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Archaeology and Bioarchaeology of Population Movement among the Prehispanic Maya

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Introduction

No society is static. Movement and migration has always been an intrinsic part of human nature, bringing about exchange, replacement, innovation, and, simply, change. Mobility itself has always been dictated by a wide array of factors, which span from family and community strategies to more encompassing political and economic measures. Also specific circumstances, such as ecological crisis, war, and famine can trigger individual or collective relocation. These dynamics and conditions also predispose to the distance of movement, whether local or interregional, and its extent. Movement can involve only few people or affect entire populations settling in new territories (Rouse, 1986).

Due to their intrinsic complexities and antagonisms, stratified societies tend to harbor a larger array of incentives that can bring about population movement than less hierarchical sedentary groups. As the title of this volume indicates, the effort is addressed specifically to the Prehispanic Maya, characterized by diversified, highly ranked social systems (Sharer, 2006). During the Classic period, city-states governed over large regions, establishing complex ties of alliance and commerce with the region's minor centers and their allies, against other city-states within and outside the Maya realm. The archaeological evidence highlights ties between the Maya and Teotihuacan in the Mexican Central Highlands (Brasswell, 2003). Raw materials or finished goods, commodities for the elite, or goods of vital importance (like salt, for example) were distributed through maritime as well as inland, internal trade networks through so-called port of trades, in a market redistribution model (Chapman, 1957). The fall of the political system during the Classic period (the Maya collapse) led to hypothetical invasion of leading groups from the Gulf of Mexico into the northern Maya lowland at the onset of the Postclassic (a view that, at least for Chichen Itza, Cobos will call into question in this volume). Even considering that an external power might have taken over the northern Maya Lowlands, it is not yet clear whether it came along with actual movement of populations into the region as well as the extent of such immigration.

As the title of this volume indicates, it will treat its capital topics, i.e., population movements in the Maya area, by combining different (bio)archaeological thematic approaches. Like every other lines of research, archaeology and bioarchaeology tend to infer specific dynamics resting upon concrete sets of variables. Such is the case of trade networks, which are usually interpreted on the base of the presence of exogenous (foreign) material and objects coming from afar (imported pottery, jadeite, obsidian, and so forth) (Earle, 2010). Yet, exchange of goods or the presence of foreign architectural patterns, by itself, do not necessarily imply the genetic admixture between groups, because human beings may migrate for reasons that may not be related only to trading (Crawford & Campbell, 2012; Manning, 2005). Population movement can only be assessed directly when the biological components of ancient communities are analyzed (i.e., the human skeletal remains). Nonetheless, the biological evidence per se, i.e., extrapolated from its cultural context, is not capable of explaining such a complex systems as a region's population dynamics by itself but needs complementation with culturally derived datasets.

The whole picture can slowly emerge only when all the pieces of the puzzle are put together in a holistic and multidisciplinary fashion, leaving behind the extreme academic specialization that makes us blind of the whole context (Rouse, 1986). It is a very complex task, since sampling in (bio)archaeology is by convenience: we rarely can decide what to study and obtain the right samples that allow to fill specific geographical or chronological gaps. In the case of the ancient Maya, their lack of cemeteries does not permit the recovery of skeletal collections that are always representative of the whole ancient population. The aggressive tropical environment strongly affects good preservation, limiting even further (bio)archaeological research. For such reasons, even though my field of interest is dental morphology, this book is not (only) about dental morphology.

The present edited volume represents the English version of the Spanish edition published in 2013 by the Universidad Autónoma de Yucatán Press (Cucina, 2013). Both books have grown out of the editor's many years of research on dental morphology to assess population dynamics in the Maya realm and the awareness of the complexity and the limitations of morphological dental traits in explaining populations' affinities without better understanding the overall cultural picture. The contributions of this volume reflect the spirit of the multidisciplinary (bio)archaeological investigation in bringing together a team of experts in archaeology, archaeometry, paleodemography, and bioarchaeology. They gathered in Merida in November 2010 to participate in the First International Congress of Bioarchaeology in the Maya Area to discuss about population dynamics and movement, each from his/her own field of expertise. With the exception of Duncan's chapter, which did not form part of the Spanish version, the rest of the contributions are the same as in the Spanish volume, updated to respond to new evidence or interpretation or completely reorganized and presenting new data, as in the case of Cucina's chapter.

Despite the object-derived limitations, all the contributors (each from his/her own field of expertise) have managed to provide interesting and valuable information that sheds more light on the complex and entangled biocultural dynamics in Prehispanic Maya society. Together, such contributions provide an initial account of the dynamic qualities behind large-scale ancient population dynamics, and at the same time represent novel multidisciplinary points of departure toward an integrated reconstruction and understanding of Prehispanic population dynamics in the Maya region.

In closing, I wish to acknowledge my gratitude to all participants in the conference that led to this compilation and specifically those, who have accepted to share their expertise and information in this volume. I thank my colleague and wife Vera Tiesler for her suggestions, ideas, and comments that came up on a daily base. Ivonne Tzab's help has been instrumental with the time-consuming editorial corrections. Finally, the editorial process of the volume was carried out under the auspices of the CONACyT sabbatical grant I0010-2014 n. 232831, and the UC MEXUS program at the University of California Riverside.

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Chapter 1
Xcambo and Its Commercial Dynamics Within the Framework of the Maya Area

Thelma N. Sierra Sosa

Introduction

The site of Xcambo lies along the northern coast of the State of Yucatan, and was the most important economic center in the Early and Late Classic northern Maya Lowlands (Fig. 1.1). Located 1.5 km from the coast, in a peten surrounded by marshland, the site was provided with the infrastructure required by this socioeconomic entity basically for the administration of salt production and trade (Fig. 1.2).

The archaeological site of Xcambo dates to the Classic period and has a surface area of 150 m wide by 700 m long. The settlement offers a series of characteristics that define it as a commercial port, such as: (1) its advantageous position on the coast; (2) a center characterized by outstanding constructions, suitable for governing activities (administrative, commercial, religious, etc.); (3) a residential area that was used principally by the families of rulers and the elite; (4) it allowed transboarding of goods from coastal trade; (5) a system of routes, both overland and maritime, appropriate for moving merchandise; (6) extensive support areas (e.g., for salt production); (7) places that were used for storage; (8) both regional and supraregional importations (especially luxury goods); and (9) the existence of people dedicated to trade (Sierra 2004:41) (Fig. 1.2).

The Xcambo site presents two outstanding periods of occupation, each defined by a different distribution pattern (Table 1.1).

By the Early Classic period (AD 350–550) the site shows a central complex with buildings belonging to the Xtampu Complex that are relatively modest, established in the middle of the peten. These must have been administrative, religious, civic,

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Fig. 1.1 The north of the Yucatan Peninsula showing the location of the Maya Port of Xcambo, in the geopolitical context of the Classic period. The black circles indicate the coastal sites that participated in the Canbalam Ceramic Sphere (AD 550–750)

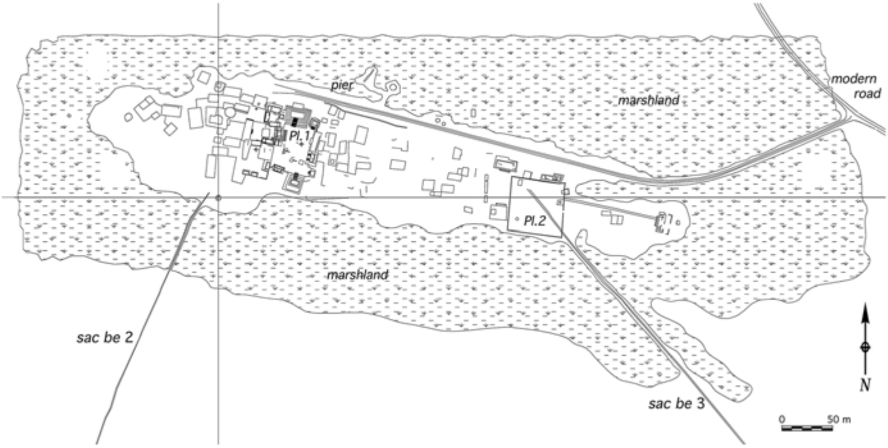

Fig. 1.2 Drawing of the port of trade of Xcambo, Yucatan

and residential buildings with broad foundations raised for dwellings and numerous storage areas or deposits.

The site must have been physically linked to at least one important interior center, as indicated by the presence of a walkway or *sac be*, located in the southern

Table 1.1 Ceramic complexes of the Port of Xcambó, Yucatán (based on Jiménez Álvarez 2002 and Ceballos Gallareta 2003)

Ceramic complexes (periods)	Groups	Horizons	Sphere	Origin	
Middle Preclassic (c. BC 800–300)	Dzudzuquil, Chunhinta, and Muxanal	Mamón-Nabanché		Southern Lowlands, Komchén	
XTAMPÚ Early Classic (c. AD 350–550)	Sapote, Sierra, Flor, Caramba, Sabán, Hubilá, Unto, Tipikal, Polvero, Habana, Huachinango, Shangurro, Timucuy, Águila, Balanza, Pucté, Lituc, Triunfo, Holol, Cetelac, Oxil	Cochuah Tzakol II–III		Central and Northwestern Yucatán; Northern Quintana Roo; Petén Campechano-Guatemalteco; Belize	Early Xolalpan Phase Teotihuacan (AD 450–550)
XCAMBÓ Late Classic (c. AD 550–750)	Koxolac, Baca, Tenabo, Nimun, Dzibalché, Suma, Cui, Ich Kanzihó, Vista Alegre, Blanquillo, Muna, Dzitás, Ticul, Teabo, Dzibiac, Batres, Hunabchén, Chencoh, Kinich, Charote, Arena, Dzityá, Kanachen, Chuburná, Maxcanú, Acú, Chencán, Holactún, Ixkipché, Chomul, Tinaja, Infierno, Egoísta, Sayán, Saxché, Petkanché, Sonaja, Azcorra, Palmar, Zacatel, Cimatán, Nonoalco, Punta Piedra, Chablekal, Dsicul, Comalcalco, Jalpa, Paraíso, Huimangüillo, Zuleapa, Balancan, Silhó, Calatraba, Poza Rica, Cocoyoles, Huanal, Jilón, Tejar	Cehpech Tepeu I–II	Coastal Sphere Canbalan Mescalapa	Campeche-Yucateco Coast; Northern Peninsula of Yucatán; Southern Campeche and Northern Guatemala, Southeastern Tabasco, Laguna de Términos; Atrasta Region; Central Veracrúz Region	Early Xolalpán Phase Teotihuacan (AD 550–600)
KAYALAC Postclassic (c. AD 1100–1543)	Navulá, Mama, Polvos, Kukula, Matillas	Tases		Western Yucatán, Mayapán, San Gervasio, El Meco, Cobá	

Fig. 1.3 *Sac be* that connects Xcambo to Misnay

side of the peten, which extends to the Early Classic/Late Classic site of Misnay, approximately 1.2 km south of Xcambo (Fig. 1.3).

The ancient road leads from here towards the interior until it is lost in the underbrush. During this period Xcambo must have controlled the salt mines of Xtampu and the surrounding coastal sites producing salt and marine resources.

During the Late Classic period (AD 550–750), known as the Xcambo Complex, the physiognomy of the previous period was completely transformed. The main plaza covered a greater area (Fig. 1.4) and residences, probably of a different type, were built over the previous constructions, covering the storage areas or deposits.

A small square or public plaza was established with two roads or *sac be'ob* extending from it—one to a residential unit located at the eastern edge of the site, and the other inland towards Dzemul (the ancient Cemul). During this period Xcambo also maintained a type of pier, located north of the main plaza on the edge of the marsh (Fig. 1.5).

During this period salt operations increased and bonds with the coastal communities tightened from Xtampu to Providencia, a coastal site located 18 km east of Xcambo. A widespread salt production area was also established in this period in the northwestern sector of Xcambo. It is important to point out that the site was densely populated.

Fig. 1.4 Panoramic view of the northern side of the main square

Fig. 1.5 Pier or dock

Trade and Routes

There was a broad trade system that operated long distances over both land and maritime routes, carrying enormous amounts of a variety of products. The coast was important for these long-distance trade systems and Classic settlements were special stations for trade.

From the Gulf Coast to the Northern Yucatán Peninsula

Maritime trade was very important. The existence of groups of traders on the Gulf Coast, known as Putunes, or Chontales (Scholes and Roys 1948) is well documented during the Terminal Classic–Postclassic periods, although they must have existed even earlier. These groups formed a series of connected centers that managed and distributed by coastal trade to the Maya region products arriving from the Central High Plain. The Laguna de Terminos and river systems formed part of an immense network of trade routes that were in use already by the Preclassic period (Eaton 1978).

Ports like Potonchan, Xicalango, and Itzamkanac or Acalan were used to reach, on the one hand, the Usumacinta and Grijalva watersheds, as well as places like Altar de Sacrificios, Seibal, Cancuen, etc., and the Ports of Naco on the Chamalecon River in Honduras and Nito on the *Golfo Dulce*. On the other hand, we find abundant ethno-historic, historic, and archaeological information (Andrews IV 1969; Edwards 1976; Farris and Miller 1977; Freidel 1978; Hammond 1978; Henderson 1976) on coastal voyages to the ports of the Yucatan Peninsula, with documented sites characterized by port facilities that may have served as places for rest, boarding and landing, places of further transactions, as well as ports open for trade to the interior of the peninsula (Hauck 1975; Nelson 1979; Pfeiffer and Stoll 1977; Piña Chan 1978).

From Belize to the Northern Yucatan Peninsula

There is evidence of coastal settlements that date back to 1000 BC, some of which, such as the Cerros site, began to function in the Late Preclassic period as stations for long-distance maritime trade between northern Yucatan and the central Maya area, via the Nuevo and Hondo rivers (McKillop 1980). Among the trade routes presented, the settlement of Santa Rita was in a perfect location to serve in a long sea route around the Yucatan Peninsula (Chase and Chase 1989). The level of technical development achieved by Maya navigators allowed them to carry out a long-term trade through the rough waters of the Mexican Caribbean Sea, enabling them to reach their destination safely with the assistance of port installations, shelter, and navigation markers and signals (Romero Rivera and Gurrola 1995).

Entering the Caribbean from the navigable rivers of Belize, the traders' canoes must have followed northbound the coast of Quintana Roo to the bay of Xel-Ha, Chunyaxche, and various other sites on the eastern coast, which must have been semiautonomous ports set up almost solely for foreign trade; from there, access to the political–economic units of northwestern Yucatan of Late and Terminal Classic Yucatan was just a step away (Robles, personal communication, 2001).

The Salt Trade

Salt has been one of the principal resources required by human communities over the centuries. Indispensable for its many important uses, salt production and consumption dates back to remote times.

Salt was used in the Maya Lowlands since the Middle Preclassic period and its trade continues uninterrupted until today. During the Prehispanic era there was a strong exploitation of the mineral for trade, to such a degree that numerous networks were created for its short- and long-distance distribution between sites on the coast of Yucatan, a strong production site of excellent quality salt, to distant points on the Gulf of Mexico and the Caribbean. Thousands of tons of salt were exported via the coastal maritime trade (Andrews 1980). It is for this reason that the Spaniards found this economic activity well developed and organized upon their arrival, as noted in numerous chronicles of the era (Landa 1966; Sahagún 1975, among others).

Andrews (1980) concludes that salt from the coast was generally the preferred type, and northern Yucatan was a great production zone. Another of his principal conclusions was that the salt mines in northern Yucatan were the principal source of salt for the Maya Lowlands, from the Preclassic period to the Spanish Conquest. New investigations in Guatemala and Belize clearly indicate that production systems and long-distance trade routes were quite varied during the Classic period; populations of the southern Lowlands may have been granted access to various different sources, and therefore were not dependent exclusively on the salt from the northern coast of Yucatan (Andrews 2002).

According to investigations, there was a strong demand for salt in the north of the peninsula. Based on our studies, the salt mines dependent on Xcambo were the most important during the Classic period as well as the principal reason for the site's development.

Trade in Xcambo

Xcambo was unquestionably a site of great commercial activity. In addition to its architectural infrastructure, the site also contains numerous items of foreign merchandise both from the interior of the Yucatan Peninsula as well as at regional and supra-regional level. The principal commercial resource of Xcambo was its administration and control of salt, as well as objects made of sea shells and comestible seafood.

It can be assumed that different forms of commerce were active in the commercial port of Xcambo: (1) individual business carried out within the community through the acquisition of goods between different production sectors. This trade was probably at a family level; (2) direct trade by the administrative government, given that it was relevant for the economic sphere and wealth of the elite. This had a relatively large sphere of activity, as it participated in the commercial network at the regional level, i.e., with communities from the interior; (3) long-distance or supra-regional trade over which the administrative government had greater control. The traders traveled by land as well as over sea and river routes in long journeys that arrived at intermediary trade ports or directly at the communities where they traded their goods for other goods and products.

During the Early Classic period, ceramic materials arrived at Xcambo from sites in the interior and from northwest Yucatán. Xcambo also carried out trade with sites in northern Quintana Roo, in the Mexican-Guatemalan Peten, Belize, and Teotihuacan (Ceballos 2003). It must be underlined, however, that at Xcambo there is practically no evidence of influence of Teotihuacan, as this is reduced to a few decorative and formal elements on certain vessels of supposedly Teotihuacan appearance. Nevertheless excavations in the *Barrio de los Comerciantes* in Teotihuacan revealed ceramic materials that were unquestionably Yucatecan in origin. Although this is not proof of direct contact between Xcambo and Teotihuacan, it does allow us to argue that the Port of Xcambo formed part of a series of ports located along the Gulf coast through which the Yucatecan Maya were able to establish commercial contacts with Teotihuacan during the Early Classic period.

According to ceramics found on the site, during the Late Classic period, Xcambo carried out trade relationships with sites on the far coasts of northern Campeche and western Yucatan, distant sites in central and northwest Yucatan, sites in the northwest of the peninsula, in the Mexico-Guatemala Peten, long the Grijalva-Mezcalapa River in Tabasco and the Zoque Forest in Chiapas, the middle and low Usumacinta River in Tabasco and Chiapas, the area of the Laguna de Terminos and the Atasta region, and the central region of Veracruz (Jiménez Álvarez 2002).

Over 90 % of the wide variety and volume of ceramic trade materials recovered from the Port of Xcambo, including vessels found in more than 600 burials, were principally imported at the regional and supra-regional level, as were a significant number of terracotta figures. An inventory of lithic artifacts made of flint, indicated that they were obtained in smaller quantities from the region of Belize, alongside being supplied in their majority from the southern region (Puuc). In turn, over 90 % of the obsidian comes from sources in the Guatemalan Peten (Braswell, personal communication, 2000). The remainder, a minority of artifacts, was imported during the later phase of occupation from different sources, such as Zaragoza in Puebla, Pachuca in Hidalgo, and Ucareo in Michoacan.

Turquoise arrived indirectly from sites on the Gulf Coast; however 100 % of jadeite arrived from the Guatemalan Peten since the Early Classic period. Basalt in

Fig. 1.6 Burials in Xcambo, Yucatan

the form of metate, and metate handles and mortars arrived from Belize during the Early Classic period and continued until the Late Classic.

Xcambo is marked by a wide variety and a number of ceramic materials (such as vessels) and luxury goods, which to date have not been found in other sites in Yucatan. This may be explained by the type of society that lived there: a dense population, above all during the Late Classic period, in a small site; people of a high economic status, dedicated to the administration of the salt mines and trade, the majority probably being businessmen and artisans of a high social level. The site was not inhabited by representatives of the majority of the Maya population (farmers, fishermen, salt workers, etc.), as we find no differentiation between the vessels, artifacts, and foods consumed. The houses at Xcambo are basically similar and well built, and the burials recovered there present numerous high quality grave goods (Fig. 1.6).

The skeletal remains from the port of Xcambo suggest the presence of peoples of different origins. Based on a study of stable isotopes on dental samples from 132 individuals, it could be affirmed that at least 4 individuals could be regional immigrants from the northern part of Yucatan, 10 of the remaining individuals probably reached Xcambo from distant places on the Campeche gulf coast or from Quintana Roo, and 118 were native to Xcambo or its surroundings (Price and Burton 2006, 2008, 2010).

The port of Xcambo was not isolated, and it must be viewed within the sociopolitical scenario of northern Yucatan. At the beginning of the Early Classic period there are indisputable cultural influences from the Peten that began to be seen in the early structures of Maya communities, above all in the northern section of the peninsula. This becomes evident since very early times on in sites like Oxkintok, Tiho (today's Merida), Izamal, Yaxuna, and Ek Balam, among others, which soon turned into regional capitals. Izamal was one of the greatest known so far; it held under its sociopolitical and economic aegis a broad territory, and no doubt had an input on contemporary sites like Acanceh, Ake, Uci, and Cansahcab. There were contemporaneous sites in the Puuc region like Oxkintok, Chunchucmil, Uxmal, Kabah, and Labna as well as those of the adjacent western coast which suggest, among other things, that they were independent but with domain over the numerous sites located within their own areas of influence.

Izamal must have had an important influence on numerous sites on the northwestern coast, with the possibility that such metropolis controlled coastal resources. It is likely that Xcambo, during the Early Classic period, benefited as an ally in an economic–political framework from forming part of the commercial network of Izamal, by providing that site with salt and marine resources. This way, Xcambo maintained some autonomy to carry out other forms of trade as a salt administration center and commercial port. Its strategic situation on the edge of the marshland, which served as a fast and safe trade route, allowed it to maintain large-scale commerce.

The panorama at the dawn of the period from AD 550 to 750 seems to mark the beginning of a new era during which the Maya civilization reached its maximum sociocultural complexity. During this period only isolated sites did begin to exercise a certain power—Dzibilchaltun, Chichen Itza, Uxmal, Culuba—while the early sites were in a process of restructuring. All of this had a decisive influence on the focus that commerce had had during the Early Classic period. However the result was not the disappearance of Xcambo; rather it was able to survive these two centuries in a more autonomous form. Xcambo had within its grasp all the local resources to maintain a strong economy, such as control of salt production and marine resources. It is in this period that, as already mentioned above, the port of Xcambo reoriented its economic interests, establishing direct and indirect links all the way to the Gulf Coast and with some sites in the central region of Veracruz.

Unfortunately for Xcambo, one of the objectives of the already consolidated Maya political entities of the Late Classic period (AD 750–900/1000) was to amplify to the maximum their areas of dominion, to centralize all production, and to have control of the movement of goods. There must have been a need to establish their presence in the ports under their jurisdiction and on those routes with the heaviest traffic, especially for luxury articles to flow without risk. The best tactic would have been to remove the autonomy of the ports of interest and to establish their own enclave ports. It is therefore during this period that new ports appeared with different commercial ties, leaving Xcambo at a disadvantage. These exogenous events, together with the internal factors of the port, ultimately led to its abandonment.

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Chapter 2
Ceramic Traditions in the Calakmul Region: An Indicator of the Movement of Ideas or Populations?

María del Rosario Domínguez Carrasco and William J. Folan Higgins

Introduction

An archaeological and physical–chemical analysis of ceramic materials in the region of Calakmul and surrounding areas (Fig. 2.1) has provided important data on movements of populations in this as well as neighboring regions, as determined both by the distribution, presence, or absence of ceramic traditions, as well as by the physical attributes of the vessels and by the chemical composition of the ceramic pastes.

The findings presented here include a comparative analysis of the ceramic materials, collected from different sites neighboring the Calakmul region, and belonging to different chronological periods. Sites sampled include the Regional State of Calakmul (Folan et al. 1999, 2008, 2010), the region bordering the eastern boundary of the State of Calakmul (Šprajc 2001, 2003, 2005, 2006; Šprajc et al. 1996), the northern region of the Guatemalan Peten (Hermes Cifuentes 2002; Hermes Cifuentes and Contreras 2002), and the northern region of Calakmul that borders the Regional State of Rio Bec (Domínguez Carrasco and Espinosa Pesqueira 2009; Domínguez Carrasco et al. 2010, 2011; Folan et al. 2009) (Fig. 2.2). These were studied for the purpose of identifying the different ceramic traditions of Calakmul in the specified regions, and based on this to infer possible movements of ceramic objects that would have functioned at a determined time as an indicator of the movement of population groups at inter- and intra-regional level.

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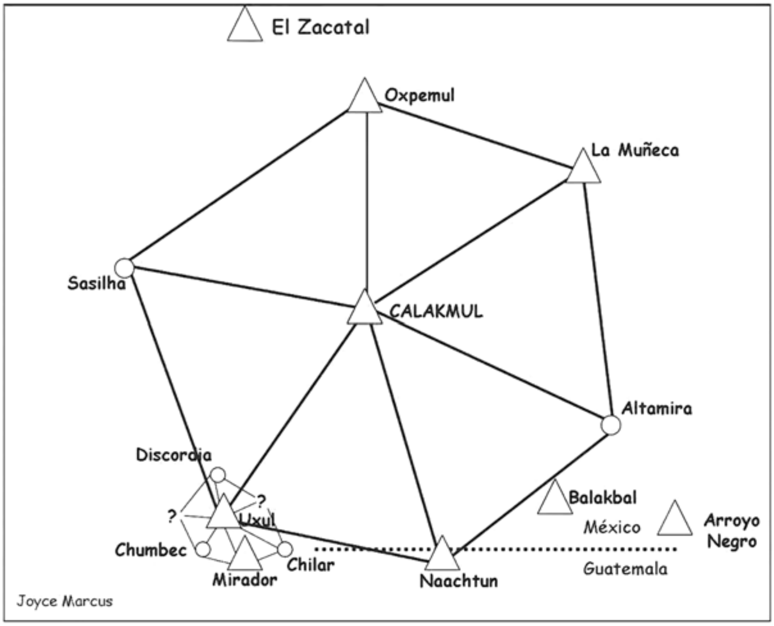

Fig. 2.1 Regional State of Calakmul and some of its tributary cities (Marcus 1973, 1976)

Materials Analysis

The process used to study the materials included an initial analysis of the ceramic using the type-variety method, in order to identify the chronology of the settlements and also to determine the presence of significant ceramic traditions. After this, we selected samples of the ceramic types that represent the different periods of occupation, in order to analyze them by physical–chemical techniques such as X-ray diffraction, low vacuum electronic microscopy (Domínguez Carrasco et al. 2001, 2002a, b, 2003; Domínguez Carrasco and Espinosa Pesqueira 2009), petrography (Chung et al. 1997; Chung and Morales 1999), and neutron activation analysis (Domínguez Carrasco et al. 1998).

