location: Terraces
Matrix: Bedrock and Paleosol

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Craniunm Direction: Northeast
Grave Goods: Absent

Demographic Information
Age: 17.5 ± 1 year
Sex: Possible Male
Dental Pathology: Present
Skeletal Pathology: Absent

Osteological Discussion
Burial 3 is estimated to be a male approximately 17.5 ± 1 years old. This age estimate was reached through an assessment of postcranial epiphyseal fusion and the developmental state of the third molars. No signs of pathology were observed except a few small carious lesions of the molars. Overall, the dentition shows few signs of wear.
**Field Photos**

Cranium of Burial 3 in situ.

Mandible, long bones of the leg, and ilium of Burial 3 in situ.
Laboratory Photos

Left humerus of Burial 3. Note lack of fusion of humeral head to shaft.

Maxilla of Burial 3. Note limited eruption of left third molar.
Mandible of Burial 3. Note limited eruption of third molars.
**Burial 4**

**Archaeological Information**
- Excavation Year: 2012
- Provenience: U108C1740
- Capa: VI
- Location: Terraces
- Matrix: Bedrock and Paleosol

**Burial Information**
- Preservation: Fair
- Primary/Secondary: Primary
- Articulation: Partially Articulated
- Body position: Flexed Left Lateral
- Cranium Direction: South
- Grave Goods: Absent

**Demographic Information**
- Age: Adult
- Sex: Possible Male
- Dental Pathology: N/A
- Skeletal Pathology: Present

**Osteological Discussion**

Burial 4 is estimated to be an adult male. This sex estimation was reached through the measurement of femoral midshaft diameter and the humeral head diameter. It is also important to note that though the above mentioned skeletal metrics are consistent with a male individual, the long bones of the individual are more gracile than those observed among the more robust males in the Cerro Magoni collection, leading to some uncertainty. It is possible that the robusticity of the femur and humerus are related to activity patterning, as opposed to sexual dimorphism. Because the cranium and pelvis of Burial 4 were not recovered it was impossible to provide a more precise estimation of age, though it is apparent that the individual was an adult. Lipping and porosity was observed surrounding the olecranon process of the left ulna. Additionally, it was noted that the left radius assumed to be part of Burial 4 is considerably different in size than the right radius. While the size of the right radius correlates with the overall size of the other skeletal elements, the left radius is more of an outlier. Given this evidence, the recovered left radius may actually belong to a second individual. Periostitis was observed on the left femur, tibia, and fibula. The reaction is most severe along the diaphysis of the femur and tibia, while a more minor reaction is found on the fibula. Overall, the affected diaphyses show signs of increased woven bone development, porosity, and bony striations.
Field Photos

Burial 4 in situ.
Periostitis of the left femur.

Periostitis of the left tibia.
Burial 5

**Archaeological Information**
- Excavation Year: 2012
- Provenience: U108C1740
- Capa: VI
- Location: Terraces
- Matrix: Bedrock and Paleosol

**Burial Information**
- Preservation: Fair
- Primary/Secondary: Disturbed
- Articulation: Disarticulated
- Body position: Nonobservable
- Cranium Direction: N/A
- Grave Goods: Absent

**Demographic Information**
- Age: Adult
- Sex: Possible Female
- Dental Pathology: N/A
- Skeletal Pathology: Present

**Osteological Discussion**
Burial 5 is estimated to be an adult female. This estimate was reached through an assessment of pelvic morphology. Though the subpublic region is absent, it was possible to evaluate the greater sciatic notch, which is characterized as feminine. Additionally, the overall superior-inferior dimension of the os coxa is relatively short. Due to the absence of the cranium and the damaged condition of the recovered os coxa, it was impossible to develop a more precise estimation of age, though the individual is adult. A small area of inactive porosity was observed on the right femoral diaphysis. Additionally, two of the lower cervical vertebrae are fused at the right laminae and spinous process region. The spinous process of the lowest affect vertebra is either resorbed or congenitally absent. The fusion is complete and does not appear to be active.
Field Photos

Burial 5 in situ.
Laboratory Photos

Fusion of lower cervical vertebrae-posterior view.