The ceramic samples from the Regional State of Calakmul range from the Late Preclassic to the Terminal Classic (Domínguez Carrasco 2008). Materials from the northern region of the Guatemalan Peten included ceramics corresponding to periods from the Late Classic to the Terminal Classic (Hermes Cifuentes and Martínez 2005), while materials from the eastern region adjacent to Calakmul (García 2006) as well as those from the northern region of the State of Calakmul Reserve, that borders the Regional State of Rio Bec, showed occupation from the Middle to the Terminal Classic periods (Domínguez Carrasco et al. 2011). The 103 samples selected are both utilitarian and prestigious vessels, with the Sierra, Aguila, Balanza, Triunfo, Nanzal, Tinaja, Infierno, Maquina, Cambio, Encanto, and Saxche groups standing out for their frequency.

Fig. 2.2 Region of the State of Calakmul, Eastern region sharing borders with the State of Calakmul, Northern Guatemalan Peten and Calakmul's northern territories bordering with the Regional State of Rio Bec (map by Domínguez Carrasco, based on the information provided by Vela Ramirez 2010)

The samples of clay collected in the different study regions (37 samples) were characterized as having a homogeneous pattern in terms of their chemical composition, with montmorillonite clay appearing as one of the principal clays in the Peten, both in southern Campeche as well as northern Guatemala, unlike caolinite which was distributed through the northern part of the Yucatan Peninsula (Domínguez Carrasco 2008; Rodríguez Lugo et al. 2000) (Fig. 2.3). The ceramic samples analyzed presented variants in their chemical composition according to the different study regions (Domínguez Carrasco et al. 2005).

Presence and Distribution of Ceramic Traditions

A combination and comparison of the chemical analysis of the ceramic sherds and the clays revealed that during the Late Preclassic period ceramics from the Calakmul region as well as those from the region on the east of Rio Bec showed a great similarity with those from the south, mainly with the Guatemalan Peten, where the vessels seem to present the same manufacturing technique with forms and finishes similar to those represented by the Sierra, Polvero, Flor Crema, Achiote, and Sapote ceramic groups.

Fig. 2.3 Regional distribution of the identified clays (map by Domínguez Carrasco, based on the information provided by Vela Ramirez 2010)

However there are also ceramic materials from the northern region that exhibit a stronger relationship with the Rio Bec region, such as some varieties of the Flor Cream and Sapote groups as well as the ceramics from the Maxcanu group of this region.

From the chemical point of view the Red Sierra type presents a homogeneous manufacture in all the regions under study, based on carbonates and ceramic fragments which are generally present in clays with hematite, showing a visible defined ceramic tradition at the regional level. Nevertheless it is important to point out in the Sierra group ceramic from the north near the Rio Bec region the presence of a wide variety of ceramic pastes, of surface finish, and of thickness of the vessel walls that are not present in the other regions of this study. Ball (1977) likewise reported this aspect for the site of Becan. This indicates different ceramic productions, with the exploitation of a larger number of clay mines for this Rio Bec region.

The Early Classic period saw the rise of the Maya regional capitals, with Calakmul establishing itself as the capital of a new Regional State (Marcus 1973, 1976). The analyses of materials from this period in general indicate a strong filiation with the Tzakol sphere of the Guatemalan Peten, reflected by the high frequency of orange and black monochrome types belonging to the Aguila and Balanza ceramic groups, respectively, and polychrome ceramics from the Dos Arroyos group. There is likewise a balance between the presence of ceramic traditions from the Río Bec and the Peten regions; this confirms the findings of Ferguson and Adams (2001) with respect to the cultural influence of the Calakmul sphere in the Regional State of Rio Bec during what is characterized as a period of maximum autonomy for Rio Bec. It is in this northern region and during this period that a large-scale local production of Flamboyan, that belong to the Aguila ceramic group, occurred; at the same time, its absence in the Calakmul region, in the eastern territories, and in the Guatemalan Peten confirms its restricted production and distribution within the Rio Bec region and in the northern part of the Regional State of Calakmul.

The Late Classic period reflects a time of great cultural and demographic intensity in these regions. The high percentages of ceramic vessels and the wide variety of utilitarian and prestigious types manifest a moment of maximum cultural extension in the majority of the sites within the region under study. During this very same time period, the close similarity between the physical attributes of highly diagnostic ceramics types of Calakmul, like the Nanzal, Infierno, and Chinja Impreso, with those of the eastern region and the Guatemalan Peten, is indicative of the existence of patterns of regional ceramic traditions. On the other hand the expression of ceramic traditions shared by the Calakmul and Rio Bec regions continues during this period through ceramic types that are absent in southern Calakmul, such as the Traino group that shows very important standardization and regionalization attributes.

With regard to the polychrome ceramics, we have also defined the presence of two widely spread and well-delimited ceramic traditions. The first formed by the Saxche and Palmar groups, and we will refer to it as the southern tradition, extended all the way to the Peten region, including the Regional State of Calakmul and its eastern section. This tradition was found in Becan as an imported good, the use of which was apparently very restricted, while it appears frequently in the Calakmul region as a result of a defined cultural relationship between Calakmul and the sites in the central Peten. The second tradition, formed by the Chimbote group, is distributed mostly through the Rio Bec region, the Chenes and northern Yucatan. We refer to this group as the northern tradition as it had a minimal presence in the other study regions (eastern region of Calakmul and the Guatemala Peten).

The Terminal Classic period reflects a time of important changes in ceramics. New types were introduced from the regions of northern Yucatan, which underwent new forms of decoration upon their arrival at the region of Calakmul. The presence of Fine Orange, Fine Grey, Slate, and Thin Slate vessels is likewise found, demonstrating a closeness with the ceramic traditions of northwest Yucatan and the Usumacinta. Nevertheless a strong presence of ceramic traditions of the Peten persists, reflecting cultural relations between Calakmul and the study regions.

The Postclassic period, or Cehache Complex, is represented in Calakmul mainly by Mayapan type incense burners, some of which were produced locally while others show changes in the paste composition, shedding doubt on their origin as they also show chemical differences with the original incense burners from Mayapan. All of this indicates a relationship with the ceramic traditions of Mayapan and Dzibilchaltun through the imitation of their style, more than the importation of goods or the movement of people from the north to settle in Calakmul.

Movements of Populations in the Calakmul Region During the Classic and Postclassic Periods

According to the ceramic materials and considering the predominant power of Calakmul in the area encompassed by its Regional State, which influenced even more distant regions, as witnessed by the distribution of its emblem glyph (Marcus 1993, 2004), the Early Classic period saw an exceptionally strong regional presence from the political and social point of view through the flow of people and ceremonial and domestic goods both inside and outside its regional territory.

During this period, we found a distribution of the Calakmul ceramic traditions both in the northern section, i.e., the Regional State of Rio Bec, as well as in the south, encompassing almost all of the region of the Guatemalan Peten, and in the eastern part, including sites like El Palmar (Fig. 2.4). This indicates the broad cultural relationship held by Calakmul with its neighboring regions, despite the stronger autonomy of the Regional State of Rio Bec where sites that formed part of the Regional State of Calakmul, like Oxpemul, seem to have been under the influence of Rio Bec as the ceramic tradition recovered at the site seems to indicate.

Fig. 2.4 Population movement and flow of goods in the region of Calakmul during the Early Classic (map by Domínguez Carrasco, based on the information provided by Vela Ramirez 2010)

On the other hand, towards the south no particular aspects are observed in the ceramic traditions shared by Calakmul with the different sites that comprise the Peten region of Guatemala, including the ceramics of southernmost sites such as Barton Ramie (Gifford 1976). The data mentioned above lead us to infer a constant movement of populations from north to south and from east to west, where Calakmul is seen as a center of traditional ceramic production of monochrome as well as bichrome and polychrome vessels.

During the Late Classic period and considering the great cultural intensity and demographic expansion shown by Calakmul, the high percentages of ceramics and the wide variety of utilitarian and prestigious types indicate evident limitations in the distribution of types of ceramics, where Calakmul appears as a center that receives and transmits ceramic traditions (Fig. 2.5). This means that some of the traditions of the north reached Calakmul, where their designs are modified such as in the case of polychrome vessels, to give them their own style, without being present farther south. In the case of the traditions of the south we see a similar pattern, where types of ceramics from the Peten are identified in Calakmul, although they are absent in the region of Rio Bec.

This leads us to think of a well-defined regionalization process with the two regions controlled by Calakmul, perhaps as a result of the power exercised as the

Fig. 2.5 Population movement and flow of goods in the region of Calakmul during the Late Classic (map by Domínguez Carrasco, based on the information provided by Vela Ramirez 2010)

capital of a Regional State, where the production of goods seems to have represented a pattern of identity as can also be seen in the Naachtun site in Guatemala for earlier times (Patiño Contreras 2011), a model that has also been reinforced by the chemical–physical analyses on ceramics and clays of the region.

The chemical analysis performed on pigments from Oxpemul and Calakmul also shows diverse patterns in the presence of certain chemical elements that formed part of the pigment recipes that were applied as coatings to stele and altars at both sites and that coincide with the results obtained in this study. This may be the result of the marked autonomy and power shown by the different political entities of the Maya area during this period, which must have expressed themselves with the production of their own ceramic traditions, among other indicators. This was also the case of the codex-style vessels, whose chemical characterization placed them in pottery workshops and with artisans located in Nakbe or El Mirador and which were transferred to Calakmul as part of a power mechanism and political alliance.

During the Terminal Classic period, sources of the raw materials used to produce ceramic goods seem to have been located at shorter distances from the regional capital than in the previous period (Fig. 2.6). This also coincides with the rural demographics study based on ceramics collected in 75 sites, which shows an apparent movement of people towards the interior of the Regional State of Calakmul at the end of the Late Classic and during the Terminal Classic period, evidencing an abandonment

Fig. 2.6 Population movement and flow of goods in the region of Calakmul during the Terminal Classic (map by Domínguez Carrasco, based on the information provided by Vela Ramirez 2010)

of the northernmost sites of their regional territory (Domínguez Carrasco 2008; Folan et al. 1999).

This movement of populations is manifest also in the large architectural remodeling of the main facade of Structure II, considered one of the most important ceremonial civic buildings during the Early and Late Classic periods (Folan et al. 2007, 2010) and that shows a strong occupation during this period. The cultural materials allow us to infer the practice of different activities related to everyday life, completely transforming the function of the building and showing a clear political and social decadence of Calakmul as the capital of a Regional State.

Likewise, Calakmul does not show any evident occupation during the Postclassic period like the majority of the cities of the region. The scarce ceramic materials recovered, including Mayapan type incense burners and fragments of Slate type vessels similar to those of Muna ceramic group of Muna, Yucatan, were produced locally. We must remember that the principal urban activity in the northern regions of the Maya area during the Postclassic period seems to have centered in the walled city of Mayapan (Gill 2000). This informs us of the presence of a “ceramic mode” process, where the vessel finishes as well as the different elements of style were imitated, as we can see in the incense burners. It would appear in this sense that population movements to Calakmul were only carried out as pilgrimages, without constituting defined settlements (Fig. 2.7), as was the case of Chichen Itza which was an important

Fig. 2.7 Population movement and flow of goods in the region of Calakmul during the Postclassic (map by Domínguez Carrasco, based on the information provided by Vela Ramirez 2010)

pilgrimage destination during this period despite maintaining a strong occupation, or like San Gervasio or the island of Cozumel, which maintained large populations during the Postclassic period and which were both pilgrimage destinations or places used to practice rituals (Stanton and Magnoni 2008).

We have attempted here to transmit the importance represented by the study of ceramic traditions, including the analysis of typology and its corresponding chemical analysis, to infer population movements at the inter- and intra-regional levels through their continuity and/or discontinuity during the different periods in Mesoamerica. In this specific case, the study was applied to Calakmul as the regional capital and the area comprising it, from a chronological perspective that included its occupation from the Late Preclassic to the Terminal Classic periods.

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Chapter 3
Cultural Interchange Regarding the Distribution of Fine Paste Ceramics Within Riverine Societies Along the Usumacinta's Mid to Low Basin and Various Gulf Coast's Communities

Socorro del Pilar Jiménez Alvarez

Introduction

This chapter's primary focus concerns fine paste ceramics that originate from various riverine communities situated throughout the Usumacinta's Mid to Low Basin (which spans across the states of Chiapas and Tabasco) as well as local groups from the Gulf Coast. In a hypothetical sense, it can be said that these locations constantly partook in the manufacturing and exchange of intercultural ceramic utensils that were valued in Maya societies during the Classic Period. The extensive distribution of these regional ceramic styles has conjectured the existence of various specialized centers or communities during the Late and Terminal Classic periods (c. AD 550/600–1050/1100) (Ancona Aragón and Jiménez Álvarez 2005; Berlin 1956; Bishop et al. 2008; Rands et al. 1982). It is plausible to consider that there were varying mechanisms involved in this type of exchange. We can postulate that some of the interior riverine communities both produced and utilized ceramic products; therefore, it can be reasoned that coastal communities may have only participated in acquiring these recipients or acted as secondary agents involved in the physical regional distribution of these goods.

Fine paste ceramics from the Maya region are characterized by differing colors. Grays, oranges, pale-beiges, blacks, browns, and creams comprise its basic shades. Usually, its texture does not display visible particles in the paste; however, under a microscope one can appreciate the various sizes of the extremely fine and uniformly shaped size of these particles (Fig. 3.1). As far as the hardness of this fine paste, there is a certain amount of variation that ranges from fragile to what can be

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Fig. 3.1 Map of the region showing the dynamic, long distance exchange network of fine paste during the Classic period in the Maya Lowlands

considered extremely compact. Furthermore, when extremely hard fine paste is struck against another hard surface, it emits an acute sound. In a very general manner of speaking, it can be said that the surface finishing of this paste can be characterized by the heightened effort that its craftsmen employed as a means to provide an artistic quality to these objects.

Based on the chemical research carried out by Ronald L. Bishop and Robert L. Rands (Bishop et al. 2008), it has been suggested that there were diverse fine-paste manufacturing centers along the Usumacinta Basin in the states of Chiapas and Tabasco, as well as in the Chontalpa region within Tabasco (Ancona Aragón and Jiménez Álvarez 2005; Armijo et al. 2005, 2010).

Fig. 3.2 Hypothetical reconstruction of a coastal, maritime transportation of fine paste (drawing by Belem Ceballo Casanova, FCAT/UADY)

On the other hand, authors in Rathje et al. (1978) have mentioned that the characteristics within a region's uniform ceramic repertoire—in this case the shapes and sizes of fine paste recipients—seem to indicate that the objects were manufactured collectively and voluminously as a means to minimize their weight and maximize their portability to make short- and long-distance transportation as practical as possible (Fig. 3.2). However, the manufacturing practice and the replication of this paste in other regions throughout the Late and Terminal Classic periods suggest that the technological development required a certain level of expertise within well-organized ceramic manufacturing centers in order to fully master its elaboration, in terms of clay preparation and the actual shape formation process. Perhaps it was during the ornamental phase when it was considered necessary to speed up the production process in order to meet the demands of the regional markets. In other cases, the consumption patterns corresponded to a limited demand, in locations far outside the confines from where the corresponding raw material was procured for these vessels (Rands and Bishop 1980).

The increase of archaeological research in the Maya Lowlands has enabled us to understand that fine paste ceramics manifest a certain standardized control in terms of their shapes, sizes, and region-specific designs. The presence of fine paste ceramics with considerable uniformity in both their shape and notable ornamental patterns has been documented along Mexico's Gulf Coast and the Usumacinta River's trajectory that spans Chiapas and Tabasco. Their notable ornamental norms indicate manufacturing practices that point to a rudimentary and plentiful production mode that was carried out by expertise artisans. These expert craftsmen left their distinguishable mark on pottery production with their well-pulverized paste and iconological styles that can be distinguished from region to region. In regards to the decorative designs found along the Mid and Low Usumacinta Basin, as well as certain coastal communities in the Gulf region, the execution of these styles does not display the need for highly developed artistic abilities. Most of these designs were exhibited along the right side of the vessel with the intent to cover a large amount of surface space. In other cases, it is still possible to observe that the artistic tracings were rather simple and either drawn or painted with little effort. In fine-paste orange vessels (X) it is evident that the depicted lines were irregularly traced with pale colors or pigments that had been mixed with some sort of adhesive. According to ethnographic indicators (Rye 1981:44), these attributes could have been acquired as a result of the fluidity in the pigments that were applied while the vessel's surface was still moist (Fig. 3.3b, d).

Various other fine-paste orange artifacts allow us to infer about the process through which these drawings were fixed. Some Balancan (fine orange "Z") and

Fig. 3.3 (**a**) In the "X" type fine orange paste, drawings were carried out on top of the dry engobe, or after the piece had been cooked; (**b**, **d**) The irregular drawing can be the result of the pigment being applied over a wet surface; (**c**) Engraving in clay

Silho (fine orange “X”) fine-paste orange vessels display regularly drawn contours in which the paint has properly adhered to the surface. This quality seemingly suggests that the designs were traced after the slip had dried, the vessel had been fired, or the clay had hardened (Fig. 3.3a). Other Balancan drawings consist of irregular borders; during the tracing of the designs there remained a considerably discontinuous surface that was caused by the clay’s displacement. In some fine-paste grays that were obtained from the coast (utilized during the initial stages of the Late Classic, c. AD 550/600), there are numerous clay protrusions on the contour of the drawings. The latter indicates that the designs were made while the clay was still very malleable (Rye 1981:91) (Fig. 3.3c).

There are only a few vessels that attest to a careful manufacturing process and/or contain complex iconographic designs; these objects are generally associated to special contexts that form part of mortuary assemblages; in fact, some of the mortuary assemblages found along the coast provide the only objects of specialized pottery that consist of finely molded and painted vessels (Fig. 3.4).

Fig. 3.4 Fragments of fine paste showing either a complex modeling or a carefully executed surface painting

Researching the different relationships between the style and change of regional styles found in fine paste vessels among coastal and riverine communities means trying to understand the technological development that led to the manufacturing of this paste as a production process and highly complex cultural interchange operation. The map displayed in Fig. 3.1 is a clear example of the dynamic fine-paste trade networks that emerged during the Classic period in the Maya Lowlands. According to the actual dates, it is implied that there were at least three moments throughout history in which this paste's raw material was distributed.

Along the Gulf Coast, the earliest recorded date concerning the presence of fine paste has been established between AD 550/600 and 750. This chronology was established in relation to the architecture, ceramics, and stratigraphy that were registered during the excavations of over 200 test pits within the site of Xcambo, Yucatan (Jiménez Alvarez et al. 2006). In addition to those 200 test pits, another two stratigraphically controlled test pits were documented in Chichicapa, Tabasco (Ancona Aragón et al. 2009), as was one of the most interesting test pits found in the monumental architectural group known as "Zayozal" in the Maya site of Jaina, Campeche (Ancona Aragón and Jiménez Álvarez 2005). Notably, everything seems to indicate that both Champoton and the city of Campeche also took part in the regional consumption of this fine paste (although, the degree of this consumption is still unknown), which has been associated to the early stages of the Late Classic period along Mexico's Gulf Coast (Bishop et al. 2006; Forsyth and Jordan 2003).

The second date is a transitional one (c. AD 750–900), and although it is known to have been characteristic of some sites along the Gulf Coast, its underlying relevance is attributed to the consumption of fine black and gray pastes. These comprise a very particular repertoire that is largely associated to Late Classic settlements situated across the Mid and Low regions of the Usumacinta River's Basin along the states of Chiapas and Tabasco. This time period is known as transitional because it is the moment in which early fine pastes were declining and the fine orange paste that would characterize the Terminal Classic began to emerge (c. AD 900–1050/1100). The latter would go on to be widely consumed throughout the Yucatan coast and inland sites in the northern part of the peninsula; this moment is easier to detect within inland sites.

The third moment is associated to the prevalence of fine orange paste ceramics that have been carefully recorded from some stratigraphic test pits in Uaymil. These were clearly linked to Terminal Classic architecture (as of AD 900) (Cobos 2004). Thus, it is plausible to argue that there are early fine paste ceramics (c. AD 550–750), intermediate fine paste ceramics (c. AD 750–900), and terminal fine pastes (c. AD 900–1050).

Early Fine Paste Ceramics

Along the Gulf coast of Tabasco and Yucatan, the abundance and quality of the clays found in the fluvial landscape of Tabasco are the key reason to explain presence of specialized artisans, the development of ceramic workshops and the evident existence of regional styles. They were sparked because of the demand of utilitarian vessels to be used in daily household activities as well as part of the paraphernalia employed in domestic and communal rituals (Armijo et al. 2005:190, 2010).

Peripheral centers containing various residential mound-like platforms were situated 2 km away from the nucleus of Comalcalco, and the settlement located on Kilometer 30 + 360, some 3,700 m southwest of Comalcalco's main acropolis, manifests an ample repertoire of ceramic vessels that consist of gray, orange, cream, and brown clays that are representative of the earliest Mexcalapa phase in the region (c. AD 550/600–750/800) (Armijo et al. 2005, 2010).

The distinctive characteristics of these materials are a result of the way in which this type of clay was fused with another that had not been properly aerated (this is made evident due to the remaining white particles that are prominent and visible to the naked eye). The amalgamation was used to produce vessels with rather thick walls. Its hematite-red pigments, with creams, whites, and yellows, are distinctive of its varying color palette. The combination of these colors seems to imitate the finishing of the lustrous Petén style in the Maya region.

Upon a closer look at the Gulf coast along the states of Campeche and Yucatan, the same stylistic pattern manifests itself in the established Canbalam spheres that pertain to the sites of Xcambo, Jaina, Isla Piedras, and to a lesser extent Uaymil. This early fine paste is assigned to the Late Classic (c. AD 550–700) and is characterized by its gray, black, and cream colors. Gray ceramics are associated to the "Early Chablekal" style; fine-paste black ceramics that have been well polished are linked to "Xcambo's fine-black Tsicul" phase; while cream colored fine paste is associated to the well-known "Isla Fina de Jaina." The latter bears resemblance to the "Villa Alta" phase found in Veracruz (Jiménez Álvarez 2009; Jiménez Alvarez et al. 2006) (Fig. 3.4b). Geometric designs and cylindrical glyph imitations are commonly found on both black and gray fine paste ceramics; notably, these were drawn while the vessel's clay was still very damp. These common designs vary according to the shape of each ceramic object, but are always displayed schematically with irregular tracings over which the exterior surface of the vessel was drawn upon in a fast-paced manner.

It should be noted that black, gray, and beige fine pastes resemble and hold ties to the ceramics found in the pan regional Gulf Coast, which includes the regions of Veracruz, Tabasco, and Yucatan (Jiménez Alvarez et al. 2006).

Transitional Fine Pastes

The second traditional time period regarding fine paste ceramics in the Comalcalco and adjacent regions (c. AD 800–1000) is characterized by the overall use of fine pastes that manifest certain changes in the shape and design of these vessels. This particular style is the most commonly noted within ceramic literature, which also happens to be the type that is associated to monumental architecture. At this moment in time, the fine paste's repertoire experienced a drastic reduction in the

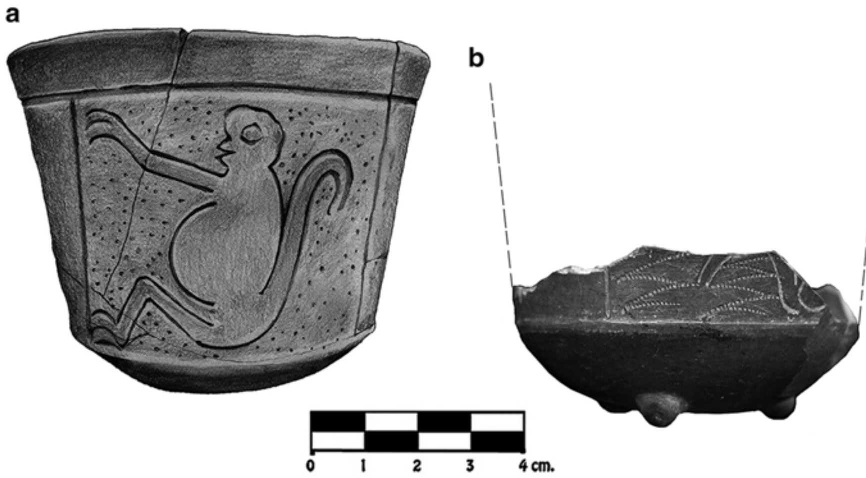

Fig. 3.5 Usumacinta-style fine grey-paste (**a**) Merida region; (**b**) Fragment of a fine grey vase from Tecolpan (INAH Ceramic Laboratory, Merida INAH center—photo by Socorro Jimenez)

girth of its walls. The most prevalent ceramics during this time and region consist of gray clays with well-polished surfaces or those with black surfaces that have been elaborated with thorough aesthetic designs and meticulous polishing; carefully developed motifs make Comalcalco ceramics highly distinctive. A figure of monkey is frequently depicted within this repertoire, notably, there is also the emergence of a new shape known as the beaker, which is very similar in shape to those found in the Peten and Chinikiha regions (Jiménez Alvarez et al. 2011; Rands 1967; Rands and Bishop 2003) (Fig. 3.5a, b). Glyph imitations are reduced in size and appear as decorative elements in a circular band that is close to the vessels rim. It is evident that during the intermediate fine paste phase, these designs were made while the vessels surface was hard enough to allow more precisely detailed motifs that led to greater decorative variation, such as, percussed, printed, or dented, there are even some designs that clearly demonstrate they were created with thinner and less profound etches (Fig. 3.5b)

On the other hand, within some Gulf Coast sites like Jaina, Champoton, and Uaymil, cream colored pastes were replaced by gray and black ones. This resulted in the emergence of new stylistic forms in the region. Bowls with dual bases and simple motifs that beard the distinctive figure monkey began to be traded. It is even possible to see that the practice of decorating vessels by stamping motifs onto their surface developed. The ceramic style of fine pastes that are associated to those found in the Usumacinta River along the states of Chiapas and Tabasco (Jonuta–Tecopan), which is known as Chablekal Usumacinta, corresponds to the fine paste from the island of Jaina that has been stratigraphically dated to AD 750 (Ancona Aragón et al. 2009).