Fusion of lower cervical Vertebrae-left lateral view.
Fusion of lower cervical vertebrae-right lateral view.
**Burial 6**

**Archaeological Information**
Excavation Year: 2012  
Provenience: U108C1740  
Capa: VI  
Location: Terraces  
Matrix: Bedrock and Paleosol

**Burial Information**
Preservation: Fair  
Primary/Secondary: Secondary  
Articulation: N/A  
Body position: N/A  
Cranium Direction: N/A  
Grave Goods: Absent

**Demographic Information**
Age: Adult  
Sex: Female  
Dental Pathology: Present  
Skeletal Pathology: N/A

**Osteological Discussion**
Burial 6 is represented by the isolated cranium of a female adult. The only observed pathology was the presence of pinpoint dental caries on the occlusal surfaces of the right mandibular first and third molars. Overall, the remains of Burial 6 are poorly preserved, as the cranium is highly fragmented and warped.
Field Photos

Burial 6 in situ with Burial 3.
Cranial fragments of Burial 6.

Burial 7

**Archaeological Information**
Excavation Year: 2012  
Provenience: U092C1778  
Capa:III  
Location: Terraces  
Matrix: Bedrock and Paleosol

**Burial Information**
Preservation: Good  
Primary/Secondary: Secondary  
Articulation: Disarticulated  
Body position: N/A  
Craniun Direction: N/A  
Grave Goods: Present, Obsidian projectile point

**Demographic Information**
Age: Adult  
Sex: Indeterminate  
Dental Pathology: N/A  
Skeletal Pathology: Absent

**Osteological Discussion**
Burial 7 contained the disarticulated remains of an individual of unknown age and sex. The grave contained elements of the left arm, ribs, vertebrae, and the left calcaneus. While all other elements of the burial were not found in anatomical position, the three recovered lumbar vertebrae were found in articulation. This may suggest that the skeletal elements were stacked upon one another at a time before decomposition was complete. Overall, it is likely that Burial 7 represents a bundle burial.
Field Photos

Burial 7 in situ.

Burial 7 in situ.
Laboratory Photos

All elements of Burial 7.

Articulation of lumbar vertebrae.
Burial 8

**Archaeological Information**
Excavation Year: 2012  
Provenience: U092LC001  
Capa: II  
Location: Terraces  
Matrix: Bedrock and Paleosoil

**Burial Information**
Preservation: Good  
Primary/Secondary: Primary  
Articulation: Articulated  
Body position: Flexed Left Lateral  
Craniun Direction: South  
Grave Goods: Present, One Desfibrador and Two Cajetes

**Demographic Information**
Age: Maximum likelihood of 29.4 years, 95% confidence range of 15.7 to 53.7 years  
Sex: Female  
Dental Pathology: Present  
Skeletal Pathology: Present

**Osteological Discussion**
Burial 8 contained the remains of a female approximately 30 years of age (range 15.7-53.7). A few minor skeletal pathologies or abnormalities were observed. A small bone spur is present on posterior surface of the left. Lipping along the superior articular facet of the sacrum was also present. Finally, moderately sized carious dental lesions are present on several of maxillary and mandibular molars, and dental calculus build-up was noted on the maxillary dentition.
Burials 8, 9, and 10 in situ. Burial 8 is southern-most individual.
Bone spur of left calcaneus.

Maxillary dentition of Burial 8.
Right mandibular dentition of Burial 8.
Left mandibular dentition of Burial 8.
Burial 9

**Archaeological Information**
Excavation Year: 2012
Provenience: U092LC001
Capa: II
Location: Terraces
Matrix: Bedrock and Paleosol

**Burial Information**
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Craniunm Direction: North
Grave Goods: Absent