Along the mid and low sectors of the Usumacinta Basin, the distributional panorama of fine pastes is quite different. Here, the height of its distribution regards regional artisan centers that intensely demanded fine pastes for their consumers. Jonuta and Tecolpan are both situated on the low part of the basin and have been considered as important manufacturers of gray and orange fine paste ceramics (Berlin 1956; Rands et al. 1982). Their regional style presents a wide distributional range along the coast, and to a lesser extent, the riverine communities of Chinkiha and Pomona. The latter sites have been linked to the second moment of fine paste usage (Jiménez Alvarez et al. 2011).

Late Fine Pastes

The third moment of fine paste usage is key to understanding the Late and Terminal Classic periods in the Maya Lowlands, especially when it comes to the trade relationships that may have sprouted between coastal and inland communities within the Yucatan Peninsula, as well as with riverine communities along the mid and low regions of the Usumacinta Basin of Tabasco. Everything seems to indicate that at some point during the transition from the Late Classic to the Terminal Classic, gray and black fine pastes were gradually substituted and eventually replaced by fine-paste orange vessels, which marked an important moment in the history of coastal sites. Along Campeche's coast, the most influential sites within the distribution and consumption network of fine-paste orange vessels were Jaina, Uaymil, and Champoton, whereas, in the northern Yucatan coastline it was the site of Xcopte. It is known that these fine-paste orange vessels were representative of the Terminal Classic period (c. AD 900–1050/1100) in the northern part of the Yucatan Peninsula.

From a chemical perspective, these late fine pastes denote the presence of two production zones associated to the Usumacinta River Basin in Tabasco (Rands et al. 1982). Thus, from a consumption point of view, the distribution model points to inland sites like Chichen Itza (Silho fine paste orange) and Ek' Balam (Balancan fine paste orange), as well as coastal communities that reflect a somewhat generalized distribution model for Silho and Balancan ceramics (Fig. 3.4c). In Uaymil, Jaina, Champoton, and Xcopte, gray fine paste ceramics appear to be associated to the fine pastes' of Silho, Balancan, and the particular Dzitas materials, as well as Nimun and Baca; these last two are diagnostic components of the Canbalam ceramic sphere.

To date, among these four sites, Uaymil is the only settlement that preserves stratigraphic evidence of fine paste transitions from the Late Classic to the Terminal Classic; it also indicates the continuity of Nimun and Baca ceramics, as well as the suggestion of ties to Sotuta ceramics. Meanwhile, in Chichén Itza, the consumption of fine pastes attests to the apogee in trade that these vessels reached; this trade was controlled by the leading political entity that was Chichén Itza, during this time it was one of the most dominant cosmopolitan centers from its inland location to the coast of Yucatan (Cobos 2004). The circulation of orange and gray fine pastes in Uaymil, as well as the distribution of Nimun and Baca coastal ceramics seems to reflect the emergence of new fine-paste trade networks as well as the continuity of domestic Canbalam production during the Terminal Classic. The presence of these ceramic components can be classified within a new sphere, "The Late Canbalam Ceramic Sphere."

The proposed scenario in this work presents us with the possibility of laying down the foundations that can allow us to understand the dynamic complexity that revolved around the large-scale trade of these highly valued vessels within coastal and inland Maya communities.

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Chapter 4
Calakmul: Power, Perseverance, and Persistence

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Introduction

According to (Marcus 2004a), the primary states in the Peten region of the Maya Lowlands include the rise of the Great Cities of Calakmul and Tikal. Of the two, Calakmul is at the center of the Maya Lowlands (Anonymous 1932; Stuart and Stuart 2008). Calakmul exhibits a massive royal court (Fig. 4.1) formed by Temple II, with 56 small rooms on its lower unfinished façade and Rio Bec style upper façade, structures IVa, b, and c, and Structure VI, the E-Group, and Temple VII. A ball court is situated to the west of the main plaza and Structure III, the Palace is to the east (Folan et al. 2001). In addition to Calakmul, this combination of structures is evident in many cities from the Middle Preclassic onward. Examples are Nakbe (Hansen 1991), El Mirador to the south (Hansen 1994; Matheny and Matheny 2011), and Oxpemul (Folan et al. 2000) to the north of Calakmul.

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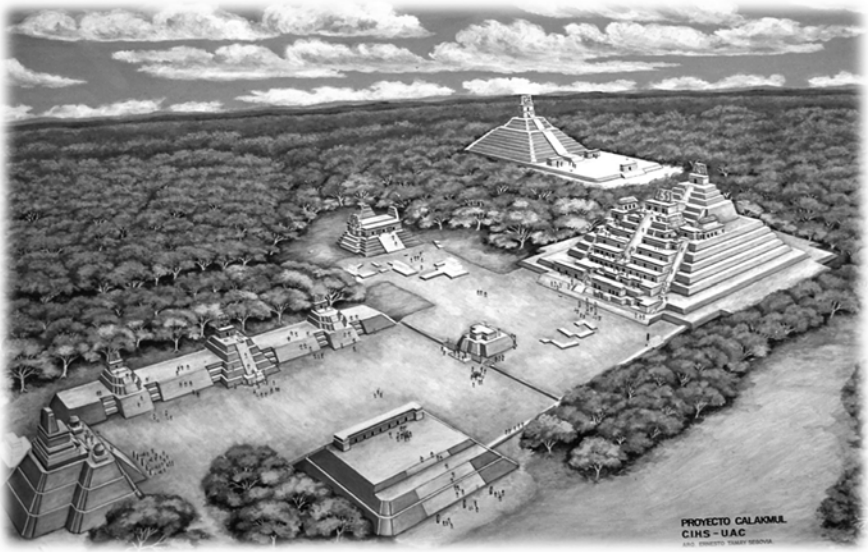

Fig. 4.1 Calakmul, Campeche: the royal court, including its Palace and Group E with Structures II, III, IV-a, b, c, VII, V. The Ball Game field lays on the west outside the figure. Painting by Ernesto Tamay Segovia

For some time we have known that Calakmul's royal court prevailed since Preclassic times based on the investigations of the Centro de Investigaciones Históricas y Sociales of the Universidad Autónoma de Campeche from 1982 until 1994. We carried out excavations on several buildings as well as mapping 6,195 structures over a 30 km^2 area (Folan et al. 1990; May Hau et al. 1990). These were recently converted into 3D images by Winemiller et al. (2013). This pattern is also manifested through the stylistic, chemical and statistical analysis of the ceramics of Calakmul by Domínguez Carrasco (2008) including the analysis of our stratigraphic excavations of Structure II.

Location and Related Components of Settlement Patterns

Addressing Marcus's (2004b) enquiry as to why the capitals and territories of primary states such as Calakmul and Tikal are located where they are is a complex problem. Calakmul, for example, is in the geographical center of the Maya Lowlands (Anonymous 1932; Stuart and Stuart 2008) and Tikal is the rector center of the Upper Holmul river (Vilma Fialko, personal communication August 7th, 2010). They were also blessed by equitable rainfall for their *milpas* during the Late Classic (see below), as well as fertile, arable soils around the edges and within the *bajos* and along escarpments (Folan and Gallegos 1992) to provide their local populations with necessary foodstuffs (Fig. 4.2) (see Siemens 1998 for the Candelaria River region).

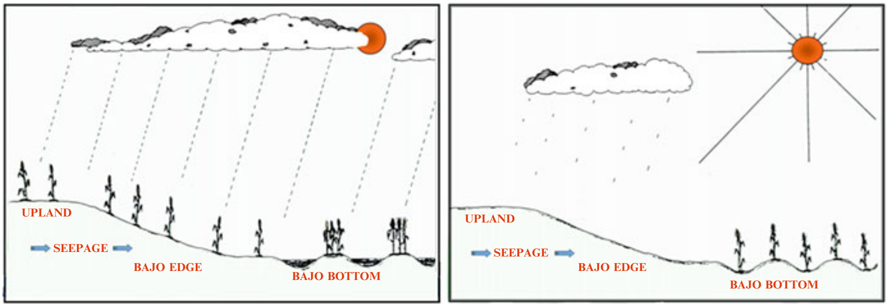

Fig. 4.2 Models of crop planting depending on seasons. *Left*: Four-step model—May/June planting; *Right*: Four-step model—tornamil (winter-crop) planting

Climate and Water

The settlement of large populations in the Peten provinces of Campeche and Guatemala through time depended on periods of equitable precipitation and the accessibility of potable surface water (Folan et al. 2000; Gunn et al. 1994, 1995) supplied by a four-stage hydraulic process to capture, retain, redistribute, and disperse this vital liquid (Folan et al. 2013).

Once the population increased, water combined with the introduction of horticultural activities in one form or another, required not only adequate precipitation to produce one or more harvests of corn and other foodstuffs per year, but the fruit and edible plants of the region from season to season as well as maintain the fauna that they trapped, hunted, or domesticated.

Formation of Complex Societies in the Interior

Once the population increased along with its ability to produce consumables sufficient to its necessities, extended family groups began to organize themselves into small units. We encountered possible analogs of such groups in our 1974 trip to define the Coba/Ixil *sac be* that were encamped around a cenote along the *sac be* (Folan 1977). Zetina Gutiérrez (2007) lately observed such groups systematically in the vicinity of Edzna.

With the appearance of "strong men" and their extended families, small villages formed chieftainships supported by a majority that contributed the energy essential to organize royal courts, including what has been classified as a market area in Calakmul behind Structure VII (Folan 1991–1992; Masson and Freidel 2013) divided by a 6 m high wall separating the sacred from the secular.

Marcus (2004b) classification refers to primary states in the Maya area as those that are able to maintain their political organization intact for long periods of time in contrast to those states that not only soon lost their tributary centers and/or allies but also their citizens. It is the location of the center and its region that is of optimal importance as in the case of Rome, the Eternal City. In agreement with Cohen (1978), Flannery (1999), and Marcus (2004b), however, some form of military conflict was one of the major routes leading toward state formation and continuity in the Peten and elsewhere in Mesoamerica.

According to Marcus (2004a), although Tikal's sphere of influence may be older than Calakmul's according to its dynastic texts, Calakmul with its 6,195 structures and 120 stelae, in the end, was the largest metropolis and regional state in the Peten while remaining in the same central place for more than 1500 years. Its indirect influence also extended further than any other state. The distribution of its emblem glyph was greater than any other dynasty in the Maya area. It conducted military campaigns over record distances (Demarest 2004; Martin and Grübe 2008).

Also according to Marcus (2004a), in that Calakmul's immediate political sphere of influence covered some 31,000 km^2 or more, there was always the danger that those loyal political units farthest from the capital at times joined other regional capitals or became tributary cities seeking autonomy, thus presenting a very dynamic situation (Grübe 2000; Marcus 2004a). In AD 751 the Kaan or Chan dynasty, but not Calakmul itself, was apparently conquered/defeated by a king of Oxpemul (Robichaux 2011; Robichaux and Pruett 2005) who is carved on the face of Stela 9, where he is shown with a weapon in his hand while standing on the body and head of a serpent supported by at least one ally, Tikal.

Why Calakmul should expand regionally to such an enormous size relative to its sister polities is of interest. As we have noted in several articles over the last three decades (Folan 1981; Folan et al. 1983; Gunn et al. 1994, 1995; Gunn and Folan 2000), the climate of any given location on the Yucatan Peninsula depends on the location of the tropical–subtropical ecotone during any given time period. Other researchers have suggested that the Inter Tropical Convergence Zone (ITCZ) is the critical issue (e.g., Haug et al. 2001). Although the ITCZ plays a coordinated role, the tropical–subtropical ecotone (boundary between tropical wet and subtropical dry) and the Bermuda/Azores Subtropical High are all aspects of the same Atlantic weather/climate system; it is the location of the ecotone that defines the balance between a wet and dry season and thus is critical to the highly productive and sustainable agricultural system developed by the Maya. As can be seen in Fig. 4.3, our modeling estimates that during the Maya Classic periods, the climate was largely disposed to equitable wet/dry seasons as later emphasized by Nooren et al. (2009). This creates a time-frame of about 500 years, during which the Maya Classic period unfolds, providing sustained, favorable, global atmospheric conditions.

Calakmul is outside the Tikal lake district to the north in the more karstic and therefore excessively well drained terrain of the Karstic Mesoplain-Calakmul (Fig. 4.4) (Gates 1992, 1999; Domínguez Carrasco et al. 2012; Folan et al. 2012). Recent research has been carried out in the El Ramonal bajo associated with the ruins of Oxpemul to the north of Calakmul (Folan et al. 2010). It is here where the bajo suggests favorable conditions for agriculture supported by the 64 *camellones* mapped by Morales López (2010). According to preliminary analysis by Torrescano Valle (2012) these features are in an area associated with *Zea maiz.*

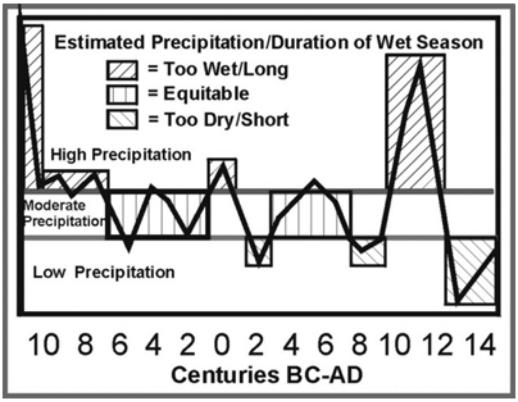

Fig. 4.3 Model based on modern discharge of the Candelaria River projects of equitable precipitation during the Preclassic (700–100 BC) and Classic periods (AD 300–700). This model is not temporally resolved enough to detect the AD 536 drought (adapted from Gunn et al. 1995)

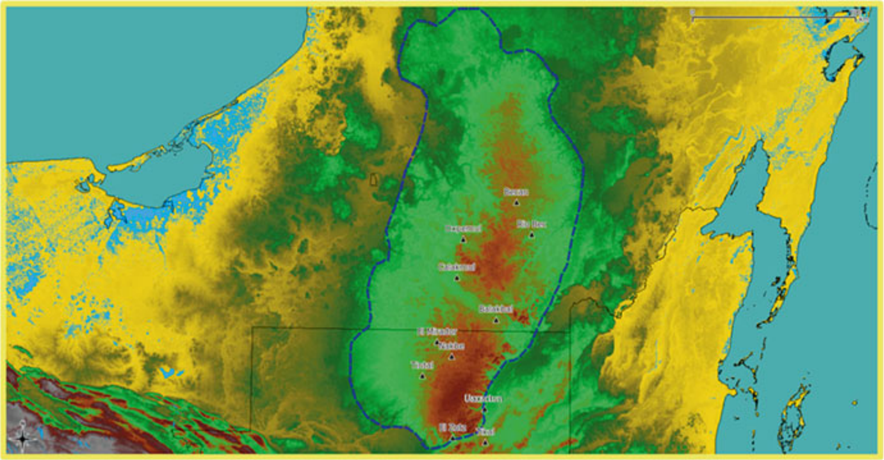

Fig. 4.4 Satellite image of the Karstic/Calakmul Mesoplane, showing the location of Calakmul and El Mirador

Besides representing a city-state, Oxpemul also forms part of a buffer zone between Chenes states such as Becan in the north and the Calakmul regional state (Adams and Jones 1981; Peña Castillo 1986).

Ceramic Changes, Linguistics, and Population Migrations

Josserand (2007) finds that the distribution of linguistic groups in the Peninsula of Yucatan and the Maya Lowlands in general is due to an expansion of the Cholano group toward the Peten near the end of the Preclassic and at the beginning of the Classic Period. In some places the Cholanos replaced Yucatecano speakers where they already existed. During the Late Classic, groups of Cholanos from the Rio Bec region began to invade Calakmul, weakened by intermittent, lengthy droughts (Folan et al. 1983; Gunn et al. 1994; Medina-Elizalde et al. 2010), and introduced ceramics from the north with traces of palygorskyte (Domínguez Carrasco 2004, 2008). At approximately the same time, members of a Yucatecano linguistic group bearing another ceramic tradition advanced from north to south toward the Calakmul regional state during a drought around AD 800. They brought ceramics and the architectural concepts of small, vaulted rooms which they added to the façade of principal structures in Calakmul (Folan et al. 2008a) and resembling the lower façade of the Templo de Cinco Pisos in Edzna and El Mirador (Suyuc Ley and Hansen 2006). This formed a north/south corridor extending from northern Yucatan to the Guatemalan Peten that has also been defined biogeographically by de la Maza (1999) (see Folan et al. 1992).

Calakmul Population Development

According to Gunn et al.'s (1994, 1995) calculations, climatic conditions in the Peten were equitable at the interface of the Middle and Late Preclassic from 500 to 310 BC (see Fig. 4.2). During this period of time the potassium and magnesium content of the El Laberinto Bajo rose to approximately 8 ppm. The results of Domínguez Carrasco's (Domínguez Carrasco and Folan 1999) analysis of the over 700 Preclassic ceramic sherds from Calakmul, including 22 Middle Preclassic sherds from a tunnel excavated into Structure II in 1993 (Folan 1999) indicate a substantial occupation of the royal court distributed around the main plaza at this time.

According to Marcus (2004a), it was during the Early Classic between AD 500 and 600 when Calakmul began to consolidate the center of its territory including at least six second level cities. They included Oxpemul with its Stone Throne emblem glyph (Robichaux and Pruett 2005; Robichaux 2011) and Uxul with its emblem glyph (Grübe and Paap 2008) as well as Naachtun being among the most recognizable. As far as we can determine, virtually all of Calakmul's principal tributaries listed by Flannery (1972) and Marcus (1976) probably had their own emblem glyphs.

A new direction is evident in Calakmul during the Early Classic including architectural additions to Structure II at practically all levels. These include several large masks on its façade, perhaps representing a feared or revered member of the new Cholano dynasty. It is very possible that the stucco masks on the façade of Palace Structure III (Pincemin 1994) also depict this ruler who may be buried in the Early Classic tomb with his jadeite masks in the base of the structure (Marcus and Folan 1994). Other jade masks were associated with tombs in Structure II-H (Folan and Morales López 1996) and Structure VII (Domínguez Carrasco 2004; Gallegos Gomora et al. 2005; Folan et al. 2008b).

Events were not favorable for Calakmul nor its region when they were severely affected by the AD 536 drought. Oxpemul, Tikal, and virtually all of the Central

Peten were also affected. It was during this time that the Kaan dynasty established political as well as military relations with numerous centers (20) of power (Braswell 2005) from Piedras Negras in the southwest, Copan in the southeast, La Corona to the south and beyond (Canuto and Barrientos 2013), Oxpemul in the north and, according to A. Benavides (personal communication 2012), Edzna to the northwest.

Despite the regional political relations and conquests of Calakmul were evidently successful, there existed indications that not all was well at home. Although they constructed a palace at the top of the principal staircase of Structure II, they failed to complete the remodeling of the façade. This left great sections of the monument unmodified including a large, partially covered mask from the previous dynasty adorning its upper eastern façade. Also unfinished were the new staircases to access the summit of Structure II. The foundation base of the staircase covered by a layer of mud mortar, arrived at a terrace with a narrow staircase framed within a series of stepped Rio Bec style adornments divided by a 1.20 m wide and 3.50 m long dais accessing the central entrance to Palace Structure II-b. Moreover, several of the small rooms mentioned below were built during the Terminal Classic over the lower reaches of the Preclassic staircases accessing Structure II-A (Folan, et al. 2001).

During the Terminal Classic, all indications are that Calakmul's population increased considerably in the area excavated by us in and around its royal court (Folan et al. 2008a). Following turbulent times during the Late Classic/Terminal Classic interface, the city was racked by declining precipitation for crops and a paucity of water in its 13 *aguadas*.

The 34,000 plus sherds pertaining to the Terminal Classic were identified by Domínguez Carrasco (1994). These were drawn mainly from the multiple rooms on the lower façade of Structure II indicating an implosion of people into central Calakmul during this time period when they built 56 rooms, with 14 preserved doorways, 13 daises, and 22 niches on the façade of Structure II with the incomplete staircase resembling Temple IV in Tikal (Ponciano et al. 2011). It was here where they carried out multiple domestic activities combined with weapon and craft production, including the formation of molded clay figurines, while also adding several rooms at the base of the main staircase accessing Structure II-A (Folan et al. 2008a).

The sea shells, shells, pearls, and stingray spines identified by Gerardo Villanueva (n.d.) (Fig. 4.5) mostly from Terminal Classic contexts included regular quantities from the Gulf of Mexico and the Caribbean as well as a large quantity of sea shell species (20 %) from the Pacific ocean that indicate direct or indirect trade from all directions. A quick comparison of Calakmul' shell material with Tikal's (Moholy-Nagy 2008) leaves us with the impression that both cities had access to basically the same or similar sources perhaps in varying degrees through time.

Folan et al. (2008a) believe that Calakmul's multiple alliances and conquests represent its importance as a major player in Mesoamerica as an early urban center and primary state, if the Olmec are not considered part of the equation.

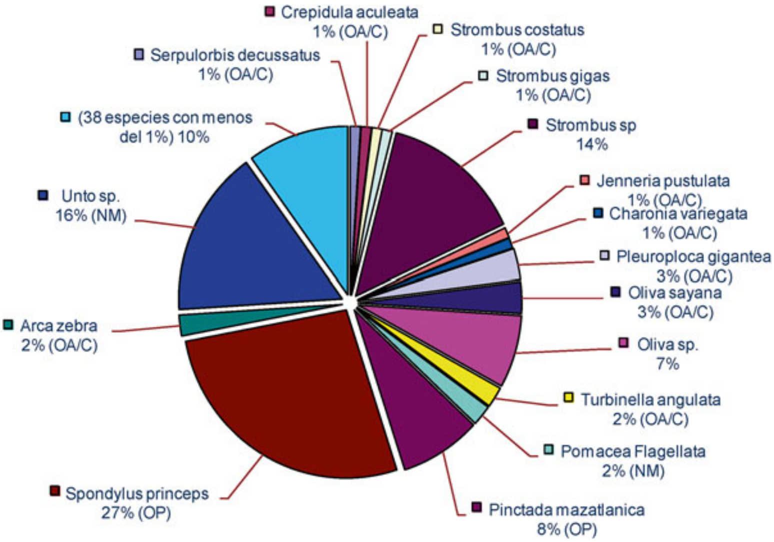

Fig. 4.5 Graphic that shows the shells identified by Villanueva (n.d.) and their frequency in the collection

Modeling and Verifying the Calakmul Developmental Sequence

To review, we have focused on the development of Calakmul and its region from 1000 BC to AD 1000. We base our summation of the region on multiple lines of evidence collected over the last 30 years. Our estimate of the paleoclimate of the region is based on calculated global–regional relationships (Gunn, et al. 1994, 1995; Gunn and Folan 1996, 2000) in combination with analyses of soils in El Ramonal and El Laberinto Bajo (Gunn et al. 2002) and from soil samples collected in 1985 from a stratigraphic pit excavated by Domínguez Carrasco (1993) at the edge of the El Laberinto Bajo some 1,200 m to the west of Calakmul's royal court (Gunn, et al. 2010). To this is added the analysis of pollen from Oxpemul (Torrescano Valle 2012) and Lake Silvituk. Within the context of paleoclimate data, we examine movements of ceramics (Domínguez Carrasco 1994) and other goods such as obsidian (Braswell et al. 2004) and shell (Villanueva n.d.). Population movements are traced by osteological studies (Cucina and Tiesler 2008) and linguistic studies (Josserand 2007) of groups in and out of the Calakmul region. These are combined with the epigraphy of the region (Robichaux 2011) and architecture as reflected in the development of Structure II and the royal court from the Middle Preclassic onward until its abandonment during the Terminal Classic (Folan et al. 2008a). To this we add recent investigations in Oxpemul (Folan et al. 2010), some 38 km to the north of Calakmul, nestled on the Mesoplano Karstico-Calakmul (Fig. 4.4) that extends south from the border between Mexico and Guatemala to near Edzna in the north (Gates 1992, 1999; Domínguez Carrasco et al. 2012).

The whole panoply of change falls within the ancient Yucatecan linguistic sphere that extended south through a cultural pipeline situated between the Xbonil hills to the west and the Xpuhil hills to the east. This linguistic roadway is akin to Cucina and Tiesler's (2008) human corridor and de la Maza's (1999) biogeographic faunal corridor. It is best described as a north–south right-of-way leading into and out of Calakmul and the Guatemalan Peten.

In the beginning, Calakmul represented an area at the edge of the El Laberinto Bajo. It is here where the earliest *Calakmuleños* made use of its eroded, fertile soils and its raised natural *culencul´ob* (Folan and Gallegos 1999) along the bajo edge leaving these soils to erode from the uplands, as did the early Romans. They increased, in this manner, the arable soil around what is one of the largest bajos and potential bread baskets in the Campeche and Guatemalan Peten. It may have once formed part and parcel of an inland port in Calakmul (Folan and May Hau 1984; Folan et al. 1990). A market (Folan 1991–1992) and habitation groups accommodated the ever-growing population formed around its royal court. El Mirador (Forsyth 2005; Hansen 1994) may have been conquered by Calakmul (Marcus 2004b) or liquidated by the 200 BC and/or AD 212–409 drought noted by Gunn et al. (1994) and Torrescano Valle (personal communication) or a combination of both climate and warfare. Calakmul and Tikal were the major players in the Peten due to power, perseverance, persistence, and sustainability of their location and inhabitants in part through their construction of several major *aguadas* (Braswell et al. 2004; Folan et al. 2008a) and the control of its soils. In a few words, El Mirador was not prepared at the beginning of various major droughts in the Maya Lowlands leaving it open to conquest (Marcus 2004b) or a forced abandonment due to a lack of potable water.

Conclusions

Based on the above, it seems reasonable to suggest that the development of Calakmul as a centrally placed Great City and its long lasting resistant and sustained power is associated with its location in the middle of the Maya Lowlands on the elevated mesoplano and, of necessity, equitable rainfall (Faust et al. 2010; Folan et al. 2008a) (tropical–subtropical ecotone). This is in addition to fertile soils including the bases of escarpments, hills, bajo edges, and elevated areas within the bajos in combination with the ability to collect and conserve sufficient quantities of the rainfall and, possibly, some underground water (Gates 1999) through time, especially during the rainy season, while using atmospheric moisture for consumption and ground water laden with gypsum for daily necessities including bathing and other domestic and personal activities but not for irrigation as far as we have been able to determine.

There is no doubt that the trigger that brought down this mighty metropolis, its regional state and empirical aspirations was a lack of equitable rainfall to which anyone living in the waterless waste of the Peten would have to agree. When there is no rain for your *milpa* there is little or no corn to grind or beans, squash, and chile to fill your *jicara*.

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Chapter 5
The Historic Presence of Itza, Putun, and Toltec in the Maya Lowlands at the End of the Classic and Postclassic Periods

Rafael Cobos

Introduction

In the archaeological literature focused on the end of the Classic and Postclassic periods in the Maya Lowlands, when speaking of Yucatan and Chichen Itza, the Maya word is generally associated with the terms Toltec, Putun, and Itza. These three words—as interpreted by archaeologists, historians, art historians, and ethnohistorians—have been and continue to be terms that designate non-Maya protagonists, or "nahuatized Maya" as those who (1) emigrated and traveled through the territory of the Yucatan Peninsula; (2) frequently and customarily traveled by canoe along the coast of the peninsula; (3) arrived, conquered, settled, and ruled Chichen Itza and Mayapan, living with the Maya people; and (4) brought new gods, religious beliefs, social and cultural practices and cults to Yucatan; in short, these words indicate those who supposedly were responsible for creating the new history of the Maya Lowlands from the tenth century until the arrival of the Spaniards in the sixteenth century.

It is important to note that these protagonists referred to as Toltec, Putun, and Itza were placed on the karstic surface of the Yucatan Peninsula based on interpretations of historic sources from both the natives of Yucatan as well as documents written by sixteenth and seventeenth century Spaniards who occupied Yucatan. Since the 1930s, researchers such as Ralph Roys, Frances Scholes, and Alfredo Barrera Vásquez have interpreted different passages from the books of the Chilam Balam, records set down in the *Relaciones Histórico Geográficas de Yucatán*, writings by personages like the Bishop Diego de Landa, who, using their own reasoning,

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explanations, and interpretations, left to us a narrative of historic events that occurred in Yucatan between the tenth and the seventeenth centuries (Barrera Vásquez and Rendón 1948; Roys 1933, 1966; Scholes and Roys 1948).

The role played by Ralph Roys in the study, analysis, and interpretation of historic documents was fundamental, and his impact and influence is still felt today. As a result, to speak of Itza, Putun, and Toltec at the end of the Terminal Classic period and during the Postclassic period in the northern Maya Lowlands, we must evaluate the proposal made by Roys more than half a century ago. Roys (1933, 1966) has the merit of having translated, analyzed, and interpreted documents from native Yucatecan literature as well as written Spanish records. Roys mentions the Toltec, Itza, and Putun in his numerous publications as groups with close ties to the principal historic events interpreted by him with regard to Yucatan and Chichen Itza.

With reference to the Toltec, Roys (1966:154) indicated that this group was the founder "of the Mexican Chichen Itza, arriving from the west via the *Laguna de Terminos*." Roys (1966) in his interpretation and reconstruction of the cultural history of Yucatan recognizes that the Toltec dominated and occupied Chichen Itza, introducing to it the cult of Kukulkan, although before the Itza arrived at this Prehispanic community.

Roys makes clear his interpretation of the historic facts in his numerous publications; however, even as he gives this interpretation, he points out: "The historic legends of Yucatan do not provide details on the Toltec subjugation of this land." He also indicates that there were no historical records on the conquest of Yucatan by the Toltec, and states that Mexican was not spoken in Yucatan after the Maya-Toltec flowering of Chichen Itza (Roys 1966:155, 157–158). Consequently, Roys gives life to the Toltec on paper when he rebuilt part of the history of Yucatan, although clearly recognizing that historic evidence is extremely weak. His affirmations of the lack of details on the subjugation and conquest and on the people who spoke Mayan suggest that we proceed with caution in our reconstruction of the facts during the tenth century.

Regarding the Itzas, Roys (1962) identified three great episodes in the history of this population. Each of these episodes occupied a complete cycle of a katun, a period of 256 years. Roys dates the first episode to between AD 950 and 1200, recognizing the settlement or occupation by the Itza—who were apparently of Chontal origin—of Chakanputun. As with the Toltec, Roys (1966:161), based on his interpretation of historic documents, supposed that Chakanputun was the site of today's Champoton, although he clearly admitted that this identification was not completely certain or exact. The second episode, which is characterized by the abandonment of Chakanputun by the Itza, is dated by Roys to between AD 1200 and 1461. Following the abandonment, the Itza migrated towards Lake Peten until they arrived on the eastern coast of Yucatan, and then entered Yucatan from the east to reach the center of the peninsula and discover Chichen Itza in *katun 4 Ajau*, between AD 1224 and 1244. The third episode—which Roys dates to AD 1461–1697—corresponds to *katun 8 Ajau*. According to Roys, this period saw the Itza abandonment of Chichen Itza and their migration and settlement in the Lake Peten of Guatemala (Pollock 1962:4).

It was Thompson (1970) who adapted Roys' historical interpretations to his own interpretation of historic events and related them to archaeological data. According to Thompson (1970:3), the Putun were Maya-Chontal, and one branch of this group was given the name of Itza in Yucatan. Thompson holds that there were two waves of migration of Putun-Maya/Chontal-Itza at Chichen Itza. During the first one, these Putun-Maya/Chontal-Itza settled on the island of Cozumel and from there conquered Chichen Itza in AD 918. The Putun-Maya/Chontal-Itza who first arrived at Chichen Itza built the substructure of The Castle. Thompson then suggests that the second group of Putun-Maya/Chontal-Itza that arrived at Chichen Itza in AD 987, or in *katun 4 Ajau*, (1970; see too McVicker 1985:4) was strongly influenced by Tula. According to Thompson this second group built The Castle and brought to Chichen Itza the cult of Kukulkan, new religious ideas, symbolism, architecture, and art. According to Thompson (1970), the Putun were characterized as bilingual, influenced by the culture of central Mexico, traders who preferred to use maritime to land routes. It is worthy to note that this reconstruction of facts by Thompson with the arrival of a second group of Putun-Maya/Chontal-Itza at Chichen Itza in AD 987 (or *katun 4 Ajau*) is actually a theory or invention of Thompson, as historic sources in no way mention either Itza or Kukulkan in Chichen Itza in the year 987 of the modern era.

Towards the end of the 1950s the interpretations of these alleged historic events proposed by both Roys and Thompson as a reconstruction of the cultural history of Yucatan sounded very attractive. In fact those interpretations seemingly provided more answers than questions, and this without including the interpretations resulting from archaeological data. For example, Tozzer used historical sources and archaeological data for his detailed historical and cultural reconstruction of Chichen Itza (1957). Tozzer (1957:35; see also Pollock 1962:7) favored the historic interpretation of Roys in his analysis, to explain the development of Chichen Itza in five periods. Those periods spanned a total of 260 years after the chronological proposal suggested by Brainerd and Thompson for that ancient city and for the rest of the northern Maya Lowlands, as we will explain here.

Thompson joined forces with Brainerd in using chronological data from the Goodman–Martínez–Thompson correlation—the same as used today—as well as in the chronological interpretation of the short-count calendric wheels, governed by katún cycles, to analyze archaeological information. These two scholars presented their interpretations in reconstructing the cultural history of Yucatan and criticized Roys, claiming that in their opinion the events dated by Roys according to his chronological interpretation of the *katuns* were 260 years posterior to the dates suggested by archaeological evidence. These two archaeologists produced the following chronological table (Pollock 1962:6) (Table 5.1).

Table 5.1 Historic events according to periods

Period	Duration	Characterized by
Late Mexican	1283–1540 AD	End of Mayapán, Spanish Conquest
Middle Mexican	1185–1283 AD	The Itzá abandon Chichén Itzá
Early Mexican	987–1185 AD	The Toltec and Itzá occupy Chichén Itzá
Flowering	889–987 AD	Maya occupation of northern Yucatán

Towards the beginning of the 1960s Pollock (1962:7) indicated that there were major differences between the reconstruction of facts considering just historic data—the position of Roys and Tozzer—and the joint interpretation of archaeological evidence and historic data—the position of Thompson and Brainerd. These differences related to the occupation and abandonment of Chichen Itza by the Itzaes. For Thompson and Brainerd, the Itza occupation of Chichen occurred during *katun 4 Ajau* that dated to AD 968; for Roys this event occurred between AD 1224 and 1244 after the collapse or disappearance of the Toltec regime that ruled or governed Chichen. As for the Itza abandonment of Chichen, Thompson and Brainerd acknowledge that this occurred during the *katun 8 Ajau* from 1185 to 1204 of the modern era, while according to Roys this event occurred between AD 1441 and 1461 (Pollock 1962:7).

Another relevant aspect of the different interpretations made by Thompson-Brainerd and Roys and Tozzer is that according to the former, the Itza brought with them the Toltec culture to Chichen Itza. On the other side, the latter are of the opinion that the Toltec were the first to occupy, inhabit, and abandon Chichen Itza, while the Itza arrived at this site after the Toltec.

An analysis of the form in which Roys and Tozzer on the one hand, and Thompson-Brainerd on the other, interpreted the historic and archaeological data, clearly reveals significant discrepancies in the attempts to reconstruct the cultural history of Yucatan. In an effort to show convincing proof of the what and why of these different interpretations, it seems that certain discrepancies arose between the historian (Roys) and the archaeologists (Thompson-Brainerd) to the point that some facts may have been exaggerated, or even slightly exceeded. For example, we must remember that Roys pointed out that there are no historic records on the Toltec conquest of Yucatan, and, more so, that his reconstruction of the history of the Itza was based on a few historic narratives and on the historic interpretation made by him of the katún prophecies. Thompson on the other hand established the arrival of a second group of Putun-Maya/Chontal-Itza at Chichen Itza as occurring in the year AD 987, although historic sources in no way make any mention of the Itza or Kukulkan in Chichen Itza in that year or at the end of the tenth century AD.

The historic-cultural reconstructions proposed by Roys-Tozzer and Thompson-Brainerd have been—and continue to be—the interpretative framework for numerous ethnohistorians, art historians, archaeologists, and epigraphists who attribute to the Putun, Itza, and Toltec the social and cultural evolution and development of Yucatan from the tenth century on. Just as occurred to Brainerd and Smith a half-century ago, interpretations by today's ethnohistorians, art historians, archaeologists, and epigraphists invariably and inevitably also end up anchored or related to the reconstruction of facts deriving from the interpretation of historic sources.

Robles Castellanos and Andrews (1986), who speak on the interpretation of the role played by the Itza in Yucatan following the chronological outline and historic events proposed by Thompson and Brainerd, as well as in the use of the term Itza, give a political–social nature to the influence of this group in the northern lowlands. According to Robles Castellanos and Andrews (1986:87–89), the Itza were a new and powerful elite that established itself in Chichen Itza due to the sociopolitical weakening of the western sphere of Yucatan, to their control of the coasts as a consequence of the trading networks that they had established, and to the military skills of the group or groups of Itza that invaded Yucatan. According to Robles Castellanos and Andrews (1986), the Itza adopted, as their ceramics, the pottery forms belonging to Peto creamware dishes, whose origin is found in the slate ceramics characteristic of Yucatan from the seventh century AD (Brainerd 1958; Cobos 2004; Robles Castellanos 2006; Smith 1970). According to Robles Castellanos and Andrews (1986), the contribution of the Itza to the material culture of Yucatan was the introduction of Silho and Tohil lead orange, fine ceramics.

For Robles Castellanos and Andrews (1986:90) the end or collapse of Chichen Itza was a result of the general rise of the Maya against their Itza oppressors whose economic and political organization, a form of exploitation that took advantage of an old system, had been slowly weakening since before their rise to power in Chichen Itza. According to Robles Castellanos and Andrews (1986:90), the Itza were "little more than traders" who tried to revitalize a dying system, and "for a short time became the Lords of an old order" in Chichen Itza and Yucatan.

A review of ceramic and architectonic evidence gathered in Chichen Itza as well as and in various coastal settlements offers information that allows to propose a different perspective from that assigned by Robles Castellanos and Andrews (1986) to the Itza a quarter of a century ago. First, Silho and Tohil lead fine orange ceramics were not introduced in late times to Yucatan and to Chichen Itza by the Itza. In fact these archaeological materials first appear in Chichen Itza in the tenth century of the modern era, and form an important part of the late Sotuta ceramic complex that characterized the rise of the city and functioning of Isla Cerritos, the main port of Chichen Itza (Andrews et al. 1988; Cobos 2004, 2010; Gallareta et al. 1989; García Moll and Cobos 2009). Second, governors and administrators of Chichen Itza established an efficient port infrastructure that functioned during the tenth and eleventh centuries along the coasts of the Caribbean Sea and the Gulf of Mexico. In this way they maintained control of, or rather, took advantage of the trading routes (Cobos 2010). The Itza did not participate in the establishment, the functioning, or the benefits of that maritime port infrastructure.

Third, ceramic materials from Peto creamware found in the archaeological context of Chichen Itza appear over the rubble of constructions or buildings that are associated with the Golden Age of the site. We can therefore conclude that Peto creamware postdates the end or collapse of the political and economic system of the city, which very probably occurred at the end of the eleventh century AD. Beginning in the twelfth century and for centuries thereafter, Chichen Itza was inhabited only by temporary dwellers, who performed ritual activities in the Sacred Cenote and reused constructions or buildings that date back to the Terminal Classic period (such as the West Colonnade [3D1], the Southeast Colonnade [3D10], the Temple of the Panels [3C16], the Great Ball Game [2D1], see Brainerd 1958:41–45; Cobos and Canto Carrillo 2010; Peraza Lope 1993:400; Smith 1970:4, 260). Or conversely, they invested minimum effort in building new rubblework constructions, reusing elements from buildings of the Terminal Classic period, as we see in the case of Structure 3C4 of the Ossuary Group (Fernández Souza 1996:28–36, 114–115).

If the Itza were present in Chichen Itza in the eleventh century, archaeological evidence suggests that they occupied a settlement that functioned more as a center of pilgrimage with a very reduced population and with no political and economic component that would act as a cohesive element to its temporary occupants.

Conclusion

Based on the Roys, Tozzer, Brainerd, and Thompson interpretation of facts registered in historic documents (both Maya and Spanish), ethnohistorians, historians, art historians, and archaeologists interested in Chichen Itza and Yucatan have identified individuals from the Toltec, Putun, and Itza ethnic groups involved in migrations, conquests, travels, and the import of new gods, religious beliefs, social and cultural practices and cults since the tenth and until the seventeenth century. Numerous researchers of the Terminal Classic and Postclassic periods continue to fit in archaeological evidence to justify the interpretation of history made by Roys and then reinterpreted by Thompson more than half a century ago to explain social, economic, and political processes. Nevertheless two things must be taken into account for those who continue to use Roys' work in the reconstruction of the historic events of Yucatan between the tenth and seventeenth centuries. On the one hand, we have the reconstruction of facts left to us by Roys based on his own interpretations as a historian; on the other, we have comments from the historian, clearly stressing the lack of details and precise historic records when he carried out his consultation of historical sources. This distinction is of crucial relevance as today we have what Roys interpreted as a scholar of the history; however this scholar could not narrate other facts due to a lack of written records and details, which is why we must turn here to archaeology.

A group of scholars—still a minority—using archaeological data and their interpretations consider that the historical–cultural development of Chichen Itza and Yucatan was essentially Maya. Unlike the scarce archaeological evidence that was available 50 years ago, today we have sufficient data to explain the historical–cultural development of Chichen Itza as well as Yucatan based on local origins and not just for the arrival, conquest, and imposition of social and cultural mores of individuals from other areas (such as the Toltec), or Maya-Nahuatized groups (Putun, Itza), as recognized by Andrews IV (1960) 50 years ago. Andrews IV (1960), using the architectonic and ceramic sequences and carbon-14 dates from Dzibilchaltun, concluded that Maya-Puuc and Toltec were fundamentally the same, and therefore recognized periods of evolution of the local culture of Yucatan. This local evolution suggested to Andrews IV (1960:263) that there was no arrival of non-Maya peoples, nor a rapid change in population as suggested by Roys, Tozzer, and Thompson based exclusively on the interpretations of historic sources.

Today, interpretations based on archaeological data have taken a firm place in the historic-cultural reconstruction of Yucatan, and with them we can question the proposals presented by Roys, Brainerd, and Thompson and reach conclusions that are very, very different from those presented by them. These new arguments without doubt allow us to place a new historical and archaeological perspective on groups like the Toltec, Putun, and Itza.

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Chapter 6
The Use of Theoretical and Methodological Bases in Population Movements' Studies: *Paleo* and *Archaeo* Demographic Approaches

Allan Ortega Muñoz

Introduction

The demographic dynamics of the ancient Mayas inhabiting the peninsula of Yucatan is of interest to many specialists. Knowing how many there were, how they reproduced, how they died, their form of settlement—among other sociodemographic questions—help to answer the big question: what was the sociocultural structure of the ancient Prehispanic Mayas?

Anthropological and demographic sciences have over time developed methodologies to answer this question. Since the 1960s, paleodemography has arisen from physical anthropology and demography (Hernández Espinoza 2006; Johansson and Horowitz 1986; Meindl et al. 2008; Ortega Muñoz 2004). This method of research has evolved from the calculations of life tables to using risk models and maximum likelihood estimators in order to evaluate the possible effects of demographic changes (Hoppa and Vaupel 2002; Konigsberg and Frankenberg 2002; Paine and Boldsen 2002). Archaeology and demography have come together to develop demographic archaeology, which estimates the population density of past societies (Chamberlain 2006, 2009; Folan et al. 2000; Renfrew 2009:381).

This chapter focuses on the migration model applied to the Maya culture. It expounds on migration concepts and existing human migratory patterns, underlines the contribution by paleodemography and demographic proxies in the study of mobility, sets out applications of the theoretical model of human mobility and paleodemography in Prehispanic Maya society, to end with some final considerations.

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Migration

The study of migration is the movement of human groups that are a factor in influencing the rebuilding of cultural patterns and new forms of social organization. This phenomenon in humans has a social, nonbiological origin (Hernández Espinoza 2006:40; Livi-Bacci 1993; Manning 2005).

It is important to know the individual, family, or group reasons which spur people to migrate. Migration may also bring about costs, such as the odds of death and the processes of acculturation of those migrants who are surviving in the community of destination (Manning 2005; Massey et al. 1993).

There are two concepts relating to migratory movements that are used indiscriminately and I want to clarify them. Mobility is understood as the capacity of the population to move within a given territory, and migration as the movement of an individual from one region to another. Therefore, migration differs from mobility by the change of residence of the individual—whether permanent or not (Leguina 1981:241; Livi-Bacci 1993:312).

Migration is a renewable and reversible event, which can be studied by rank order of events. An analysis of migration should measure its intensity, as well as the composition of the renewal and extinction of population flows and their subsequent effects on the dynamics and demographic structure, as well as their differential social, cultural, and economic aspects (Livi-Bacci 1993). A migration study requires that migration processes be reduced to a unique and unrepeatable event by means of a simple ordinal operation (first, second, third migration $[m_{1j},_{2j}, mm_{3j}, \ldots, m_{nj}]$) taking into account the number of events and people as a group of the same nature when constructing any rate (Leguina 1981:241).

Migratory movements are classified according to the type of displacement: definitive, long term, or temporary (Leguina 1981). Migration allows populations to be open, defined as growing demographically by births and immigration, and decreasing through deaths and emigration (Livi-Bacci 1993:73). Migration is a complex concept and therefore difficult to reduce to schema and models, but in spite of that, there are several proposals.

The Human Migration Model

Manning's (2005) model is based on the knowledge that human groups are organized into communities, around a proper and distinctive language that marks the boundaries between them. Communities established through language allow an analysis of the group as it was at that time and, in turn, is a perfect analytical framework for studying migration.

The author gives four categories of migration (Table 6.1). The first category refers to the movement of people inside the community, necessary to maintain a genetic pool suitable for reproduction.

Table 6.1 Categories of human migrations

Class migration	Function	Human pattern
Home-community migration	Broaden gene pool by moving within community	Mostly female migrants
Colonization	Extend range of species	Mostly male migrants
Whole-community migration	Alternate among ecological settings	Annual or occasional displacement of community
Cross-community migration	Share community experience	Mostly male migrants

Source: Manning (2005:7)

Colonization implies that individuals depart one community to a new one, replicating the original community; this therefore requires that there be either an "empty" space in which to colonize or the displacement by the newcomers of indigenous groups (Chamberlain 2006).

Whole-community migration or transhumance is the displacement of an entire community towards alternative ecologies or other environments. It is likewise observed in migrants fleeing natural disasters or wars (Bilsborrow et al. 1997). Cross-community migration consists of individuals or groups who leave their home community and are accepted by another, occupying a local role, learning a new language and customs, as well as teaching their own language and customs.

The last three categories are responsible for the major historical changes of humanity. Each migration has a specific demographic profile and is facilitated by social and family networks (Brettell 2000; Manning 2005; Massey et al. 1993).

It is therefore essential, at least theoretically, to establish a category of migration that analyzes the demographic profile of migrants. From this we can say that migration currently tends to have a structure by age with young people around 20 years, together with their dependent children, exhibiting a high mobility and, therefore, a high probability of migrating (Castro and Rogers 1983; Rogers 1988).

Studying Mobility by Paleodemography and Demographic Archaeology Proxies

An analysis of the mobility of illiterate societies is favored in the context of hunter-gatherers (Bellwood 2001; Bocquet-Appel et al. 2009; Galeta et al. 2011; Riede 2009), and refers to colonization and its relationship with the settlers' adaptive, cultural and biological processes (Chamberlain 2009; Rockman 2003). Archaeology uses several proxies to analyze mobility, and establishes demographic variables (Chamberlain 2009:276; Wright and Yoder 2003:49–51). There are two possible perspectives to generate these proxies: demographic archaeology and paleodemography.

Demographic archaeology regards consequences rather than the process itself (Chamberlain 2006; Folan et al. 2000). Westley and Dix (2006:11) stated it "… provides details of sites A and B, but little information of how humans moved [its flow and its characteristics] among [sites]."

Site A used a proxy to establish settlement patterns, population density, and number of inhabitants. It is an algorithm built from the number and size of structures inside the site, extension of the settlement area, economic potential of the areas around population centers, and various measures for the extraction, consumption, and disposal of raw materials and artifacts, frequently calibrated with historical and ethnographic information (Chamberlain 2009:279; Folan et al. 2000:8).

An example of the calibrated data may be the average of persons per household (McAnany 1990; Santley 1990), a standard procedure for estimating the density of rural populations called the house-count method (Turner 1990:304). The proportion of structures occupied by a home at a certain time and the average number of people per household is derived from the following equation:

$$\mathrm{POP}(t) = \mathrm{OcStruct}(t) * \mathrm{HHS}(t) \tag{6.1}$$

Where:

$$\mathrm{OcStruct}(t) = \mathrm{Struct} * \mathrm{Prop}(t) * \mathrm{OcRate}(t) * \mathrm{DwellRate}(t) \tag{6.2}$$

[in the (6.2) formula, "Struct" refers to the number of independent structures in an archeological site. Prop(t) represents the number of structures inside a specific chronological age. OcRate(t) indicates occupation rate, and DwellRate(t) is the proportion of all the occupied structures].

Nevertheless, some observations must be made with regard to this proxy: What structures were actually dwellings as opposed to buildings used as warehouses or kitchens? What were the average real size of the household and the temporality of occupation? Conservative estimates establish that between 40 and 50 % of the residences had different functions, greater than what is traditionally attributed to them: an average of six to eight persons per household (Folan et al. 2000:9).

Other archaeology-demographic proxies that study human mobility in the context of the Neolithic transition in Europe are population projection methods (Galeta et al. 2011) and scalar hierarchical models (Zimmermann et al. 2009) as well as other mathematical models to analyze human dispersal and population density (Lynnerup 1996; Steele 2009).

The paleodemographic perspective used the remains of ancient inhabitants of archaeological settlements and simulated demographic profiles of a population: population structure by age and sex, and mortality and fertility indicators.