**Demographic Information**
Age: Young Adult
Sex: Male
Dental Pathology: Present
Skeletal Pathology: Absent

**Osteological Discussion**
Burial 9 contained the remains of an young adult male. A line of fusion is still visible on the left proximal tibia, the left and right femoral heads, and left humeral head. In all cases, the fusion of these epiphyses is complete, and the line of fusion remains most visible in the case of the left humerus. Additionally, the left mandibular and maxillary third molars are partially erupted, but not yet in occlusion. The right maxillary molar is visible, but not yet erupted. Given the closeness of the third molars to the second molars and the general angle of the third molars it is difficult to determine if the non-erupted status was due to age or dental impaction. The presence of carious lesions of the occlusal surfaces of the left maxillary and mandibular third molars suggests that they were exposed for some time prior to death, supporting the impaction hypothesis. In addition to the carious lesions discussed above, a large carious lesion was observed on the right second mandibular molar. The infection engulfed over two-thirds of the occlusal surface and extended deep into the tooth root, potentially resulting in an abscess.
Burials 8, 9, and 10 in situ. Burial 9 is the northern-most individual.
Note the visibility of the line of fusion of the humerus.
Mandibular dentition of Burial 9. Note partial eruption of the third molar and large carious lesion of the right second molar.
Burial 10

Archaeological Information
Excavation Year: 2012
Provenience: U092LC001
Capa: II
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Left Lateral
Cranium Direction: South
Grave Goods: Present, Cajete

Demographic Information
Age: Maximum likelihood of 66.6 years, 95% confidence range of 40.3 to 85.6 years
Sex: Female
Dental Pathology: Present
Skeletal Pathology: Present

Osteological Discussion
Burial 10 contained the remains of a female of approximately 67 years of age at time of death (95% confidence range of 40.3-85.6 years). All left maxillary teeth, except a third molar, were lost antemortem and the alveolar cavities had filled with bone. The gum line also exhibits intense porosity. The left third maxillary molar, which is represented by the empty alveolar cavity was of unusual size and shape, and was potentially a single rooted peg-tooth.
Burials 8, 9, and 10 in situ. Burial 10 is central individual.
Laboratory Photos

Left maxilla of Burial 10. Note resorption of alveolar cavities and cavity of possible peg molar.
Burial 11

Archaeological Information
Excavation Year: 2012
Provenience: U092C1529
Capa: III
Location: Terraces
Matrix: Bedrock and Paleosol

Burial Information
Preservation: Excellent
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Dorsal
Cranium Direction: North
Grave Goods: Present

Demographic Information
Age: Maximum likelihood of 30.4 years, 95% confidence interval of 23.5 to 40.6 years
Sex: Female
Dental Pathology: Present
Skeletal Pathology: Present

Osteological Discussion
Burial 11 contained the remains of an adult female. Transition analysis suggests that this individual was approximately 30 years old at time of death (95% confidence range of 23.5-40.6 years), but given the estimated age derived from the pubic symphysis alone (maximum likelihood 41.5, 95% confidence range 26.5-72.9), the presence of lipping on many of the joint surfaces, and the observed dental wear, it seems likely that this individual was somewhat older. Four molars were lost antemortem and the alveolar cavities were fully resorbed. In addition to the resorption, many teeth are and many show signs of small pin-point dental caries. While not considered pathological, pronounced muscle attachment sights were observed on the lateral inferior surface of the clavicles. On the 4th and 5th lumbar vertebrae, lipping is present on the superior edge of the vertebral body. Lipping also surrounds the interior edge of the acetabula, and pronounced lipping is present on the distal right and left femurs and proximal right and left tibiae. Bone spurs were also observed on the superior edge of the right patella. Finally, two bony changes were observed in the feet. Small bone spurs are present on the posterior surfaces of the calcanei, and a malformation or possible healed fracture was observed on one medial foot phalanx.
Burials 11 and 12 in situ.
Laboratory Photos

Lipping of the right acetabulum.

Lipping of the left acetabulum.
Lipping of the distal right femur.

Lipping of the proximal right tibia.
Lipping of the superior surface of lumbar vertebra.