Certain observations must be considered for this proxy. There are many limiting factors for the realization of simulations such as deposition, preservation, and recovery of the skeletal remains, and incomplete samples, which may be biased and non-representative of the population (Ortega Muñoz 2004; Wright and Yoder 2003). Mathematical exercises cannot be performed directly from the paleodemographic approach as these can break down assumptions such as those regarding the closed population.

However, there may be two methodologies that will allow us to study human mobility in the past by taking information from the palaeodemography and based on demographic theory: the first involves using information on the fertility of the populations of the past. This may come indirectly from mortality and population growth rates, measured through their effects on the distribution of ages at death, with a simple nonconventional demographic indicator.

It is the proportion of immature skeletons (5–15 years of age) P over the total skeletal population from the cemetery, excluding children under 5 years, $d_{(5+)}$, referred to as juvenility, framed within a chronology index called *dt* (Bocquet-Appel 2009; Bocquet-Appel and Naji 2006):

$$P_{(5-15)} = d_{(5-15)} / d_{(5+)} \tag{6.3}$$

This responds to changes in the rates of population growth, changing the structure by age in the direction of the categories by a younger age and, therefore, raising the rate of infantile deaths. However, the index is usually more sensitive to the overall level of mortality than for the population growth per se (Bocquet-Appel 2009; Chamberlain 2009:282).

One interpretation of this index may be that once these values are obtained—associated in terms of Total Fertility Rate (TFR) or Crude Birth Rate (CBR)—for a given population and contextualized with the archaeological information, under the assumption that if there is a change in the fertility over time, it could be indicative of spatial mobility changes for this population at a specific time, given various factors (Bocquet-Appel 2002; Bocquet-Appel et al. 2008:279–280).

This interpretation can give an account of what happens when a population is subject to climate stress. Under these terms, Halstead and O'Shea (1989) as well as Minc and Smith (1989) both cited by Riede (2009:323) identified four possible answers by any group of people: diversification, storage, exchange, and increased mobility. So if a population decides to operate under the last option, it may cause an effect in the reduction of the TFR. The increase in mobility in marginal landscapes would mark reproductive and social costs for the population (Riede 2009:323), especially under conditions of low population density. Such pressures in mobility break down reproductive and social networks and "without pairing networks, couples cannot be secured and [cause] the subsequent reproductive failure" (Riede 2009:323–324).

Lynnerup (1996) proposed the second methodology used to study human mobility in the past. He studied the population dynamics of a settlement in Greenland using a model of population growth and migration based on an ethno-historical approach. This is given by the formula for exponential growth with migration (Renshaw, 1991 cited by Lynnerup 1996):

$$N_t = N_0 \cdot \mathrm{e}^{rt} + a / r\left[\mathrm{e}^{rt} - 1\right] \tag{6.4}$$

$$N_t = N_0 \cdot \mathrm{e}^{rt} - a / r\left[\mathrm{e}^{rt} - 1\right] \tag{6.5}$$

Where: N_t = population at time t; N_0 = initial population (t = 0); r = growth rate; t = time; a = immigration in equation (6.4) and, emigration in equation (6.5).

Galeta et al. (2011) offered an interesting modification to this equation and produced three stochastic models from population projections for simulations of growth and TFR, without applying the factors of migration analyzed by Lynnerup.

Applications of the Theoretical Model of Human Mobility and Paleodemography in Prehispanic Maya Society

Comments by Faust and Bilsborrow (2000:73–74) supported by Boserup (orig. 1965 [1967]) and his theory of the intensification of agriculture:

> As a population grows in a fixed area the resulting pressures on living standards induce people to adopt technologies that increase production by the use of more labor per unit area. In traditional populations this could develop the adoption of more intensive methods of work (construction of terraces, high fields, and irrigated fields) as has been seen in many densely populated tropical areas. In addition the population pressures can induce migration either through cleaning land and deforestation of agricultural or rural–urban migration which makes growing cities.

A question arises from this theory: What about the demographic dynamics of the Maya area during the Classic periods? The Classic period (600 years) had continued growth with constant interactions between the different Maya cities (Thompson 2003). It can therefore be inferred that there might have been remarkable pressure on resources (cultural and living spaces, especially in large cities like Tikal, Calakmul, Copan, and so on), forcing people to rural–urban migration from the already overcrowded cities and surrounding areas.

The proportions of immature skeletons (Fig. 6.1) were obtained with the CBR for different sites of the Maya region. One of the biggest problems for simulating demographic behavior of past societies is sample size (Waldron 2007). However, we can see that from the Preclassic until the Classic periods birth rates decreased, although they remained almost constant throughout the Classic periods (Fig. 6.2).

From this information we can establish scenarios. The first is in the Classic period when the population possibly remained stable with a settled growth rate, a *habitus* in migratory movements of people in the Maya territory, which was represented by different sites, and therefore movement supporting this mobility: Cross-community migration and Home-community migration.

During the Maya collapse due to changes in environmental and power systems (Leyden et al. 1998; Lucero 2002), people started to move between communities, leading them to perform a migratory pattern of colonization or cross-community migration, to coastal places like El Rey and El Meco (Andrews and Robles Castellano 1986; Vargas Pacheco 1978), where the archaeological record has a lag in ceramic chronology and settlement between the Preclassic and Postclassic eras. However, it is also expected that this process of mass migration was gradual so that, in the early stages of this collapse, cross-community migration was maintained until the total migration from the great classical cities was imminent. Paleodemographic data sustain this second hypothesis, because Terminal Classic birth rates decrease

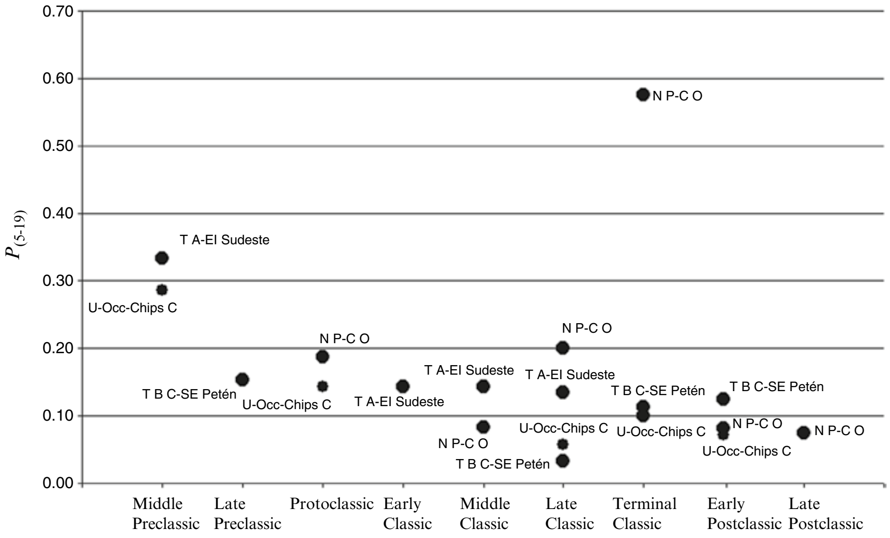

Fig. 6.1 Proportions of immature skeletons in regions of the Maya area, according to the distributions by age. Calculations use 19-years limit. Np-cor (North of the Eastern Peninsula-Coast); T B C-SE Peten (Lowland-Peten); T A-Sudeste (South East) and U-Occ-Chips C (Usumacinta—the west-central Chiapas). The studied Mayan zone includes three countries, analyzing eight States (El Quiche, El Peten—Guatemala; Copan—Honduras; Campeche, Chiapas, Quintana Roo, Tabasco, Yucatan—Mexico) with a total of 1,193 cases and 78 archaeological sites

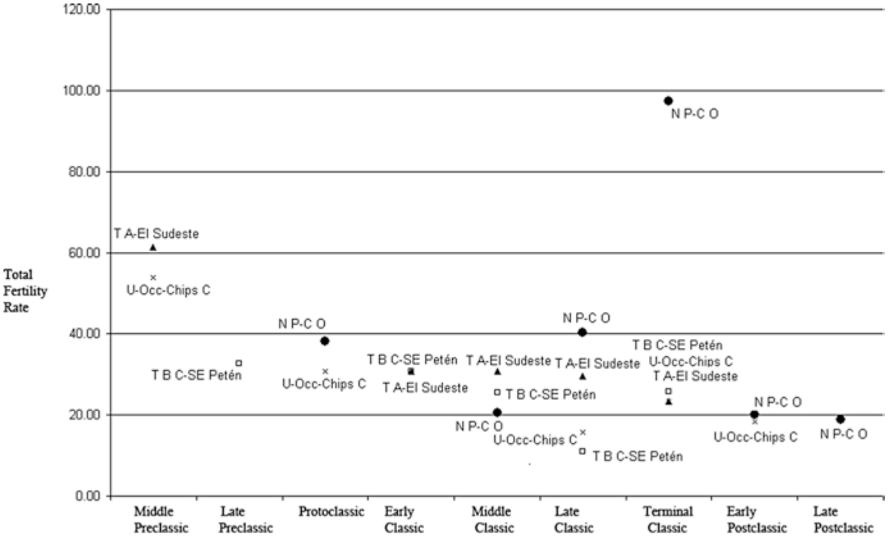

Fig. 6.2 Crude Birth Rates, extrapolated from the values of the proportions of immature skeletons, applying Bocquet-Appel (2002) regression

considerably in regions outside the North and East coast of the Yucatan Peninsula, while rising within that area (Fig. 6.2).

Theoretically, coastlines have been considered as important routes for dispersions throughout the world. Westley and Dix (2006:23) use a variety of paleoenvironmental records to show the coast as a complex and diverse landscape, with different scenarios that contextualize the migration. According to these scenarios the dynamism of the coast may have resulted in the fast movement of people in a search for new but familiar environments; the process of colonization may have been more organic between adaptations, coastal and inland, with a flexible behavior, depending on the prevailing environmental conditions, and coastal migration may have occurred by taking advantage of certain windows of environmental stability.

Consequently, we can analyze communication and exchange of people via the coast. Gonzalez-Oliver and collaborators (2001:234) show evidence of possible miscegenation among coastal Maya groups with other Mesoamerican groups. Cucina et al. (2010:224) found a certain degree of biological affinity between Postclassic human groups of Champoton and Tulum, which denotes that the "biological substrate may be shared with the towns of prechontales and Chontal, whose presence is remarkable on the coast." Data from the proportions of immature skeletons from the Postclassic presented significantly low values, especially when including the CBRs, which are around 20 births per thousand people in a population (Fig. 6.2). This is notoriously low, leading to the theory that there may be an underestimate of immature individuals, as stated below. Therefore, we must use these last data with caution.

I believe that coastal communication was not a means of mass communication. However it is possible that certain groups of individuals may have used it, especially men of a certain age (perhaps merchants and their helpers—see Sierra Sosa 2015). Thus it is not surprising that in the archaeological record we found a larger number of male individuals, primarily for coastal areas (although we must not forget other factors concerning this bias in skeletal samples) (Ortega Muñoz 2007).

Conclusions

The study of births, deaths, growth rates, population size and dispersal, and migration in an archaeological town has experienced an encouraging advance with the use of demographic theory and paleodemography. Today we are able to recreate a demographic simulation of a population by using stable model populations. Weiss (1976) stated in this sense that it has been assumed that migration is zero, and it is reasonable to suppose that the migration mainly consists of the exchange of spouses in which both migrants are around the same age and sex. However, these assumptions cannot be proven and limit the study of migration in past populations (Gage 1985:644).

The contribution to this volume comes from demographic theory and especially from the paleodemographic approach in assessing population movements.

The information stated here is likewise intended to assist in the correct use of the concepts of migration and to help to establish a framework that could be useful as a model for establishing migratory patterns.

Some hypotheses about migration in the Maya area are stated here. These assumptions require verification. However, we can establish that it is possible to propose certain migratory patterns of the past at the theoretical level, which will allow us to strengthen the hypotheses that we develop and compare them with the osteological evidence.

It is indisputable that the intensity and the demographic profile of migration in this cultural area are more complicated than that of the present populations. However, I believe that we are on track to elucidate certain migratory patterns that might have occurred throughout Classic to Postclassic times, without negating what has already been written so far on the social history of the Maya evolution. In the end, as once said by Hilaire Belloc, "that when weary [of these theories or hypotheses] we can abandon all (hypothesis) without major losses" (Thompson 2003).

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Chapter 7
Population Dynamics During the Classic and Postclassic Period Maya in the Northern Maya Lowlands: The Analysis of Dental Morphological Traits

Andrea Cucina

Introduction

The transition from the Classic to the Postclassic period in the northern Maya Lowlands has long been thought to have occurred with a population transition following the arrival of Toltec, Putun, and Itza groups; supposedly, they brought in new cultural patterns, traditions, and genes (Roys 1962, 1966; Thompson 1970). However, Cobos (2015) calls into question these interpretations by stating that the cultural evolution in the Yucatan Peninsula from the Classic to the Postclassic was essentially Maya (see also Brainerd 1958; Smith 1970).

In order to understand ethnicity, migrations, and cultural changes of such a complex society as the ancient Maya during a very particular period of transition, it is of paramount importance from an archaeological perspective that the analysis of a wide spectrum of indicators be undertaken. In archaeological contexts, contact between populations, regions, or cultures as consequences of trade or of political relationships can be assessed through the analysis of shared ceramics and other material items, architectonic, and other similarities (Beaudry and Parno 2013; Cucina 2013; Dillian and White 2010). It is not a surprise, therefore, that to date the majority of the studies on the ancient Maya have centered on the material record from an archaeological, epigraphic, or iconographic point of view.

From the bioarchaeological perspective, chemical analyses of strontium and oxygen isotopes have permitted the detection of foreign individuals in archaeological human communities (Price et al. 2000, 2002; see also Price et al. 2015). Migratory phenomena lead to microevolutionary processes that give shape to a

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biological population in its geographical, social, and chronological environment (Turner 1969). In this sense, dental morphological traits have been used to assess morphological (biological) affinities among ancient Maya human groups (Aubry 2009; Cucina et al. 2008, 2010; Tiesler and Cucina 2012; Wrobel 2004) and have been interpreted in accordance with dynamics related to trade routes or political hegemony of important city-states. The direct analysis of ancient human remains is intended to encourage us to listen to, and learn from, what the ancient humans can tell us; the study of their skeletal remains is aimed to obtain direct testimony from those very actors who gave life to, and shaped, the society and its sociocultural dynamics. The scope of this chapter is to assess, through the analysis of dental morphology, population movement and variability during the Classic and Postclassic periods, and test the hypothesis of replacement or continuity between these two chronological horizons in the northern Maya Lowlands. In order to accomplish this task, dental morphological traits have been examined in 18 skeletal collections from the northern Maya Lowlands (Fig. 7.1).

Materials and Methods

Specifically, the samples dated to the Classic period are Altar de Sacrificios (Guatemala), Baking Pot and Barton Ramie (Belize), Noh Bec-Cono Sur, Calakmul, Dzibanche, Jaina, Kohunlich 27 Escalones, Puuc and Xcambo (Mexico). Chichen and Mayapan are two skeletal collections that lie at the threshold between the Terminal Classic and the Early Postclassic (the collection from Mayapan is not the same analyzed in this volume by Serafin et al. 2015). Individuals dated to the Classic period form the Kohunlich sample, even though specimens from the Postclassic are also present; however, they could not be treated independently because of the small sample size. Last, Champoton, Cozumel, Tulum, El Meco and El Rey are all dated to the Postclassic period.

Dental morphological traits were scored on all available permanent teeth following the standardized methodology known as the ASUDAS (Arizona State University Dental Anthropology System) (Turner et al. 1991; Scott and Turner 1997). When individuals presented both left and right antimeres, they were scored independently from each other and then, for every trait, only the side showing the highest degree of expression was used for further analyses. This approach allowed us to maximize the information on the individual's genetic potential in the expression of the traits (Scott and Turner 1997). Overall, for every individual a total of 79 traits were scored.

For biodistance analyses of morphological affinities, 24 traits were selected among those that showed the highest degree of variability. Thirteen of them were dichotomized into presence vs. absence by selecting one specific threshold of expression of each trait; below that degree of expression the trait was considered as absent (Scott and Turner 1997). In turn, for the other eleven traits, more than one range of expression was selected, which led to a total number of 36 variables used for the initial data exploratory analysis.

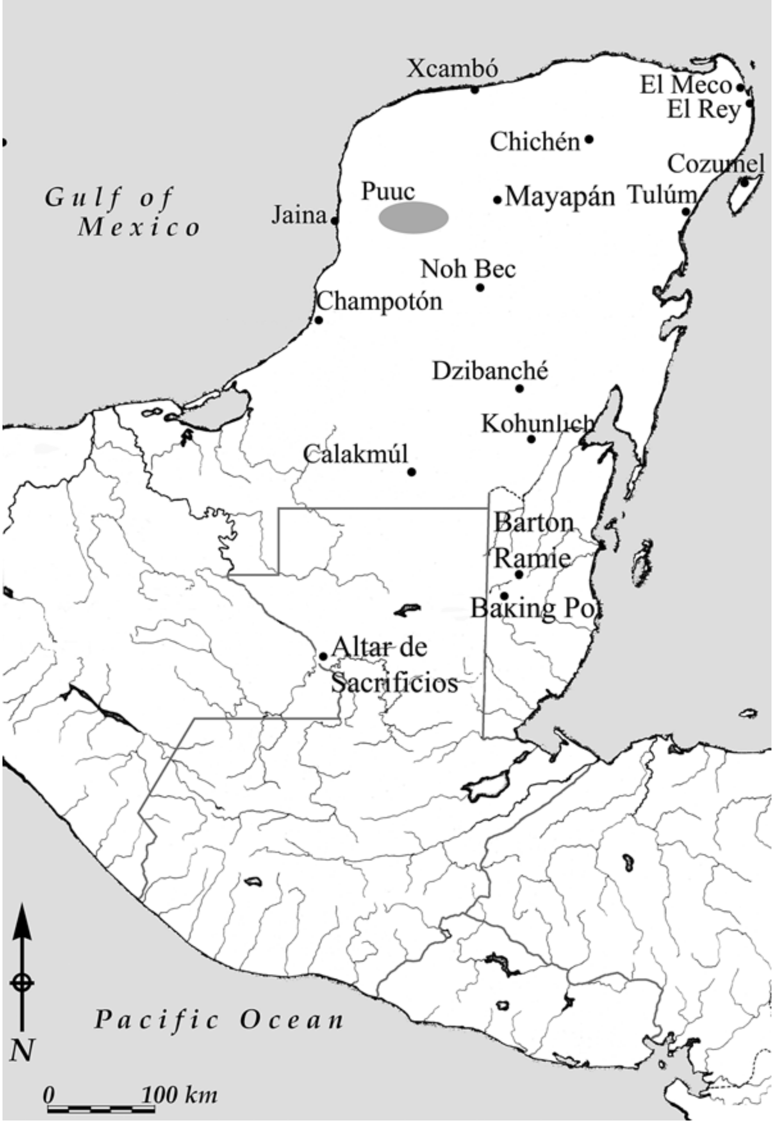

Fig. 7.1 Geographical location of the 18 sites analyzed in this study

Conversely, for analysis of intra-site morphological variability, all 79 traits were used in their dichotomized form (present or absent). Intra-site variability was calculated by applying the algorithm $2*x_i*y_i$ (here x_i and y_i represent the frequency of presence and absence of the dichotomized trait) (Cucina 2014, modified from Tiesler and Cucina 2012). It rests on the assumption that a dichotomized morphological trait reaches the highest degree of variability when its frequency is 50 %. For every group, the final value corresponded to the mean calculated from the 79 traits.

Results

At this stage, a Principal Component Analysis was carried out as an initial data exploratory analysis using the 36 variables selected. From the factor loadings obtained from this analysis, which indicated the extent of correlation of each trait along all the components, we selected all those 21 traits that presented a correlation of 0.6 or higher on any of the components (Table 7.1). Such traits are those that have the strongest effect on the distribution of the samples and more strongly discriminate between samples.

Table 7.1 Factor loadings of the Principal Component Analysis carried out on 36 variables

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
I1′ Shovel 3-4	0.395730	0.535550	0.015993	0.025969	0.231749
I1′ Shovel 5-6	–0.325804	**–0.692377**	0.028406	0.164132	–0.319258
I2′ Interr. Groove	–0.314554	**0.666913**	–0.069559	0.123863	0.202279
P3′ Cusp N	–0.598551	0.223142	0.365900	–0.042377	0.175466
M2′ Hypo 3,5-4	–0.247747	**0.619947**	–0.003659	0.060704	0.061723
M2′ Hypo 5	–0.393021	–0.020653	0.435743	–0.393072	0.207321
M1′ Cusp 5	–0.244377	0.117369	0.455977	0.419084	0.042094
M1′ Carabelli 3-5	0.137960	–0.196156	**0.733472**	0.473654	0.077302
M1′ Carabelli 6-7	–0.361753	0.082415	–0.009772	**–0.762226**	–0.082765
M2′ Two-rooted	0.588215	**–0.642842**	–0.131055	–0.122413	0.300712
M2′ Three-rooted	–0.584581	0.530382	–0.323288	–0.310496	–0.016659
C, DAR 1+	–0.323248	**–0.750648**	–0.013598	–0.026649	0.083397
P4, Cusp N	–0.537500	0.132624	0.208357	–0.193270	0.377018
M2′ Y Groove patt.	–0.089805	–0.148301	**–0.712995**	0.110401	0.316622
M2, Four-cusped	–0.246508	–0.342298	–0.540755	0.153384	0.397238
M2, Five-cusped	**0.627272**	0.445974	–0.015951	0.074871	–0.326180
M2, Six-cusped	–0.457795	–0.144716	**0.603619**	–0.252473	–0.053113
M1, Protostyl 3+	–0.296319	–0.375757	0.383891	–0.129409	–0.420265
M1′ Cusp 7	–0.484141	0.580988	–0.135082	0.051536	0.336859
M2′ Cusp 5 2-3	**–0.789994**	–0.308779	–0.051684	–0.107553	–0.254977
M2′ Cusp 5 4-5	**0.692179**	0.213313	–0.034176	0.065117	0.227659
M2′ One-rooted	0.461909	–0.120583	0.041799	–0.217739	**0.611259**
I1′ Doub Shov 2,3	0.048026	–0.184119	–0.130995	0.397309	0.227290
I1′ Doub Shov 4+	0.179439	0.167527	**0.702232**	–0.347041	–0.342029
I1′ Tub Cing 0	**0.615814**	–0.150097	0.013921	–0.533508	0.085765
I1′ Tub Cing 5+	0.499485	0.291777	0.302940	–0.111723	0.126411
M3′ Metacone 0-2	–0.198085	0.268397	–0.378766	–0.492328	–0.303933
M3′ Metacone 5	–0.313219	0.046160	0.168707	–0.088260	**0.746576**
M1, Trig Crest	0.123461	**0.762944**	–0.335693	0.081125	–0.228375
M1, Five-cusped	–0.274560	–0.367351	**–0.740844**	–0.106596	0.041358
M1, Six-cusped	0.449064	0.257867	0.383394	0.298826	–0.136938

(continued)

Table 7.1 (continued)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
M2′ Enam Ext 2-3	0.064125	0.361656	0.093258	–0.459382	–0.037080
M1, Cusp 6 3	–0.374543	**0.634481**	0.182376	0.114005	0.201974
M1, Cusp 6 4-5	**0.647786**	–0.065270	0.094639	–0.533825	0.134306
M1, Ant Fovea	0.131772	–0.364961	0.469873	–0.431857	0.399922
M1, Defl Wrinkle 3	–0.313785	–0.099125	**0.711073**	0.309884	0.211231

Values in *bold* indicate traits with a loading value above 0.6

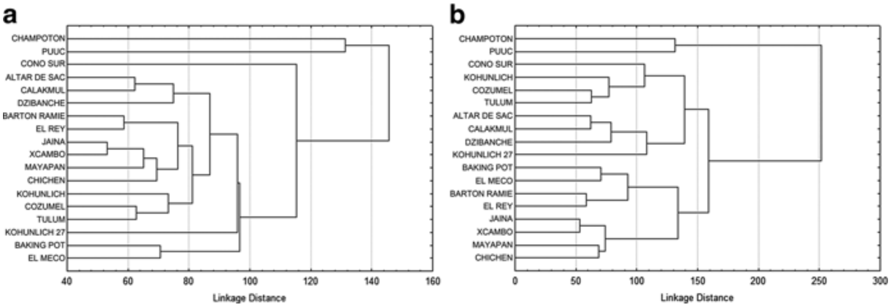

Fig. 7.2 Cluster analysis. (**a**) UPGMA method; (**b**) Ward method

Resting on these 21 traits, multiple statistical elaborations were performed. Specifically, similarities or differences were assessed using two methods of Cluster Analysis, the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) and the Ward grouping methods; a second Principal Component Analysis and a Maximum Likelihood, tested using the bootstrap method, were also performed. The application of multiple statistical techniques assures that patterns of similarity or differences among groups that tend to repeat in more than one elaboration are not the product of the specific algorithm, but witness a real affinity among groups (Coppa et al. 2007).

The UPGMA Cluster Analysis shows that the Puuc and the Champoton samples differentiate from all the other groups, followed by the Cono Sur collection. Inland samples from the Peten area (Calakmul, Altar de Sacrificios and Dzibanche) form a first cluster, while Classic coastal samples and Postclassic samples generate a major subgroup that spans from Barton Ramie to Tulum. Baking Pot in Belize and El Meco in Quintana Roo gather together (Fig. 7.2a).

The Ward grouping method confirms the difference between Puuc and Champoton with the rest of the collections. Almost all the smaller subgroups noted with the UPGMA analysis appear also with the Ward method. Nonetheless, in this case, we can appreciate two major groups: one that encompasses all the Classic inland Peten sites along an inland corridor that reaches the center of the peninsula (but which also includes the Postclassic coastal sites of Tulum and Cozumel), and a second one

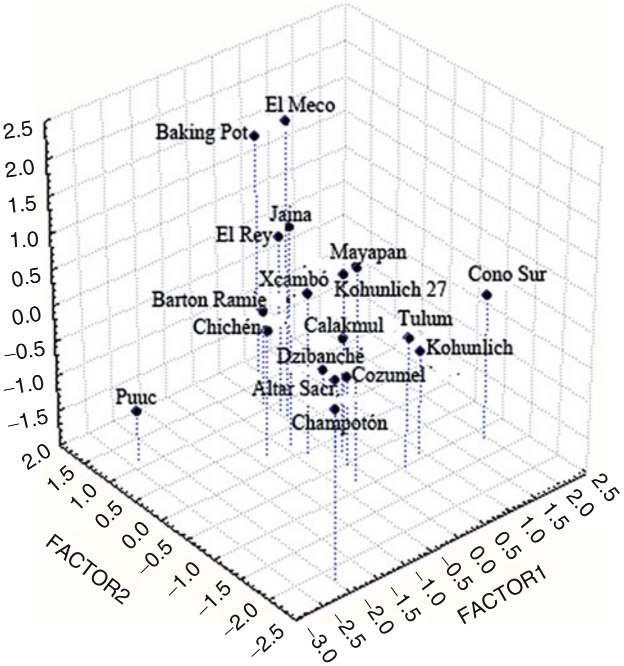

Fig. 7.3 3D plot from principal component analysis

formed by coastal sites along the peninsula, the Belize samples, and the Terminal Classic groups of Mayapan and Chichen (Fig. 7.2b).

A Principal Component Analysis generated a 3D distribution along the first three major components, which overall explain 55.9 % of the total variance. The 3D plot once again indicates that Puuc and Champoton are separated. El Meco and Baking Pot tend to stay on one side along the third component, but are similar to a larger group formed by the coastal and Terminal Classic samples. On the other side, the inland Peten and central Yucatan sites form a cluster (Fig. 7.3).

Finally, a Maximum Likelihood analysis, tested using the bootstrap method, highlights the similarity among the Peten samples; the peninsula’s easternmost samples (El Meco, El Rey, Baking Pot and Barton Ramie) tend to form a second group, while the northernmost samples (Jaina, Xcambo, Chichen, and Mayapan) form another cluster. Tulum and Cozumel tend to gather together with Cono Sur and Kohunlich. Once again, Champoton and the Puuc set aside. With few exceptions, the majority of the nodes do not appear frequently, which suggests a strong level of heterogeneity within groups (Fig. 7.4).

Average variability calculated for all the 79 traits ranges from 0.18 to 0.26, and 95 % confidence interval shows a marked overlapping among samples (Fig. 7.5). Notwithstanding this, samples with lower levels of variability, such as Kohunlich, but also Tulum, Puuc, or Champoton, reflect population dynamics that, for different

```
                                                        +---------------Kohunlich 27
                        +--------------------------30.0-|
                        |                               |       +-------Calakmul
                        |                               +--23.0-|
                        |                                       +-------Dzibanché
                        |
                        |                       +-----------------------Barton Ramie
                +--16.0-|       +----------9.00-|
                |       |       |               |       +---------------El Rey
                |       |       |               +--13.0-|
                |       |       |                       |       +-------El Meco
                |       |       |                       +--46.0-|
                |       |       |                               +-------Baking Pot
                |       |       |
                |       +--6.00-|                               +-------Kohunlich
                |               |                       +--70.0-|
                |               |               +--30.0-|       +-------Cono Sur
                |               |               |       |
        +--48.0-|               |       +--16.0-|       +---------------Tulum
        |       |               |       |       |
        |       |               |       |       +-----------------------Cozumel
        |       |               +--1.00-|
        |       |                       |       +-----------------------Chichén
        |       |                       |       |
        |       |                       +--3.00-|               +-------Jaina
+-------|       |                               |       +--18.0-|
|       |       |                               +--5.00-|       +-------Mayapán
|       |       |                                       |
|       |       |                                       +---------------Xcambó
|       |       |
|       |       +-------------------------------------------------------Altar de Sacrifios
|       |
|       +---------------------------------------------------------------Champoton
|
+-----------------------------------------------------------------------Puuc
```

Fig. 7.4 Maximum Likelihood unrooted tree. Values at the nodes indicate the number of times such node appears in 100 iterations

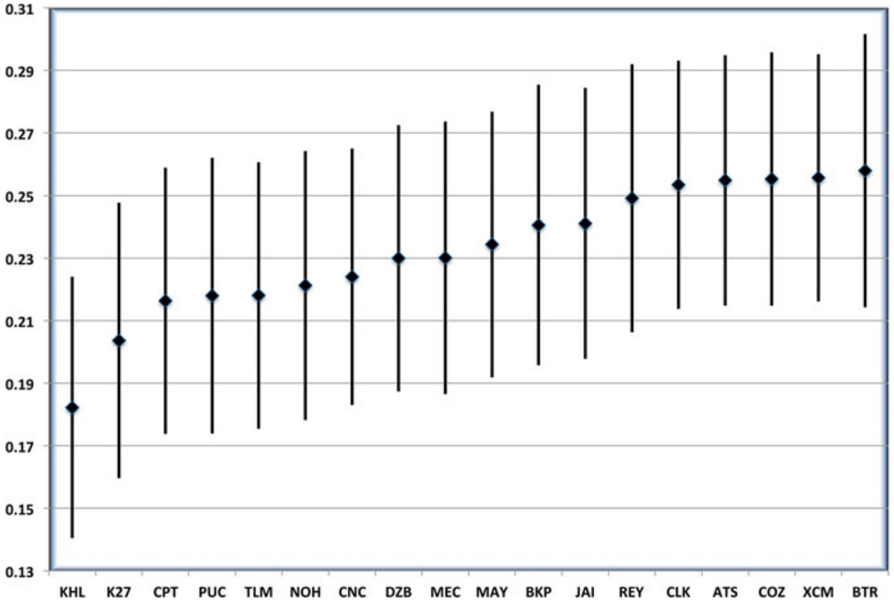

Fig. 7.5 Intra-site variability. Central points represent the average level of variability for each site; the bar represents the 95 % confidence interval (average ±1.96 random error)

reasons, led to the formation of less variable, more closed groups. Conversely, the higher mean values found in Xcambo, Cozumel, Calakmul, and Barton Ramie are indicative of centers that stood as capital centers of regional states (like Calakmul), or that endured in intense and long-distance commercial activities, like the coastal ports of Xcambo and Cozumel, respectively, during the Classic and Postclassic periods.

Discussion

Migratory events or simply individuals' or populations' movements are processes of considerable complexity (Leloup 1996), and rarely can they be conceived as straightforward and mono- or bi-directional. Instead, if at macroscopic level they are integrated in their own socioeconomic and spatial environments, at microscopic level they are eventually the product of individual decisions (Leloup 1996:103), which depend on a wide range of variables that can span from economical needs, marriage, adverse environmental conditions that no longer permit subsistence in one specific region, warfare, and more. As Ortega Muñoz (2015) states, some of these movements affected only the individual's microsphere (such as, in the case of marriage, the movement of isolated individuals or with their families in search of better working or living conditions), while others affect whole segments of a population or the population itself.

Modern models are built on past, real data to predict future movements (Leloup 1996). Unfortunately, it is very difficult to reconstruct, or even infer all the potential individuals' and social variables behind movement in past societies. Accurate taphonomic and contextual analyses should be carried out to reconstruct some patterns or factors at the base of individuals' migrations. While it is feasible in relatively few cases—as for example the case of the famous K'inich Yax K'uk Mo, founder of the Copan lineage (Buikstra et al. 2004)—it is beyond imagination for the majority of commoners' contexts. Yet, at the evolutionary level, the biological/morphological effects on a population are visible when movement involves large groups of individuals, the majority of whom are (usually) commoners. Although they do not leave behind "interesting" traces of their existence, and therefore do not catch the attention of archaeologists, it is the movement of commoners that eventually modifies the biological structure of a population.

Population movements are complex systems, and as such, they are difficult to assess using few, and sometimes, isolated parameters. Despite the inherent and objective limitations in bioarchaeological studies of this kind, the analysis of dental morphological traits analyzed in the present study highlights interesting patterns of population dynamics that can be reconstructed at least from a general perspective.

The intra-site variability shows that none of the 18 samples analyzed stands out for marked high or low heterogeneity; high heterogeneity would witness intense exogamy, while endogamy is represented by low intra-site variability.

On the contrary, the marked overlapping among samples speaks of generalized and diffused population movements within the region that generate an overall fairly homogeneous population, as already noted by Scherer (2007). It is true, in fact, that basic utilitarian cooking remained unaltered for a long time, in contrast to elite wares (Luke 2010) that tended to change rapidly in a fashion-like mode but that concerned only one or few specific segments of the society (Rice and Forsyth 2004). This suggests a cultural homogeneity that mirrors the biological homogeneity in the Maya Lowlands.

Nonetheless, among the samples characterized by higher levels of variability, we find places like Calakmul that stood as the State-capital center (see Folan and colleagues 2015) and that, because of its socioeconomic and political position, attracted people from other regions, or facilitated the biological and cultural contact among its people and those from other regions. Other places, like Xcambo and Cozumel, represented important trade centers involved in short- and long-distance commercial activities and were therefore exposed to an in-and-out flow of people. As regards Xcambo, for example, ceramics from all around the Maya area and all the way to the Gulf Coast of modern Veracruz were recovered at the site, witnessing its active role in trading activities (Sierra Sosa et al. 2014). Stable strontium isotopes (Sierra Sosa et al. 2014) and trace element studies (Cucina et al. 2011) revealed the presence of approximately 15 % of foreign individuals buried at the site whose places of birth were in several different regions in the Maya real; in some cases the Sr isotopic ratio is compatible with the Veracruz region along the Gulf Coast (Sierra Sosa et al. 2014). In a similar fashion, Cozumel formed part of an important coastal network along the Caribbean coast of the Yucatan Peninsula during the Terminal Classic/Late Postclassic (AD 800–1500) (Freidel and Sabloff 1984). During the time the site of San Gervasio (Cozumel) was in use, coastal trading directed from the Maya Highlands and from the Belize region towards the northern centers in the Yucatan Peninsula passed through the island (Cozumel). Despite there being no strontium isotopic evidence available for Cozumel, the presence of foreign figurines and ceramics at the site, along with variability values similar to those calculated at Xcambo, is suggesting population movements in conjunction with the trading of goods.

On the other hand, the low variability value at Tulum can be related to the fact that the dental collection belongs to the ossuary that was recovered from inside the walled town. Vargas Pacheco (1997) suggested that this town was funded by elite members from the west, was independent from the east-coast confederations, and constituted a strategic settlement along the Caribbean coast trade route during the Postclassic. The low morphological variability therefore suggests that this collection was somehow (genetically) isolated and might not have been representative of the "local" populations that were supposedly buried outside the walled town and of which no archaeological evidence is available. Obviously, caution must be taken since the lack of a direct comparative sample makes such hypothesis speculative.

Lastly, the two samples from Kohunlich show the lowest variability. Kohunlich 27 Escalones corresponds to the skeletal collection unearthed from the homonymous structure complex (Nalda and Balanzario 2004). Unlike the other complexes, it was a residential compound that provided a large number of skeletal remains, and the only ones belonging to the elite. Groups of migrants from the east or the center of the peninsula may have populated this residential area, though the authors also point to possible kinship relations in some of the multiple elite burials (Nalda and Balanzario 2004:191, 195). These two possibilities are not mutually exclusive and show that the low variability could be explained by genetic drift or founder effect. On the other hand, the lowest rank of variability of the other sample from Kohunlich, which comes from various other parts of the site, is not clearly explicable in terms of endogamy or genetic drift, and more detailed analyses are necessary to understand the reason(s) for such low variability.

As regards the morphological relationships among groups, the fact that samples tend to aggregate in diverse clusters in the different multivariate analyses witness an overall genetic homogeneity in the region. Nonetheless, some patterns can still be highlighted.

In previous studies, as already noted, the Classic period was characterized by a strong relationship among populations located in the Peten region. Calakmul and Dzibanche always cluster together, and in many cases Altar de Sacrificios, too. Calakmul shows weak similarities with the areas outside the Tepeu sphere, but maintained strong external ties with the Rio Bec, and the Chenes region (Brasswell et al. 2004), along with a number of more distant, peripheral sites up to Coba (Rice and Forsyth 2004). The Cono Sur sometimes forms part of this cluster as also suggested by the Chenes architecture and ceramics found at the site; this makes it likely that the populations from this southern part of the modern state of Yucatan were related to the northern Peten, not only economically but also biologically. In particular, this is shown by the similarity with Kohunlich, which may indicate the existence of more specific affinities that will require further investigations.

In contrast, while a geographic grouping gathers the samples in the northern part of the peninsula, with Xcambo, Jaina, Mayapan, and Chichen often getting close to one another, it is striking that the indication provided by dental morphological traits shows no distinct groupings exist based strictly on chronology. Several Classic and Postclassic period samples form part of the same clusters, which indicate that morphological continuity existed through time. With the exception of Cozumel and Tulum, which cluster with each other, the Belize collections of Barton Ramie and Baking Pot gather with the Postclassic samples of El Meco and El Rey, all along the eastern coast of the peninsula. These groupings are often accompanied by the presence of the Classic coastal sites of Xcambo and Jaina, located respectively along the northern and western shores of the peninsula. In Belize, the Postclassic period was characterized by a sudden cessation of trade relationships with the inland Peten territories, as noted by Laporte (2004) who reported very low frequencies of ceramics from Belize in the Postclassic southern Peten. During the Postclassic, and as a consequence of the abandonment of inland cities because of the collapse, sites in Belize (such as Wild Cane Cay, McKillop 2004) simply readjusted their economy and redirected it as long-distance sea trade towards the emerging powers in the northern Maya Lowlands. At the same time, it is possible that northern Yucatan sites (i.e., Chichen) expanded their influence to Belize, as the Chichen-inspired architectural assemblage at Nohmul, in northern Belize seems to indicate (Chase and Chase 1982). The presence of ceramics from Belize in the Late Classic period at Xcambo (Sierra Sosa et al. 2014) is one more indication of contacts between the northern coast of the Yucatan Peninsula and Belize that started during the Late Classic and likely protracted during the Postclassic period. Although much caution has been exercised in the interpretation of the data, dental morphology suggests that the coastal groups along the Yucatan Peninsula during the Classic period had already started showing a dental morphology that would be visible also during the Postclassic and that would spread at regional level through the coastal corridors in response to (or as a consequence of) the diffused coastal trading network.

The samples from Champoton and from the Puuc region never cluster with any other group. They behave as outliers in the regional population dynamics. Rice and Rice (2005) suggest that people at Champoton might have had relationships with the Guatemaltecan Peten region in the Postclassic, which might explain the lack of association with any of the groups that form the present study. Nonetheless, at present, it is difficult to infer whether such isolation from the rest of the collections might be the result of intrinsic problems with the dental collections, or whether the samples effectively represent isolated groups. After all, their variability values are, respectively, the third and fourth lowest ones, though such evidence by itself is not enough to explain their behavior.

Conclusions

In conclusion, dental morphological traits suggest intense population dynamics through the Yucatan Peninsula in the Classic and Postclassic times. Classic models of population genetics, like isolation by distance, do not apply in this context. The inland, central groups tend to cluster more tightly among themselves than with coastal and northern groups. At the same time, coastal samples dated to the Classic period seem to manifest a morphological continuity with Terminal Classic samples in the northern region as well as with coastal groups in the Postclassic one.

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Chapter 8
The Buk Phase Burials of Belize: Testing Genetic Relatedness Among Early Postclassic Groups in Northern Belize Using Dental Morphology

Gabriel Wrobel and Elizabeth Graham

The Early Postclassic "Buk" Phase at Lamanai

The Early Postclassic Buk phase at Lamanai extends from the tenth century to about AD 1200/1250. Intriguing evidence for foreign cultural influences from the northern Yucatan and Gulf Coast may help to explain the shift to a successful Postclassic economy following disruptions to Peten trade networks. While a few Postclassic architectural features have northern attributes (Graham 2004; Pendergast 1981:44–46), most discussions have focused on ceramics (Aimers 2008; Howie 2012). In general, there is ceramic continuity from the preceding Terclerp phase through the following Cib phase (Graham 1987; Howie 2012), but notable stylistic features distinguish Buk phase elite ceramics, including Orange-Red monochrome slip, incised exterior decorations, new forms, and applied motifs (Fig. 8.1). Slipped ceramics with these features were also recovered from Cerros and have been designated as Zakpah Orange-Red and Zalal Gouge-incised, heretofore referred to as Zakpah (Walker 1990). While many of the forms (e.g., "chalices" and pedestal-base bowls) and features (e.g., serpent and scroll motifs) of these vessels appear to have local antecedents at Lamanai (Aimers 2008:119, 120; Graham 1987:82; John 2008; Pendergast 1981:48), the effigy appliqués on flanged jars and bowls, as well as segmented flanges, demonstrate ties to the northern Yucatan, and may be precursors of ceramics that would come to characterize Mayapan (Graham 1987:82; Pendergast 1981:48).

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Fig. 8.1 Examples of Buk phase Zakpah-group ceramics

Despite similarities of individual features to earlier local and to northern ceramic traditions, Buk phase Zakpah ceramics are absolutely distinctive and have no clear parallels. Their distribution is largely limited to sites in northern Belize, including Chau Hiix (Andres and Pyburn 2004), Marco Gonzalez (Graham and Pendergast 1989), Caye Coco (Masson and Rosenswig 2005:363), and Cerros (Walker 1990); they appear in limited frequency in other Early Postclassic contexts along riverine and coastal trading routes, including Saktunja (Mock 2005:434), Wild Cane Caye (McKillop 2011, Personal communication), Moho Caye (McKillop 1980: fig 62), and Turneffe Island (MacKie 1963: fig. 651, s). The distinctive execution found at different sites suggests strongly that Zakpah group pottery was manufactured in more locations than just Lamanai (Graham and Pendergast 1989). Smashed Zakpah ceramics also have been found in ritual deposits on abandoned structures at the sites of Lamanai (Howie et al. 2010), Chau Hiix (Andres and Pyburn 2004:408), Altun Ha (Pendergast 1982:140, fig. 81d), Mayflower (Graham 1985:222), and Caracol (Chase and Chase 2012:64), and fragments occur in construction core of Postclassic buildings at Tipu (Graham 1987:86) and Chau Hiix (Andres and Pyburn 2004:408). Additionally, a complete Buk urn was deposited in Actun Yaxteel Ahau, a cave in western Belize (Awe and Helmke 2000). The deposition of these Zakpah group ceramics at important landmarks across the landscape is consistent with ritual behavior related to pilgrimage.

Burials at Lamanai with Zakpah ceramics are also distinctive (Fig. 8.2; see Graham et al. 2013 for further discussion). Many were well furnished with gold and copper artifacts, which attest to long-distance trade connections (Pendergast 1981:48; Simmons and Shugar 2008). These individuals are distinguished from

Fig. 8.2 Distinctive Buk phase elite burials at Lamanai

contemporaneous interments lacking Zakpah pottery by the presence of dental filing (Williams and White 2006) and display distinctive tabular erect or oblique cranial modifications with a post-coronal sulcus and biparietal bulging that are unique at the site (White 1996:400). The majority of the Buk burials were interred in a "VPLF" position (ventrally placed, legs flexed; following Donis et al. 2011), in which individuals lay prone with the knees fully flexed so that the feet rested on the hips. This distinctive burial position, however, has also been found in Terminal Classic contexts (not associated with Zakpah ceramics) at Marco Gonzalez (Graham and Pendergast 1989) and Barton Ramie (Willey et al. 1965), as well as Late Postclassic contexts from Lamanai (Pendergast 1981) and perhaps San Pedro (Graham and Pendergast 1994; Pendergast and Graham 1991). Isotope studies have shown that these individuals at Lamanai had more dietary variation than those in other Postclassic residential groups at the site (Metcalfe et al. 2009) and that five of them likely immigrated to Lamanai after birth (Howie et al. 2010:392). Principal burials from Structures N10/2 (Burial 10) and N10-4 (Burial 46) boasted relatively rich graves and individuals were seated, which is often considered a sign of elite status or rulership (McAnany 1998:276–277).

These ceramic and mortuary attributes are also found at other Belizean sites, such as Chau Hiix, which may provide context for understanding their presence at Lamanai. Chau Hiix is connected to Lamanai via the New River and a series of small creeks (Pyburn 2003). Ten individuals interred within structures in the site core were associated with Zakpah ceramics and/or in the VPLF position, and all had similar cranial modifications to those at Lamanai. Seven were found in simple pits placed within residential structures; two were interred within a small Postclassic shrine; and another was placed within a large Zakpah urn within the crumbling façade of the main temple pyramid (Andres and Pyburn 2004:419). Dietary isotopes suggest that all but the urn burial were distinct from those at Lamanai, and were likely from the coast (Metcalfe et al. 2009). Isolated burials with similar ceramics and/or VPFL position also have been found at the coastal Belizean sites of Saktunja (Mock 2005:434) and possibly Wild Cane Caye (McKillop 2011, Personal communication).

In summary, the transition to the Postclassic period at Lamanai was accompanied by economic success as demonstrated by refurbishment of ritual, civic, and residential structures, and by impressive burial wealth. The exotic nature of some of the grave goods (e.g., copper bells and gold) and close cultural ties (e.g., ceramics and VPLF burial position) with coastal communities such as Marco Gonzalez suggest integration into far-flung trade networks (Graham 2011; Graham and Pendergast 1989; Howie et al. 2010). Also appearing during this transition is the distinctive Zakpah ceramic group, which has some exotic, non-Classic period attributes, though the ceramics of the group appear to be manufactured locally. Although the association of Zakpah group vessels with particular interment practices (VPLF position, seated position, burial in jars or urns) is not conclusive, the occurrence of these burials in structures associated with elite activities, the presence of dental filing and the distinctive and relatively consistent cranial modification form, and the quantity and quality of burial accompaniments appear to be elements defining a restrictive and elite corporate group. In this study, we follow up on the previous investigations reviewed above by using odontometric data and nonmetric epigenetic dental traits to test whether the Buk phase elites at Lamanai are morphologically (and by extension, genetically) distinct from earlier groups living at the site.

Dental Analysis

The 44 burials comprising the Lamanai Buk elite sample were identified on the basis of: (1) their stratigraphic placement within structures from at least three plaza groups in Square N10; and (2) Zakpah ceramics in the burials. Because so few Late and Terminal Classic burials ($n=5$) were securely identified from the plaza groups that produced the Buk burials, we also included dental data from all securely datable Late and Terminal Classic interments from Lamanai and from the nearby sites of Chau Hiix ($n=42$) and Altun Ha ($n=33$), as well as from the Buk group at Chau Hiix ($n=8$). Thus, the total Late–Terminal sample is 80 individuals and the total Buk sample is 52 individuals. Although the inclusion of data from sites other than Lamanai is not ideal, the close social, economic, and political ties among the sites in the Classic period may indicate that their populations were highly integrated, and hence would have formed a regional gene pool.

For each dataset (metric and nonmetric), basic statistical comparisons of means ascertained whether morphological differences exist between the Buk and Late–Terminal Classic groups. Following this, distance statistics provided a relative measure of the amount of dissimilarity between groups. Greater morphological differences between groups translate into larger distance values, whereas smaller distance values denote similar morphology, which is typically interpreted as indicating genetic similarity. The use of distance statistics was intended to test whether or not Buk groups displayed genetic continuity with earlier and later groups living in the area. To facilitate these analyses, we used an "outgroup" sample from Colonial Lamanai ($n = 89$).

Metric Comparisons

The buccolingual and mesiodistal diameters of the crown of each permanent tooth were measured using a Mitituyo vernier caliper calibrated to .05 mm following the standards described by Moorrees (1957). The data were subjected to several tests for biases related to age, sex, and intraobserver error, none of which was significant. Comparisons focused on individual diameters and on crown area, which was calculated for each tooth by multiplying the buccolingual and mesiodistal diameters. We first assessed the presence and extent of differences between the groups using a univariate *t*-test statistic to compare the means and variations of each measurement.

The second set of metric data analyses was in the form of a Penrose shape statistic, which provided a basic relative measure of genetic distance. Penrose (1954) proposed dividing the "mean square distance" into two separate measurements, one for "shape" and one for "size," because these two factors contribute to genetic distance in different ways. The present study utilized only the Penrose shape statistic, which reflects proportions rather than overall size, because it is more reliable in reproducing known genetic relationships between closely related populations (Harris and Nweeia 1980).

Metric Results

Among the 32 diameter and 16 occlusal surface area measurement comparisons between the Buk and Late–Terminal Classic groups, seven comparisons were significantly different at the .05 level, and three at the .10 level (Table 8.1). While this would tentatively support the hypothesis that these groups were genetically distinct, seven of these comparisons consisted of relatively small sample sizes (i.e., at least one group with 20 or less measurements), which may have influenced the statistics. Furthermore, eight of these significant measures were from the incisors, and their variation may be affected by attrition. Specifically, when compared to other teeth, the points of contact for the mesiodistal measurement on the incisors are relatively close to the incisal edge, making these measurements unreliable in all but the most unworn teeth.