Malformation of the distal portion of a medial foot phalanx.
Inferior-lateral view of clavicles. Note pronounced muscle attachment sites.
Maxillary dentition of Burial 11.
Mandibular dentition of Burial 11.
Burial 12

**Archaeological Information**
Excavation Year: 2012
Provenience: U092C1529
Capa: III
Location: Terraces
Matrix: Bedrock and Paleosol

**Burial Information**
Preservation: Excellent
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Ventral
Cranium Direction: East
Grave Goods: Absent

**Demographic Information**
Age: Birth ± 1 month
Sex: N/A
Dental Pathology: N/A
Skeletal Pathology: Absent

**Osteological Discussion**
Burial 12 contained the well-preserved remains of an infant. No visible pathological conditions were observed.
Burial 13

**Archaeological Information**
Excavation Year: 2012
Provenience: U092C1729
Capa: VI
Location: Terraces
Matrix: Bedrock and Paleosol

**Burial Information**
Preservation: Excellent
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Left Lateral
Cranium Direction: North
Grave Goods: Absent

**Demographic Information**
Age: 10 ± 3 months
Sex: N/A
Dental Pathology: Absent
Skeletal Pathology: Absent

**Osteological Discussion**
Burial 13 contained the remains of an infant approximately 10 months old (± 3 months). Age was estimated through an evaluation of dental development fusion of the mandible. The remains are well preserved, and no signs of pathology were observed.
Field Photos

Burial 13 in situ.
Laboratory Photos

Deciduous mandibular dentition of Burial 13.
Erupted deciduous mandibular incisors of Burial 13.
Burial 14

Archaeological Information
Excavation Year: 2012
Provenience: U092C1729
Capa: VI
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Excellent
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Left Lateral
Cranium Direction: Southeast
Grave Goods: Present, Un defibrador de basalto, raspador de obsidiana y piezas de cerámica completos

Demographic Information
Age: Maximum likelihood of 62.3 years, 95% confidence range of 29.4 to 86.8 years
Sex: Female
Dental Pathology: Present
Skeletal Pathology: Present

Osteological Discussion
Burial 14 contained the remains of a female who was approximately 62 years of age at death (95% confidence interval 29.4-86.8 years). The dentition of Burial 14 shows considerable signs of wear and antemortem tooth loss. Additionally, almost all teeth that are present show signs of infection along the gum-line with lesions that have cause bone loss at the margin between the tooth crown and root. Several teeth were taphonomically broken at this junction, suggesting that the infection was present in almost all teeth that were not lost antemortem. In addition to severe dental pathology, the right parietal has a circular bony protrusion that extends approximately 10mm beyond the cranial surface and is 6mm in diameter. Overall, the postcranial skeleton shows signs of advanced age and injury. One rib fragment presented with a round indentation on the anterior surface, which was approximately 16mm long, 11mm wide, and 2mm deep. Many of the ribs are unusually thick and have abnormally large trabecular cavities. Moderate lipping is present on the inferior edges of the bodies of the lower thoracic vertebrae, and severe lipping is present on the inferior and superior edges of the bodies of all lumbar vertebrae. The greater trochanter of the right femur is essentially absent, as the area has been flattened in the medial-lateral direction. The area contains intense irregular bone development and porosity. It is likely that this area of inflammation was active at time of death. Lipping of the interior edge of the right acetabulum is also present. The interior of the acetabulum also shows signs of active porosity. It is likely that an injury that directly affected the greater trochanter led to the lesions observed in the vertebrae and the acetabulum. In addition to this condition, lipping is also present on the left distal femur, the patellae, and the right cuboid. Porosity was also observed along the distal diaphysis of the right and left fibulae.
Field Photos

Burial 14 in situ.
Laboratory Photos

Deformation of the right greater trochanter and irregular bone development.
Lipping of the patella.
Lipping of the left cuboid.
Example of lipping of the lumbar vertebrae.
Mandibular dentition of Burial 14. Note resorption and heavy wear of occlusal surfaces.
Left mandibular dentition. Note lesions inferior to the crowns of the molar and premolars.
Maxillary dentition of Burial 14.
Burial 15

**Archaeological Information**
Excavation Year: 2016  
Provenience: Looter’s Pit  
Context: N/A  
Location: Terraces  
Matrix: N/A

**Burial Information**
Preservation: Fair  
Primary/Secondary: N/A  
Articulation: N/A  
Body position: N/A  
Craniunm Direction: N/A  
Grave Goods: N/A

**Demographic Information**
Age: Maximum likelihood of 39 years, 95% confidence interval of 18.6 to 78.5 years  
Sex: Female  
Dental Pathology: N/A  
Skeletal Pathology: Present

**Osteological Discussion**
Burial 15 contained the remains of a female, around 39 years of age at time of death (95% confidence interval 18.6-78.5 years). Cartilage ossification was observed on the right first rib and lipping was present along the articular platform of the sacrum.
Laboratory Photos

Lipping of the sacrum.