The Penrose shape comparison was calculated in three ways. Table 8.2 shows the results using (a) all of the 32 diameters in the calculations (Table 8.2a), (b) only the occlusal surface areas of the upper and lower M1s and M2s (Table 8.2b), and (c)

Table 8.1 Measurements that showed a significant difference between the Late–Terminal Classic (LTC) and Buk groups

Tooth	Sample size (n) LTC	Buk	Measurement	p-value
UI 1	34	20	m – d	.049
UI 2	27	17	m – d	.036
UI 2	32	23	b – l	.020
LI 2	25	27	m – d	.040
LM 3	32	21	m – d	*.069
UI1	28	14	Occlusal area	.018
UI2	23	14	Occlusal area	.000
LI1	17	10	Occlusal area	*.052
LI2	18	13	Occlusal area	*.087
LM3	31	21	Occlusal area	.047

*Significant to the .10 level

Table 8.2 Relative measures of genetic distance calculated with the Penrose shape statistic using various combinations of data (indicated in the table), noting the total number of observations (n)

(a)	All m – d and b – l diameters	Buk	Historic Lamanai (n = 1,121)
	Late–Terminal Classic (n = 1,245)	3.037	6.333
	Buk (n = 862)		11.12
(b)	Combined occlusal surface areas of maxillary and mandibular M1s and M2s	Buk	Historic Lamanai (n = 78)
	Late–Terminal Classic (n = 69)	8.338	2.403
	Buk (n = 46)		2.271
(c)	Surface areas only from the "key teeth" (i.e., I2, C, P1, and M1)	Buk	Historic Lamanai (n = 250)
	Late–Terminal Classic (n = 298)	1.974	4.171
	Buk (n = 200)		4.238

the diameters only from the "key teeth" (i.e., I1/I2, C, P1, and M1; Table 8.2c). In general, the different Penrose calculations inferred contradictory relationships among the three temporal groups. These inconsistent results could indicate that the genetics at Lamanai did not change substantially over time, and that the observed differences represent random variations within a single population.

Nonmetric Trait Comparisons

Nonmetric traits were scored using the Arizona State University Dental Anthropology System (ASUDAS) (Turner et al. 1991), but following Jacobi's (2000) suggested modifications to the scoring keys for some traits. Many of the traits in the ASU system were eliminated because they displayed high intraobserver error (suggesting they were scored inconsistently); the trait list was reduced further by removing traits that did not vary, leaving a total of 63 variables available for analysis. First, a χ^2 was calculated to determine whether the differences in the prevalence of traits between the Buk and Late–Terminal Classic groups indicated significant morphological variation between the groups. χ^2 is a nonparametric goodness-of-fit test that determines whether the differences between the observed and expected scores are more likely to be the result of some actual difference between the groups or are attributable to chance.

The second approach utilized the Standardized Mean Measure of Divergence (SMMD) statistic, which measures the genetic distance between the groups by calculating a relative measure of dissimilarity based on differences in the proportions of multiple traits (Buikstra 1976:54). Redundancy (i.e., "linked" traits) was identified by testing for correlations between pairs of traits using the nonparametric statistics Spearman's *rho* and Kendall's *tau* rank order correlations. The trait list was further reduced to 17 traits by removing some of the correlated traits until no significant correlations remained.

Nonmetric Results

Out of the 67 nonmetric traits used in the comparison of trait frequencies between the Late–Terminal Classic and Buk individuals, 17 chi-squares were significant to the .10 level and 11 of these are within the .05 level (Table 8.3). This number is much

Table 8.3 Chi-square comparisons between LTC and Buk groups showing significant ($p < .1$) differences

		Sample size (n)		χ^2	
Trait	tooth	LTC	Buk	value	p-value
Enamel Extensions	UM1	31	20	8.37	.00
Hypocone	UM2	41	27	6.25	.01
Cusp 5	LM3	29	18	6.12	.01
Shovel	UI2	38	25	5.99	.01
Groove Pattern	LM3	33	20	5.71	.02
Double Shovel	UP1	47	28	5.25	.02
Cusp Number	LM2	35	27	5.12	.02
Protostylid	LM1	55	36	4.23	.04
Shovel	UI1	46	30	4.01	.05
Anterior Fovea	LM1	44	32	3.97	.05
Parastyle	UM1	51	30	3.81	.05
Double Shovel	UC	49	28	3.54	.06
Deflecting Wrinkle	LM1	45	31	2.96	.09
Root number	UP1	37	25	2.89	.09
Shoveling	LI	46	36	2.82	.09
Protostylid	LM2	46	31	2.72	.10
Cusp 7	LM1	57	36	2.64	.10

Table 8.4 Results of the standardized mean measure of divergence calculated using various combinations of data (indicated in the table), noting the total number of observations for each sample and total number of traits included in each comparison

(a) All traits ($n=67$)	Buk	Historic Lamanai ($n=2,393$)
Late-Terminal Classic ($n=2,638$)	.094	.072
Buk ($n=1,766$)		.061
(b) Selected traits ($n=17$)	Buk	Historic Lamanai ($n=613$)
Late-Terminal Classic ($n=701$)	.113	.140
Buk ($n=467$)		.015

higher than would be expected to fall randomly within this range. Thus, on the basis of these comparisons, it appears that the two groups display significant morphological differences that may be interpreted as genetic distinctions.

In the genetic distance analysis, the SMMD statistic was calculated in two ways: using all of the traits in the calculations ($n=67$) and using only the modified list of uncorrelated traits ($n=17$). In both instances, the Buk and Historic Lamanai groups showed the least genetic distance. However, the relative relationship of the Late–Terminal Classic group appeared more similar to the Colonial group when considering all traits (Table 8.4(a)), but similar to the Buk group when considering only the modified list of 17 traits (Table 8.4(b)). As with the metric data, the results vary dramatically depending on which variables are used, thus reducing confidence in the power of these data to inform about ancient relationships.

Discussion

Buk phase burials from Lamanai are an archaeologically intriguing subgroup. Although it appears that, in the Postclassic period, new elites were emerging with new status hierarchies reliant on trade and commerce, none of the current archaeological data conclusively identify the origin of these Buk phase elites as either local or foreign. Their distinct patterns of mortuary treatment—elaborate furnishings, unusual patterns of cranial and dental modifications, and association with Zakpah ceramics—distinguish them from other burials at the site (Pendergast 1981). Zakpah ceramics, which are generally found associated with communities demonstrating strong ties to circum-peninsular trade networks, are characterized by both local and nonlocal attributes, and appear to have been made out of local materials (Howie et al. 2010).

In an effort to further investigate the nature of Postclassic society in northern Belize, we used dental morphology to test whether this restricted social group of Buk elites differed morphologically from earlier local groups. Significant differences would theoretically imply that Buk elites were derived from a nonlocal population, whereas overall similarities would suggest that they descended from local groups who simply incorporated foreign styles. The current study was unable to resolve this issue definitively, citing several potential deranging factors related to small sample sizes and inherent biases in the data, a topic discussed generally for Maya contexts elsewhere by Wrobel (2014; Wrobel and Graham 2013). With this caveat in mind, metric (*t*-tests) and nonmetric (χ^2) comparisons of Early Postclassic elites with Late to Terminal Classic groups showed a greater number of significant differences than would be expected to have occurred randomly. If accurate, these results suggest that at least some of Lamanai's Buk elites may not have recent local origins or are the product of a mixture of nonlocal elites marrying into local families, which is also tentatively implied by the isotopic and cultural modification data from Howie and colleagues (2010) and by ceramic analysis (Aimers 2008). These data thus have significant implications for explaining the nature of trade ties to nonlocal groups, perhaps originating in the northern Yucatan, though the difficulty of distinguishing local vs. nonlocal traits suggests a measure of continuity in the power shifts that marked the transition to the Postclassic.

Conclusions

Future studies of this kind will benefit greatly from further resolution of Lamanai's burial chronology by enlarging the sample of local Late to Terminal Classic individuals. Other groups will be sought to provide comparison, such as a contemporaneous Early Postclassic non-elite group. In addition, further dental studies aiming to determine the specific epigenetic variables that best distinguish Maya groups are needed (see Cucina 2015). Finally, the isotope study by Howie and colleagues (2010) provides an excellent model by which to utilize skeletal remains to test the significance and meaning of contextual data that can point to nonlocal influence. While such studies could be expanded to help identify foreigners, it is important to note that "foreign" could just as easily apply to rival cities rather than faraway Mexico, and the movement of families or related groups from one town or region to another has deep roots in the Maya area.

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Chapter 9
Dental Nonmetric Investigation of Population Dynamics at Mayapan

Stanley Serafin, Carlos Peraza Lope, and Andrea Cucina

Introduction

As described elsewhere in this volume by Wrobel and Graham, as well as Cucina, dental morphological traits have demonstrated utility in the analysis of genetic relationships between populations, within a population, and sometimes even at the familial level (Ricaut et al. 2010). However, despite this potential, such studies of the Maya are rare, though recent years have seen this trend reverse (e.g., Cucina et al. 2010; Duncan 2005; Jacobi 2000; Rhoads 2002; Scherer 2004; Serafin 2010; Wrobel 2004). This chapter contributes to this growing body of research on Maya dental morphology by demonstrating the utility of this approach to illuminate aspects of Mayapan's internal population dynamics. Archaeological background to the questions addressed by this study is presented in the next section, including an evaluation of the potential and limitations of biodistance analysis and the present

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sample to address these questions. The methods and results of dental morphological analysis are subsequently presented, followed by a discussion of the broader implications of these findings.

Archaeological Background, Potential and Limitations for Reconstructing Ancient Maya Population Dynamics at Mayapan

Ethnicity and identity are themes of great interest in recent archaeological studies (Jones 1952). Archaeologists have attempted to identify boundaries between social groups based on artifact styles, architecture, cranial and dental modification, geographic origin, and biological relationships. At Teotihuacan, studies of material culture and strontium isotopes concur in the identification of the Oaxaca barrio (Price et al. 2000). In the Maya area, however, these types of studies have met with little success. As a result, it remains to be demonstrated how the ancient Maya constructed and maintained social boundaries.

At Mayapan, several hypotheses have been proposed associating specific architectural assemblages with particular social groups mentioned in ethnohistoric accounts. The Cocom have been associated with serpent column temple assemblages and Chichen Itza revival architecture (Milbrath and Peraza Lope 2009; Ringle and Bey 2001). The Xiu have been associated with basic ceremonial groups, the stela cult and Chac (Milbrath and Peraza Lope 2009; Ringle and Bey 2001). The Itzmal Chen group, located in the site's northeast corner, has been associated with the Kowoj based on the mention of the city's eastern gate guardian of the same name in the *Chilam Balam de Chumayel* as well as new architectural evidence from Peten Lakes district of Guatemala (Edmonson 1986; Pugh 2003). This concentration of administrative and ritual structures is the second largest at the site. It has also been suggested that colonnaded halls represented the city's noble lineages, since their number approximates the number of provinces that may have been controlled by Mayapan (Proskouriakoff 1962; Ringle and Bey 2001).

Despite optimism that material traces of high status social groups described in colonial accounts could be found, conclusive evidence has proved elusive. Recent large-scale excavations and analysis of artifact spatial distributions have not found distinct clusters that might suggest ethnic enclaves (Masson and Peraza Lope 2010). Instead, foreign elites migrating to Mayapan may have intermarried shortly after arriving to mix in quickly and forge local alliances, thus "raising polity above ethnicity as a primary marker of social identity" (Masson and Peraza Lope 2010:102).

Another way in which group affiliation may be reflected is through acts of violence. Several large multiple burials containing possible victims of violence were excavated by the Carnegie Institution of Washington in the 1950s. While only a small fraction of the burials excavated by the Carnegie were retained, recent excavations have accrued a sample of approximately 200 individuals. These include several anomalous burials where violence is suspected. Three of these were encountered in the site's monumental center. One was located directly east of the northern stairway of the Temple of Kukulkan (Q-162). A second was found near structure Q-79 just outside the main plaza's entrance. The third was found in a passageway directly east of structure Q-152, the main round temple, though few teeth were recovered in this deposit. A large multiple burial of suspected victims of violence was also recovered just southwest of the platform of the Itzmal Chen group (Masson and Peraza Lope 2007; Peraza Lope et al. 2006). Elsewhere in the Maya area, similar deposits have been discovered in Kowoj-controlled territory in the Peten Lakes district (Duncan 2009). In addition, it has recently been proposed that the Kowoj were affiliated with the Xiu (Rice 2009), who instigated the rebellion that led to Mayapan's collapse.

Before setting out hypotheses and the corresponding expectations of the data, brief mention is made of the statistics employed, as each statistical approach has its own set of restrictions with regard to the questions that it can be used to address. In order to maximize sample size and include as much of the available data as possible, Smith's Mean Measure of Divergence (MMD) was selected as it permits inclusion of secondary remains. The MMD is calculated between two burial groupings at a time, with the resulting value representing the biological distance between the two groupings being compared. Comparisons producing higher values indicate more distant genetic relationships, while smaller values reflect a greater degree of common ancestry or gene flow.

The Mayapan dental series is large enough to be divided into three samples. Burials were classified according to contextual data reflecting social status and mortuary treatment. The three samples were designated Low Status, High Status, and Extra-Funerary, the last of which represents victims of violence. Distinguishing burials according to status is not always straightforward, owing to the dispersed distribution of status markers at the site as well as the reduction in social hierarchies in the Postclassic in general (Chase 1992; Masson et al. 2010; Metcalfe et al. 2009; Pugh 2003). Nonetheless, this classificatory scheme serves as a useful starting point for investigating social diversity at Mayapan.

The first hypothesis posits that members of Mayapan's own society predominate among the suspected victims of violence in the anomalous burials described above. If this were the case, we would expect comparisons between the Extra-Funerary and the other two samples to exhibit the smallest biodistances. While strontium and oxygen isotope analyses have found numerous foreigners among sacrificial victims and trophies at Classic period sites (e.g., Price et al. 2007; Tiesler et al. 2010), this has yet to be demonstrated for the Postclassic. While colonial accounts do mention external military campaigns waged by Mayapan, some of which likely resulted in the taking of foreign captives for sacrifice, they stress internal violence.

The second hypothesis posits that the majority of the victims of violence pertain to Mayapan's elite. If this were the case, we would expect the comparison between the Extra-Funerary and High Status groups to exhibit a smaller biodistance than between the Extra-Funerary and Low Status groups.

The third hypothesis posits that many of Mayapan's elites were of foreign origin. If this were the case, we would expect comparisons involving the High Status group that produce the largest biodistances.

Materials and Methods

Dental remains representing at least 95 individuals dating to the Late Postclassic period were analyzed for the present study (Fig. 9.1). To evaluate the hypotheses posed in the previous section, these remains were divided into the three samples described above. The Low Status sample consists generally of single, primary burials that were placed directly in the ground without any associated artifacts. The High Status sample consists of teeth from burials excavated in large residences located to the east and southeast of the site center as well as colonnaded halls and shrines in the center itself. The Extra-Funerary sample consists of teeth from deposits in the site's main civic/ceremonial center as well as one deposit in the Itzmal Chen secondary center (Masson and Peraza Lope 2007; Peraza Lope et al. 2006). Each deposit represents numerous individuals and in most cases was found near the surface. This sample presents the only evidence of *perimortem* violence, as well as the highest concentration of tool marks indicating *postmortem* manipulation (Serafin 2010; Serafin and Peraza Lope 2007). These remains are believed to represent the victims of sacrifice or war (Masson and Peraza Lope 2007; Peraza Lope et al. 2006).

Dental nonmetric data collection is based on the Arizona State University Dental Anthropology System (ASUDAS) (Turner et al. 1991). Data entry and most statistical analyses were carried out using SPSS. Biological distance was measured using Smith's MMD, the most commonly used statistic for measuring biological distance with nonmetric data.

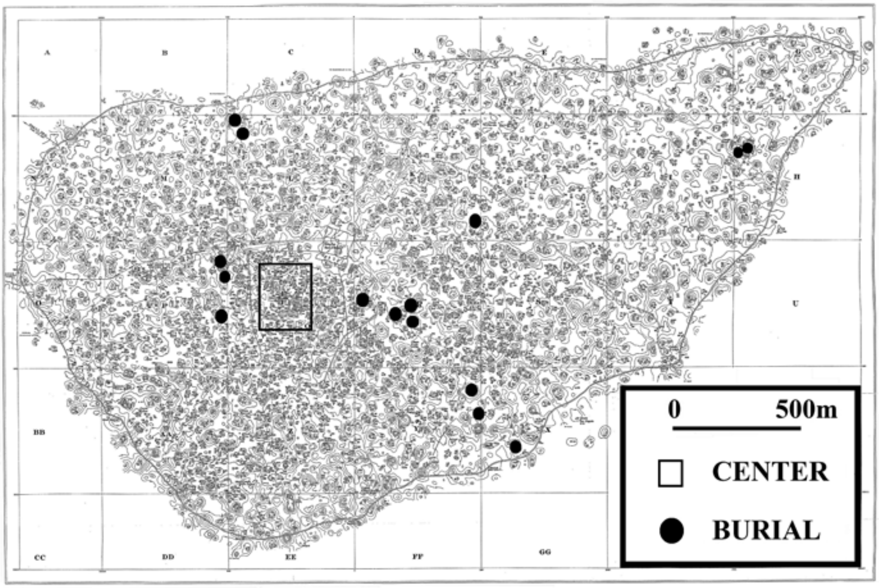

Fig. 9.1 Map of Mayapan indicating locations of Postclassic burials included in the present study (adapted from Jones 1952)

Before data analysis could be performed it was first necessary to identify and exclude traits that exhibited significant intraobserver error and associations with sex and age. To maximize sample size, scores for the left and right sides for each trait for each individual were combined, as were data for males and females.

To dichotomize traits into presence or absence, as required by most statistical analyses, breakpoints were selected that allowed the maximization of variability when comparing the relatively closely related groups under study here. Breakpoints and dichotomized frequency of expression are listed in Tables 9.1 and 9.2 for maxillary and mandibular traits, respectively. Additional details on the methods used are provided elsewhere (Serafin 2010; Serafin et al. 2013).

Table 9.1 Breakpoints and dichotomized frequency of expression of nonmetric traits of the maxillary dentition

Trait	Breaking point	Frequency	Trait	Breaking point	Frequency
Winging I1	0/1–3	15.4	C5 (hypoconule) M2	0/1–5	5.1
Labial curvature I1	0/1–4	48.1	C5 (hypoconule) M3	0/1–5	15.0
Shoveling I1	0–3/4–6	65.6	Carabelli's cusp M1	0/1–7	78.9
Shoveling I2	0–3/4–7	54.3	Carabelli's cusp M2	0/1–7	31.6
Shoveling C	0–1/2–6	54.5	Carabelli's cusp M3	0/1–7	22.2
Double-shoveling I1	0–2/3–6	51.2	Parastyle M1	0/1–6	32.7
Double-shoveling I2	0–1/2–6	61.9	Parastyle M2	0/1–6	11.4
Double-shoveling C	0–1/2–6	62.7	Parastyle M3	0/1–6	3.1
Interruption groove I1	0/1–4	2.6	Peg-shaped I2	0/1–2	3.6
Interruption groove I2	0/1–4	26.8	Peg-shaped M3	0/1–2	7.8
Labial groove I1	0/1	6.8	Congenital absence I2	0/1	0.0
Labial groove I2	0/1	2.3	Congenital absence P2	0/1	1.7
Labial groove C	0/1	0.0	Congenital absence M3	0/1	7.5
Tuberculum dentale I1	0–1/2–6	53.6	Enamel extension P1	0/1–3	0.0
Tuberculum dentale I2	0–2/3–6	37.0	Enamel extension P2	0/1–3	0.0
Tuberculum dentale C	0/1–6	64.7	Enamel extension M1	0/1–3	67.6
Distal accessory ridge C	0–2/3–6	39.3	Enamel extension M2	0/1–3	78.3
Accessory cuspules P1	0/1	6.1	Enamel extension M3	0/1–3	61.5
Accessory cuspules P2	0/1	6.1	Root number P1	1/2	7.7
Disto-sagittal crest P1	0/1–2	1.8	Root number P2	1/2	0.0
Disto-sagittal crest P2	0/1–2	0.0	Root number M1	1–2/3	91.7
Odontome P1	0/1	0.0	Root number M2	1–2/3	47.6
Odontome P2	0/1	2.2	Root number M3	1–2/3	19.4
Metacone M1	0–4/5–6	98.5	Radical number I2	1/2	31.4
Metacone M2	0–4/5–6	95.0	Radical number C	1/2	72.5
Metacone M3	0–4/5–6	56.1	Radical number P1	1/2	100.0
Hypocone M1	0–4/5–6	88.2	Radical number P2	1/2	96.8
Hypocone M2	0–3/4–6	53.7	Radical number M1	1–4/5–6	70.4
Hypocone M3	0–2/3–6	55.0	Radical number M2	1–3/4–6	38.9
C5 (hypoconule) M1	0/1–5	20.0	Radical number M3	1–2/3–6	74.2

Table 9.2 Breakpoints and dichotomized frequency of expression of nonmetric traits of the mandibular dentition

Trait	Breaking point	Frequency	Trait	Breaking point	Frequency
Shoveling I	0–1/2–3	58.8	Cusp number M1	4/5–6	98.4
Distal accessory ridge C	0–1/2–5	41.9	Cusp number M2	4/5–6	54.1
Odontome P1	0/1	1.9	Cusp number M3	4/5–6	82.8
Odontome P2	0/1	0.0	Deflecting wrinkle M1	0–1/2–3	58.3
Lingual cusp variation P1	0–1/2–9	15.0	Deflecting wrinkle M2	0–1/2–3	5.3
Lingual cusp variation P2	0–1/2–9	25.9	Deflecting wrinkle M3	0–1/2–3	0.0
Radical number I1	1/2–3	83.9	Deflecting wrinkle m2	0–1/2–3	63.2
Radical number I2	1/2–3	92.9	Distal trigonid crest M1	0/1	7.8
Radical number C	1/2–3	92.5	Distal trigonid crest M2	0/1	0.0
Radical number P1	1/2–3	65.9	Distal trigonid crest M3	0/1	0.0
Radical number P2	1/2–3	24.1	Distal trigonid crest m2	0/1	35.0
Radical number M1	2–3/4–6	41.4	Protostylid M1	0–2/3–7	18.8
Radical number M2	2/3–4	63.3	Protostylid M2	0/1–7	89.1
Radical number M3	2/3–4	33.3	Protostylid M3	0–3/4–7	34.5
Tome’s root P1	0/1–5	50.0	C5 (hypoconulid) M1	0–3/4–6	82.3
Root number C	1/2	0.0	C5 (hypoconulid) M2	0–2/3–6	47.1
Root number P1	1/2	2.1	C5 (hypoconulid) M3	0–4/5–6	36.0
Root number P2	1/2	0.0	C6 (entoconulid) M1	0/1–6	9.3
Root number M1	1–2/3	2.9	C6 (entoconulid) M2	0/1–6	12.1
Root number M2	2–3/1	24.3	C6 (entoconulid) M3	0/1–6	27.6
Root number M3	1–2/3	15.0	c7 (metaconulid) M1	0–1/2–4	5.0
Congenital absence I1	0/1	0.0	C7 (metaconulid) M2	0–1/2–4	2.2
Congenital absence P2	0/1	0.0	C7 (metaconulid) M3	0–1/2–4	7.1
Congenital absence M3	0/1	17.8	Enamel extension P1	0/1–3	0.0
Anterior fovea M1	0–2/3–4	48.1	Enamel extension P2	0/1–3	2.8
Mid-trigonid crest M1	0/1–2	23.7	Enamel extension M1	0/1–3	72.9
Mid-trigonid crest M2	0/1–2	13.9	Enamel extension M2	0/1–3	93.5
Mid-trigonid crest M3	0/1–2	20.0	Enamel extension M3	0/1–3	71.4
Mid-trigonid crest m2	0/1–2	40.0			

Results

As previously mentioned, dichotomized dental trait frequencies are presented in Tables 9.1 and 9.2 for the maxillary and mandibular dentitions, respectively. Moderate frequencies are expected for a majority of traits due to the use of a Mayapan-specific dichotomization scheme (Scherer 2004).

Next, traits were identified that vary significantly among the High Status, Low Status, and Extra-Funerary samples using Pearson's Chi-Square Tests (Sutter and Cortez 2005). Only those traits that produced at least one significant difference ($p < .05$) between the samples were included in the MMD multivariate analysis. In addition, only one tooth was used for each trait (Turner et al. 1991). Further, traits that were found to be significantly correlated ($p < .05$) using Pearson's Correlation Coefficient were excluded. Finally, only traits with sample sizes of 10 or greater were retained.

MMD values were calculated following Sjøvold (1977) and Green and Suchey (1976). MMD values were calculated using a final set of seven traits. Table 9.3 lists the traits employed, as well the sample size and frequency for each. Significance at $p < .05$ was achieved when MMD values divided by their standard deviations were greater than 2.0 (Sjøvold 1973).

Table 9.4 lists the results of the MMD analysis. All three comparisons produced significant results. The Extra-Funerary sample exhibits the smallest biodistances, supporting our first hypothesis, which posited that members of Mayapan society, rather than foreigners, predominated among victims of violence.

Contrary to expectations for the second hypothesis, the biodistance between the High Status and Extra-Funerary samples is greater than the biodistance between the Extra-Funerary and Low Status samples. Last, the High Status sample exhibits the greatest biodistances, meeting the expectations of our third hypothesis.