Ossification of the costal cartilage of the first rib.
Burial 16

**Archaeological Information**
Excavation Year: 2016  
Provenience: U092C1781  
Context: 619  
Location: Terraces  
Matrix: Bedrock and Paleosol

**Burial Information**
Preservation: Excellent  
Primary/Secondary: Primary  
Articulation: Articulated  
Body position: Flexed Left Lateral  
Craniun Direction: Southeast  
Grave Goods: Present, One Complete Ceramic Vessel

**Demographic Information**
Age: Maximum likelihood of 32.3 years, 95% confidence interval of 18.6 to 55.4 years  
Sex: Female  
Dental Pathology: Present  
Skeletal Pathology: Present

**Osteological Discussion**
Burial 16 contains the remains of a female who was approximately 32 year of age at time of death (95% confidence interval of 18.6-55.4). The dentition of Burial 16 shows moderate wear, but large carious lesions have destroyed much of the first right mandibular molar and the left second premolar. Additionally, the left mandibular first molar has been lost antemortem and the alveolar cavity is completely resorbed. A small lesion is also present on the left mandibular second molar as well. The third molars are congenitally missing. Two healed rib fractures were also identified near the sternal end of the ribs. Many of the thoracic vertebra have shallow, symmetrical cavitations on their sides and articular surfaces. Furthermore, lipping is present on many of the vertebra and ligaments have ossified on the lower lumbar vertebrae. Proliferation and porosity are present on many of the associated rib heads. Finally, lipping was observed on the acetabulum.
Burial 16 in situ.
Laboratory Photos

Healed rib fractures.

Ligament ossification and lipping.
Osteophyte growth on lumbar vertebra.

Vertebral cavitation and proliferation
Vertebral cavitation and proliferation

Lipping of the acetabulum.
Mandibular dentition of Burial 16.

Left maxillary dentition of Burial 16.
Burial 17

Archaeological Information
Excavation Year: 2016
Provenience: U092C1830
Context: 623
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Not Applicable
Cranium Direction: East
Grave Goods: Absent

Demographic Information
Age: 18 ±1.5 years
Sex: Male
Dental Pathology: Present
Skeletal Pathology: None

Osteological Discussion
Burial 17 contained the cranium, 1st cervical vertebra, hands, and feet of a male who was approximately 18 years of age at time of death. While the hands, feet, and cranium of Burial 17 were not positioned anatomically, the bones of hands, feet, and cranium were articulated suggesting that hands, feet, and cranium were detached from the body and interred prior the completion of decomposition. Additionally, the 1st cervical vertebra was found in articulation with the base of the skull, but no cut marks were observed on the skeletal elements. The feet of the individual were placed on either side of the cranium with the hands placed on top of the feet. It also appears that red pigment may have been applied to the remains prior to burial.

An enamel pearl was observed on the right maxillary 3rd molar. The dentition of Burial 17 shows few signs of wear, but a large dental abscess encompasses the anterior third of the left palate. In relation to this infection, the root of the 1st left maxillary incisor had begun resorb, as had the alveolar bone of the 2nd incisor. The 2nd incisor was not recovered and may have been lost antemortem.
Field Photos

Initial discovery of Burial 17.

Initial removal of Burial 17.
Photo demonstrating the articulation of the left foot.
Laboratory Photos

Mandible of Burial 18.
Left maxilla of Burial 18. Note the sizable abscess and the non-occlusion of the third molar.

Right maxilla of Burial 18.
Possible red pigmentation adhering to Burial 17.

Enamel pearl on third molar.
Burial 18

Archaeological Information
Excavation Year: 2016
Provenience: U092C1781
Context: 624
Location: Terraces
Matrix: Bedrock and Paleosol

Burial Information
Preservation: Excellent
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Craniunm Direction: East
Grave Goods: Absent

Demographic Information
Age: 1.5 months ± 2 months
Sex: N/A
Dental Pathology: None
Skeletal Pathology: None

Osteological Discussion
Burial 18 contained the remains of a young infant. No pathologies were present in the dentition or post-cranial skeleton.
Field Photos

Burial 18 in situ.
Laboratory Photos

Dentition of Burial 18.

Right and left mandibles of Burial 18.
Right and left maxillae of Burial 18.
Burial 19

Archaeological Information
Excavation Year: 2016
Provenience: U092C1781
Context: 626
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Partially Articulated
Body position: Flexed Right Lateral
Cranium Direction: North
Grave Goods: Present, Two Complete Ceramic Vessels

Demographic Information
Age: 11.5 ± 1 year
Sex: N/A
Dental Pathology: Absent
Skeletal Pathology: Present

Osteological Discussion
Burial 19 contained the remains of a child approximately 11.5 ± 1 years of age. No dental pathologies were observed, but mild cribra orbitalia was observed on the superior surfaces of the eye orbits.

Additional Associated Material
One proximal adult foot phalanx was also found in association with Burial 19.
Field Photos

Burial 19 in situ.
Cribran orbitalia of the right orbit.
Maxillary dentition of Burial 19. Note partial eruption of the permanent premolars.
Maxillary dentition of Burial 19. Note partial eruption of the permanent dentition.
Burial 20

Archaeological Information
Excavation Year: 2016
Provenience: U092C1629
Context: 526
Location: Terraces
Matrix: Bedrock and Paleosoil

Burial Information
Preservation: Fair
Primary/Secondary: Disturbed
Articulation: Disarticulated
Body position: N/A
Cranium Direction: N/A
Grave Goods: Present/Shared

Demographic Information
Age: Commingled Subadults
Sex: N/A
Dental Pathology: Absent
Skeletal Pathology: Absent

Osteological Discussion
Burial 20 likely contained the remains of at least two subadult individuals, which were recovered from the context of Burials 21 and 22. The first individual is represented by a cranium and mandible. Based on dental development patterns, it is likely that the individual was approximately 5 years of age at time of death (±1.5 years). No pathological conditions were observed for this individual. The second individual is represented by a cluster of partially articulated remains from the northwest corner of the grave. Fusion patterns of the vertebrae suggest that this individual is significantly younger than the individual represented by the cranium and mandible described above. Subadult elements that had become intermixed with the remains of Burials 21 and 22 were also recovered, though it is still unclear if these materials are associated with individuals who have already been identified, or if they represent a third subadult.
Burial 21

Archaeological Information
Excavation Year: 2016
Provenience: U092C1629
Context: 526
Location: Terraces
Matrix: Bedrock and Paleosoi

Burial Information
Preservation: Excellent
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Cranium Direction: Northeast
Grave Goods: Present/Shared

Demographic Information
Age: Maximum likelihood estimate of 39.4 years, 95% confidence interval of 27.6 to 58.9 years
Sex: Female
Dental Pathology: Present
Skeletal Pathology: Present

Osteological Discussion
Burial 21 contained the remains of a female approximately 40 years (95% confidence interval 27.6-58.9 years) of age at time of death. The dentition of Burial 21 is moderately to heavily worn and some pin-point caries are present. Additionally, a large carious lesion is present on the left maxillary 3rd molar. The infection encompasses approximately two-thirds of the occlusal surface and extends into the root cavity. Inactive periostitis is present on the diaphysis of the right tibia, and a small area of reaction is also present on the right fibula. Additionally, the left trapezoid is fused with the 2nd metatarsal.

301
Burial 21 in situ.
Laboratory Photos

Fusion of the left trapezoid to the 2\textsuperscript{nd} left metatarsal.

Healed periostitis of the right tibia.
Healed periostitis of the right fibula.

Maxilla of Burial 21.
Right mandible of Burial 21.

Left mandible of Burial 21.
Burial 22

Archaeological Information
Excavation Year: 2016
Provenience: U092C1629
Context: 526
Location: Terraces
Matrix: Bedrock and Paleosol

Burial Information
Preservation: Good
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Cranium Direction: Northeast
Grave Goods: Present/Shared

Demographic Information
Age: Maximum likelihood estimate of 69.9 years, 95% confidence interval of 39.2 to 87.7 years
Sex: Male
Dental Pathology: Present
Skeletal Pathology: Present

Osteological Discussion
Burial 20 contained the remains of a male approximately 70 years of age at time of death (95% confidence interval 39.2 - 87.7 years). The dentition of Burial 20 is moderately to heavily worn. Large carious lesions are present on the left maxillary 1st molar and the right maxillary 2nd premolar. Both lesions encompass at least half of the occlusal surface and extend into the root cavity. Lipping is present around the left glenoid cavity and on the inferior edge of the lumbar vertebrae. A healed fracture was observed on the medial right clavicle. Additionally, a healed oblique fracture is present in the right tibia. Though the fracture is completely healed, the bone is dramatically misaligned and irregular bone spurs are present on the diaphysis.

Note on Commingled Elements
In addition to materials that could be definitively assigned to Burials 21 or 22, many adult skeletal elements were recovered that could not be separated. These largely consisted of small bones such as those found in the hands and feet, rib fragments, and isolated teeth. No pathological conditions were observed among these elements, though the teeth are heavily worn.
Burial 22 in situ. Burial 22 is the middle individual.
Lipping of the left glenoid cavity.

Healed fracture of the right clavicle.
Lipping of the inferior body of a lumbar vertebrae.

Fracture of the right tibia.
Maxillary dentition of Burial 22.

Mandibular dentition of Burial 22.
Burial 23

Archaeological Information
Excavation Year: 2016
Provenience: U092C1629
Context: 527
Location: Terraces
Matrix: Bedrock and Paleosol

Burial Information
Preservation: Fair
Primary/Secondary: Primary
Articulation: Articulated
Body position: Flexed Right Lateral
Craniun Direction: North
Grave Goods: ??

Demographic Information
Age: Young Adult, 25-30 years
Sex: Female
Dental Pathology: Present
Skeletal Pathology: Absent

Osteological Discussion
Burial 23 contained the remains of a young adult female. The skeleton suffered severe taphonomic damage, but the morphology of the available pubic symphysis and auricular surface, and dental wear patterns suggest that the individual was in early adulthood at time of death. No pathological conditions were observed, other than a potential pin-point carious dental lesion of the lower right third molar.
Field Photos

Burial 23 in situ.
Laboratory Photos

Right maxillary dentition.

Right mandibular dentition.
Burial 24

**Archaeological Information**
Excavation Year: 2016  
Provenience: U092C1629  
Context: 526  
Location: Terraces  
Matrix: Bedrock and Paleosoil

**Burial Information**
Primary/Secondary: Primary  
Articulation: Articulated  
Body position: ??  
Cranium Direction: N/A  
Grave Goods: Present/Shared

**Demographic Information**
Age: Subadult  
Sex: N/A  
Dental Pathology: N/A  
Skeletal Pathology: Absent

**Osteological Discussion**
Burial 24 contained the articulated spine of a subadult. Further analyses are required before a more precise age at death can be established. During preliminary analyses, no pathological conditions were observed.
Emily J. Kate

VITA

EDUCATION
2021 Ph.D. in Anthropology and Demography, Pennsylvania State University, U.S.A
2017 M.A. in Anthropology and Demography, Pennsylvania State University, U.S.A
2014 B.A. in Archaeology and Anthropology, The College of Wooster, U.S.A

PUBLICATIONS
Douglas Kennett, Mark Lipson, Keith Prufer, et al. including Emily Kate
In Review Large-Scale Migration from the South Coincided with the Arrival of Farming in the Maya Region. Cell.

Emily J. Kate and Meggan Bullock

Douglas Kennett, Keith Prufer, et al. including Emily J. Kate

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