Rare occurrences of dental nonmetric traits can identify closely related individuals (Jacobi 2000), a particularly useful property when the samples of interest are small. Rare traits include the Uto-Aztec premolar and odontome, which occur once in elite residential structures R-106 and R-183b, respectively. However, these traits do not

Table 9.3 Frequencies and simple sizes for traits employed in calculation of the MMD

		High status		Low status		Extra-funerary	
Trait	Tooth	*n*	*N*	*n*	*N*	*n*	*N*
Double-shoveling	UI2	8	13	8	17	10	12
Accessory cuspules	UP1	0	22	1	15	2	12
Carabelli's cusp	UM3	0	13	4	11	4	12
Protostylid	LM2	11	16	14	14	16	16
C5 (hypoconulid)	LM1	12	18	19	21	19	22
Enamel extension	LM1	10	14	13	13	11	20

Table 9.4 MMD results

	High status	Low status	Extra-funerary
High status		.427296*	.353299*
Low status	.075419		.213748*
Extra-funerary	.074990	.077360	

Note: *Upper right* values are biodistances, *lower left* values are standard deviations

*$p < .05$

occur anywhere else, making them too rare to be useful. Peg-shaped maxillary lateral incisors, on the other hand, occur twice, and both individuals exhibiting this trait (Burial 53 and Burial 54) were buried in close proximity to each other. Both burials are single, primary, and were placed directly in the ground near small residential structure Q-67 (Peraza Lope et al. 2003). Both were classified as Low Status in the MMD analysis. Taken together, this evidence suggests these two individuals were closely related.

Discussion

Multivariate analysis of dental nonmetric data produced the highest MMD value in the comparison between the High Status and Low Status samples. This suggests some degree of endogamy by social class. This result is surprising given the dispersed nature of high status markers at the site (Chase 1992). This also differs from the earlier findings of Rhoads (2002) at Copan, where endogamy by class appears to have existed only between the royal family and the rest of the population.

Alternatively, the large difference between the High Status and Low Status samples may instead reflect a large proportion of elites of foreign origin. This is supported by the fact that the High Status sample exhibits the greatest biodistances overall. It should be noted that an earlier biodistance analysis consistently classified a small subgroup of the Mayapan dental series with Jaina and far away from other Postclassic sites, suggesting biological continuity in northwest Yucatan (Cucina et al. 2010; see also Cucina 2015). By contrast, the results of the present study suggest that the population had diverse origins. The earlier study of Cucina et al. (2010) did not include burials from the main civic/ceremonial center and, as a result, may represent a more homogeneous segment of the population. Comparison with published dental morphological data for colonial Tipu in Belize sheds additional light on these findings. Inclusion of these data in multivariate analysis produced the largest MMD value for the comparison between Tipu and the Low Status sample (1.223651), while the comparison between Tipu and the High Status sample produced the smallest MMD value (.354169). Taken together, these results suggest that Mayapan's population included people native to northwest Yucatan as well as elites of foreign origin. In particular, the concentration of raised shrine ossuaries in the site center suggests considerable interaction between Mayapan's elites and coastal populations during the Late Postclassic. Raised shrine ossuaries have been reported at Playa del Carmen in Quintana Roo (Márquez et al. 1982) and Quiahuiztlan in Veracruz (Izquierdo 1986). Further, the foreign origin of elite individuals interred in raised shrine ossuaries at Mayapan is corroborated by analysis of dental metric data (Serafin et al. 2014).

An unexpected finding is that the biodistance between the Extra-Funerary and High Status samples is greater than the biodistance between the Extra-Funerary and Low Status samples. This suggests that victims of violence included not only members of elite groups but individuals of other social classes as well. According to

Landa, slaves included war captives, thieves, and orphans, and were sometimes chosen for sacrifice (Tozzer 1941). Further, it is possible that some of the individuals of low status represented in the Mayapan skeletal series were slaves. This might partially explain the dispersed distribution of markers of status at the site, in particular two concentrations of simple interments lacking offerings near small residences in the site center. In one of these concentrations described above, two closely related individuals were found.

Conclusions

In conclusion, the present study represents the first biodistance analysis of the complete Mayapan dental series. Intrasite patterns of dental nonmetric trait variation were analyzed to reconstruct population dynamics at this Late Postclassic capital city. Smith's MMD was calculated in order to test the supposedly foreign origins of the site's elites, as well as to test claims that they were frequently among the victims of violence buried here. Our results support the former assertion but not the latter. In addition, two individuals who may have been closely related were identified on the basis of a shared, rare morphological trait.

A limiting factor of this study, and bioarchaeological studies in general in the Maya area, is sample size. The Mayapan sample, however, is relatively large and well preserved. In addition, continuing excavations are constantly increasing the size of this sample. As a result, future analyses will be able to shed additional light on population dynamics at this important site and clarify its role in Maya culture history.

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Chapter 10
Dental Morphometric and Strontium Isotope Evidence for Population History at Tikal, Guatemala

Andrew K. Scherer and Lori E. Wright

Tikal and the Matter of Mobility

Tikal was one of the most populous Maya sites and its rulers had substantial influence on the political affairs of the Classic period (Culbert et al. 1990; Haviland 2003; Martin 2003; Martin and Grube 2008). Settlement at Tikal began in the Middle Preclassic as evidenced by pre-Mamom (Eb phase) ceramics that date to approximately 800–600 BC. Tikal experienced continuous settlements for roughly 2,000 years. Population sizes peaked during the Late and Terminal Classic periods (AD 550–950) when 25,000 individuals or more lived within the greater Tikal area (Becker 2003:255). In the Early Postclassic period (AD 950–1200?) populations precipitously declined until only a few isolated pockets of settlements remained (Culbert 2003:62–63).

For a site with such a deep history of occupation, large population size, and commanding sociopolitical influence, there are many questions directly relevant to the matter of mobility. Chief among those is how do we understand the overall population history of Tikal? Was its massive Late and Terminal Classic period population simply the product of a fecund population? Or, like so many urban centers of the ancient world, was Tikal's population fed by immigration? What of the inverse, how stable was the population of Tikal over the duration of its history? And can we identify the remains of foreigners who may have ended up at Tikal as victims of capture and sacrifice?

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Our ability to answer these questions is limited by the size and diversity of the skeletal sample. As of 2004, an estimated 410 burials had been excavated at Tikal, with additional human remains coming from caches and problematic deposits. Additional burials have been excavated at Tikal since that time but have not been analyzed by Wright as part of her osteological analysis of the site. Of those burials, only 5.4 % (22/410) date to the Preclassic period. The remaining burials, with the exception of a single individual, date to the Classic period. Further, the sample is biased towards the urban core of the site.

Maya Mobility: The Regional Picture

Scholars often assume ancient Maya populations were stable and stationary; mobility is treated as a rare event, restricted to the instances of royal bride exchanges or captives of warfare. In this view, population growth is attributed to high reproductive rates among stationary populations. The tendency to treat Maya populations as nonmigratory is most evident in some dramatic models of the so-called ninth century Classic collapse where, rather than acknowledging the likelihood of mass population movements, the abandonment of the southern lowland sites is explained as "millions of Maya disappeared from the Earth" (Gill et al. 2007:283).

Other scholars recognize the likelihood of mobile populations, though are vague in their modeling of population dynamics. A number of years ago, Robert Fry (1990) pointed out that the demographic profile of Tikal does not appear to have been one of continuous growth, but rather consisted of disjunctive cycles of growth and occasional decline (see Fry 1990: fig. 14.1). In a similar fashion, both Joyce Marcus (1992, 1998) and Robert Sharer (1991) have pointed to the dynamic cycle of Classic Maya polities—that the individual power and size of Maya polities oscillated, oftentimes dramatically so, over the course of each kingdom's history. For both Marcus and Sharer, "size" referred to the territorial extent of the polities or the size of occupation at a given center, with little explicit reference to the behavior of populations as part of these political cycles of boom and bust.

More recently, Takeshi Inomata (2004) called for greater attention to the mobility of non-elite populations. According to Inomata, the dramatic cycles of rapid growth and precipitous decline of Classic period populations in the Petexbatun region of Guatemala demonstrate the process of aggregation and dissolution of populations around different royal courts and other elite bodies over the course of the Classic period. Certainly there is abundant ethnohistoric evidence from the Late Postclassic and early colonial periods that describes the migration of entire Maya populations. For example, the *Popol Vuh* details K'iche' migrations and the founding and subsequent abandonment of three different settlements, the final being Q'umarkaj, better known as Utatlan, the K'iche' capital at the time of conquest (Christenson 2007). Late Postclassic migrations are also well established for the highland Kaqchikel (Nance 2003) as well as the Itza and Kowoj of the Peten Lakes region of Guatemala (Jones 1998, 2009).

Table 10.1 F_{ST} values in various global populations based on morphometric data

Region and time period	F_{ST}	Source
Pacific Northwest, nineteenth century	0.109	Ousley (1995)
Ohio River Valley, Pre-Contact	0.078	Tatarek and Sciulli (2000)
Algonquian Speakers, nineteenth century	0.055	Jantz and Meadows (1995)
Iroquois, nineteenth century	0.053	Langdon (1995)
Illinois River Valley, Late Precontact	0.028	Steadman (2001)
Ireland, nineteenth and twentieth century	0.027	Relethford and Blangero (1990)
Maya, Classic Period	*0.018*	Scherer (2007)
Jirel, Nepal, Contemporary	0.010	Williams-Blangero (1989)
Georgia Coast, U.S., Contemporary	0.008	Stojanowski (2004)

Biological evidence from the Classic period provides good evidence for mobility among the ancient Maya. Using dental metric data for 321 skeletons from 12 archaeological sites in Guatemala, Mexico, Belize, and Honduras and using Relethford and Blangero's (1990) approach to R matrix analysis for quantitative data, Scherer obtained an overall F_{ST} of 0.018 among the samples in his study (Scherer 2007). F_{ST} is a widely used measure of among-group variation within population genetics (Wright 1951) and the value obtained for the Maya is quite low compared to that obtained in other anthropometric analyses (Table 10.1). When Scherer excluded the highland site of Kaminaljuyu from the analysis that value was further reduced to 0.012, revealing even less variability when the samples compared were exclusively from the lowlands. The lack of genetic differentiation among Maya populations suggests that individual migration and large population movements were regular phenomena. This was the same conclusion reached in a study of autosomal DNA variability among contemporary Maya in Mexico and Guatemala. Lisa Ibarra-Rivera and colleagues (2008) found that overall, the modern Maya exhibit very little genetic variability relative to other Mesoamerican ethnic groups and they suggest the lack of modern variability is due to a deep history of gene flow among Maya populations.

Tikal Mobility: The Local Picture

In light of the overall lack of genetic variation among Maya populations, we suggest that it would be very difficult to detect specific episodes of migration or genetic exchange using biological distance approaches. Despite these limitations, a diachronic study of population structure can still reveal much about the overall history of a population. When populations grow as a result of immigration, gene flow increases genetic variability. Similarly, when a population undergoes a rapid demographic decline as a result of emigration, catastrophe, or dwindling reproductive rates, genetic variability decreases. By looking at population variability at Tikal over time we can make some inferences regarding those cycles of growth and decline first suggested by Fry, Sharer, and Marcus noted earlier.

The present analysis relies on the same Classic period Tikal data used in previous studies (Scherer 2004, 2007), though the Preclassic data have also been included. We use the same reduced set of nine morphometric measurements as in Scherer's earlier work. Missing data were estimated in order to estimate the covariance matrices. As in the previous works, all individuals that were missing more than 1/3 of the measurements were culled from the dataset prior to imputation.

We divide the Tikal data by time period into Preclassic ($n=9$), Early Classic ($n=46$), Late Classic ($n=57$), and Terminal Classic samples ($n=11$). We further subdivide the Early Classic skeletons into groups based on whether the remains were recovered from funerary ($n=22$) or non-funerary contexts ($n=24$), much of which dates to the Early Classic period and includes victims of sacrifice within royal tombs, deposits of commingled human remains (possibly also sacrifices), and isolated human elements found in non-mortuary contexts. In other words, these non-funerary remains are individuals whose identity as former inhabitants of Tikal is uncertain. The Terminal Classic sample is a mix of Terminal Classic burials as well as human remains from non-funerary contexts, combined due to small sample size.

For this study, we adopt an approach proposed by Hans Petersen (2000) in which the ratio of the determinants of the covariance matrices are used to test the null hypothesis that the variability in one skeletal sample is less than or equal to the variability in a second sample. In this approach, phenotypic variability is reduced to a single univariate measure (the determinant) in a comparative sample, $|H|$, that can then be compared to the same measure of variability in a reference sample, $|W|$, as the ratio $|H|/|W|$. Three methods are used to test for statistically significant differences in the determinants: Zhivotovsky's F-ratio, a parametric bootstrap based on Wishart's matrices, and a non-parametric bootstrap (Petersen 2000). All statistical analyses were run in R.

Late Preclassic to Early Classic

We begin with the null hypothesis that variability in the Late Preclassic period sample (H) was less than or equal to the variability in the Early Classic period (W) sample. By doing so we test whether the establishment of a dynastic state at Tikal resulted in substantial immigration to the site.

Determinant ratio	5.412×10^{-17}
Zhivotsky F-Ratio, p-value	NA
Wishart Bootstrap p-value	0.394
Non-parametric Bootstrap p-value	0.389

Because of the extremely small determinant ratio, the test statistic and p-value could not be calculated using the Zhivotsky F-ratio method. However, both the Wishart and non-parametric bootstrap analyses failed to reject the null hypothesis. The extremely small ratio indicates very little variability among the Late Preclassic sample relative to the Early Classic period sample. In other words, phenotypic variability increased substantially at Tikal during the Early Classic period, presumably reflecting increased immigration following the establishment of dynastic rule and Tikal's emergence as a regional power.

Early Classic Burials to Early Classic Non-funerary Contexts

In order to investigate whether the skeletal elements in the Early Classic period non-funerary contexts are the remains of individuals that originated from outside the Tikal populace, we explore the possibility that this sample might exhibit a greater degree of variability relative to the contemporary burial sample. Thus, we test the null hypothesis that variability among the non-funerary context remains (*H*) was less than or equal to variability in the Early Classic sample (*W*).

Determinant ratio	0.215
Zhivotsky *F*-Ratio, *p*-value	0.819, 0.890
Wishart Bootstrap *p*-value	0.889
Non-parametric Bootstrap *p*-value	0.836

The null hypothesis could not be rejected; there is equal or perhaps even less variability among the non-funerary context sample. Certainly, the small determinant ratio points towards less phenotypic variability among remains collected from non-funerary contexts. It is difficult to say what, if any, conclusions can be drawn from this analysis. Essentially, the non-funerary context sample appears less diverse than the funerary sample; however, there are too many possible scenarios to explain that difference. Nevertheless, the results underscore the morphometric variability present among the inhabitants of Tikal during the Early Classic period, as represented in the funerary context sample.

Early Classic to Late Classic Period

In order to explore whether the Late Classic period population boom at Tikal was due to immigration, we test the null hypothesis that population variability in the Late Classic period (*H*) was less than or equal to population variability during the Early Classic period (*W*).

Determinant ratio	10.839
Zhivotsky *F*-Ratio, *p*-value	1.083, 0.288
Wishart Bootstrap *p*-value	0.496
Non-parametric Bootstrap *p*-value	0.412

Based on the analysis, there is not a statistically significant increase in phenotypic variability in the Late Classic period relative to the Early Classic period. The large determinant ratio suggests greater variability in the Late Classic period sample, though that difference is not statistically significant. In other words, the Late Classic period sample appears to demonstrate substantial variability, but so too did the Early Classic period sample.

Late Classic to Terminal Classic Period

In order to explore whether there was greater phenotypic variability among the Late Classic period sample relative to the Terminal Classic period, we tested the null hypothesis that the Late Classic period (*H*) exhibits less than or equal to variability as the Terminal Classic period (*W*).

Determinant ratio	20,766.710
Zhivotsky *F*-Ratio, *p*-value	1.448, 0.097
Wishart Bootstrap *p*-value	0.091
Non-parametric Bootstrap *p*-value	0.265

The test demonstrated a statistically significant difference in variability at the 0.10 level for the *F*-ratio and Wishart Bootstrap. The Late Classic period sample does exhibit significantly more variability than the Terminal Classic period. This likely reflects decreased genetic variability at Tikal as the population dwindled due to emigration around the years before and after the collapse of the Tikal dynasty.

Tikal Morphometric Summary

The results of the biological distance analysis point towards a general increase in population variability over the course of the Classic period, followed by subsequent loss of variability in the Terminal Classic period. The most significant increase in population variability seems to have occurred during the transition from the Preclassic to Early Classic period as the population became far more variable, presumably due to immigration. Of course we must be cautious in interpreting these results, especially in light of the low sample sizes for the Preclassic and Terminal Classic periods. The lack of phenotypic variability may in part be an artifact of the restricted Preclassic period sample; we may not have captured the full population variability that may have existed at that time. However, a loss in phenotypic variability during the Terminal Classic period is certainly an expected outcome of the demographic collapse of the site.

Tikal Strontium Isotopes

In order to test the robustness of our conclusions from the morphometric analysis we turn to strontium stable isotope analysis. The ratio of the two stable isotopes of strontium (^{87}Sr/^{86}Sr) in bodily tissue is determined by the ratio of all strontium ingested during the period of time in which that tissue formed. Plant and water strontium ratios reflect the geology of where they originate since different geologic strata possess different strontium ratios. Strontium values in animals, including humans, reflect the strontium of consumed plants and water, as well as that of any other mineral they may have ingested. For the Maya, strontium would have been consumed through plant and animal tissue, as well as lime from the processing of maize and salt used to prepare food. Tooth enamel reflects childhood diets. Episodes of migration are detected when the strontium values of either the enamel differs from that of the region in which the individual was interred. Hodell and colleagues (2004) have produced a strontium isotope ratio map for the Maya area. The strength of this method is that it can be used to identify individual migrants. However, strontium analysis is inadequate for detecting local episodes of migration when movement occurs within the same strontium region.

Wright sampled tooth enamel from 97 skeletons from all time periods at Tikal (Preclassic, $n=7$; Early Classic, $n=40$; Late Classic, $n=43$; Terminal Classic, $n=7$) in order to identify individuals that spent part of their childhood outside of the Central Peten (Wright 2005a, 2005b, 2012). Most of the samples were taken from the mandibular canine ($n=57$) or third molars ($n=28$). Canine enamel formation occurs between birth and the third year of life and third molar enamel formation occurs between the ages of 9 and 12 years. Of the 97 individuals sampled, 52 (53.1 %) of those skeletons are also represented in the dental metric sample that was used for the multivariate analyses.

Of the 97 individuals in the strontium analysis, eleven (11.3 %) demonstrate non-local strontium isotope signatures (Fig. 10.1). Although it is possible that some of the individuals that demonstrate non-local signatures were born at Tikal, spent part of their childhood elsewhere, and then returned to the site, the most parsimonious interpretation is that the individuals with non-local signatures were natives to another part of Mesoamerica and migrated to Tikal at some point after their childhood.

On one hand, the results of the isotopic analysis may create an inflated image of the overall presence of foreign-born individuals at Tikal since the skeletons sampled were disproportionately drawn from the urban core of the site where we might expect to find a greater number of human remains attributable to foreign-born wives, sacrificial victims, or trophy remains. On the other hand, we must also consider that strontium analysis at Tikal can only detect individuals that immigrated from outside of the Peten. In that regards, it is likely that we are underestimating the number of foreign-born individuals at Tikal. Whatever the case, a 11.3 % immigrant population for Tikal is remarkably high. As a point of comparison, 6–8 % of the population of Classical Rome, one of the most cosmopolitan cities of the ancient world, was foreign born during the time of Augustus, excluding the slaves (Morley 1996:38)

Of the eleven foreign-born individuals identified in the isotopic analysis, six are from the Early Classic period, four from the Late Classic, and one from the Terminal Classic. Of the six Preclassic skeletons sampled, none exhibit non-local signatures. From the isotopic analysis, it appears that the bias for immigration was during the Early Classic period. This finding is in concordance with the morphometric analysis which found a substantial increase in phenotypic variability during the Early Classic period, marking an influx of migrants to the city during that period.

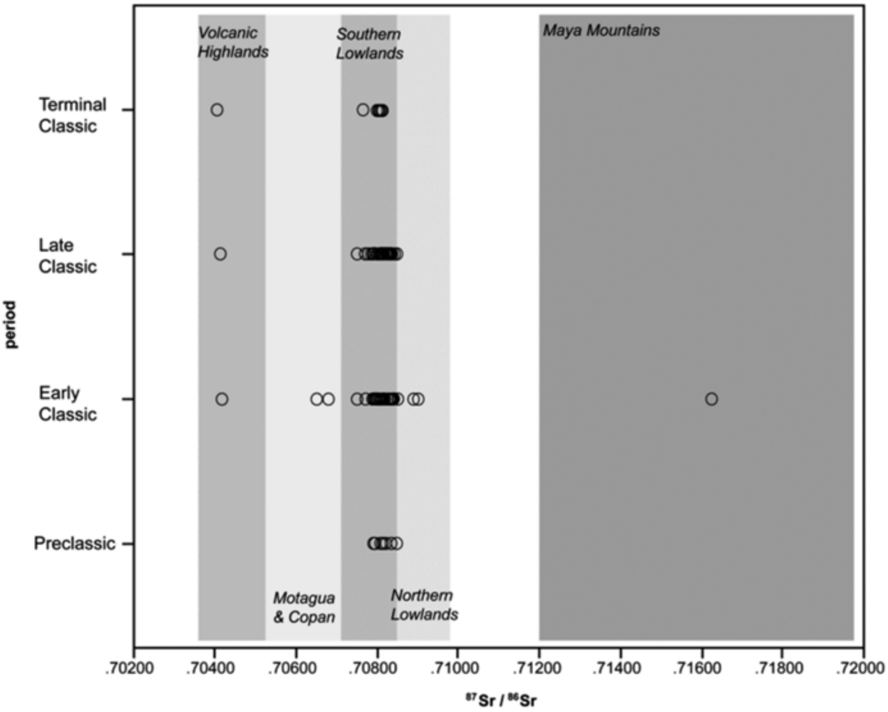

Fig. 10.1 ^{87}Sr/^{86}Sr ratios in human dental enamel from Tikal. The *grey* and *white* bars delimit the aggregate geographic ranges defined by Hodell and colleagues (2004)

Moreover, these foreigners originated from a range of homelands including the northern Yucatan, Belize, and the Guatemalan Highlands. Further, migrants were identified among individuals in the funerary and non-funerary contexts at Tikal.

Conclusions

This study of population history at Tikal provides good evidence for population mobility throughout the Classic period. In the results of both the morphometric and isotopic analyses, we found that Tikal experienced substantial immigration, especially during the Early Classic period. Similarly, as Tikal's fortunes waned during the Terminal Classic period, phenotypic variability declined as people emigrated for new environs. These data contribute to the growing evidence for mobility among Classic Maya populations (Inomata 2004). These results have implications not only for how skeletal samples are used in site-specific studies of diet and health (see Wood et al. 1992) but also how we understand the rise and fall of Maya polities. Rather than making absurd claims that "between AD 760 and 930, millions of Maya disappeared from the Earth" (Gill, et al. 2007:283), we should instead recognize site abandonment as the archaeological signature for migration throughout the history of the Maya people.

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Chapter 11
Strontium Isotopes and the Study of Human Mobility Among the Ancient Maya

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Introduction

Isotopes of strontium have been used successfully to identify non-local individuals among ancient burials (e.g., Budd et al. 1999; Montgomery et al. 1999; Price et al. 2000, 2006, 2008; Sealy et al. 1995). In some areas, such as Mesoamerica, it is possible not only to identify non-local individuals but also to constrain potential places of birth. In this study we examine human dental enamel, as well as the bones of humans and other animals and shell, to determine the local isotope ranges for more than 30 locations and to compare the local ratios among different regions. The results show

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that such $^{87}Sr/^{86}Sr$ ratios in human enamel indeed mimic the local geology of the place of birth and can be used to determine geographic origins.

Dental enamel is almost exclusively composed of the mineral known as hydroxyapatite, or hydroxy-calcium phosphate $Ca_{10}(PO_4)_6(OH)_2$. Strontium has similar chemical properties and can substitute for calcium in enamel, commonly at concentrations on the order of 100 parts-per-million (0.01 %). Strontium has four stable isotopes: ^{84}Sr (0.56 %), ^{86}Sr (9.86 %), ^{87}Sr (7.0 %), and ^{88}Sr (82.58 %). While the abundances of ^{84}Sr, ^{86}Sr, and ^{88}Sr do not change, ^{87}Sr can be produced by decay of ^{87}Rb. The relative abundance of ^{87}Sr, commonly expressed as the ratio of ^{87}Sr to ^{86}Sr or $^{87}Sr/^{86}Sr$, varies according to both the original Rb/Sr ratio and the age of the sample (Faure and Mensing 2005).

Radiogenic ^{87}Sr—and hence $^{87}Sr/^{86}Sr$—is much higher in ancient, high rubidium rocks such as granite than in young (<100 M.Y.) rocks with lower original Rb/Sr such as limestone. While metamorphic rocks older than a billion years can have $^{87}Sr/^{86}Sr$ exceeding 0.720, such ratios are rare in marine sediments and volcanic rocks younger than 100 million years, which generally range from 0.704 to 0.709. Such a range might seem small, but it is large compared to local variability, which rarely exceeds ±0.001, and to the precision with which $^{87}Sr/^{86}Sr$ can be measured, i.e., better than ±0.00001.

Plants assimilate the locally available strontium and reflect the underlying geology (Blum et al. 2000; Graustein 1989; Price et al. 2000). Likewise, the $^{87}Sr/^{86}Sr$ ratio of dental enamel reflects the $^{87}Sr/^{86}Sr$ ratio of the diet during the time over which the enamel developed, which for most permanent teeth corresponds to the first few years of an individual's life. Thus, analysis of the $^{87}Sr/^{86}Sr$ ratio of tooth enamel provides the ratio determined by geology of the place of childhood residence even though an individual might have moved substantial distances during its lifetime.

Bones, in contrast to teeth, continue to exchange calcium and strontium with the environment during the life of an individual and the $^{87}Sr/^{86}Sr$ ratio can shift if there is a change of residence to a region with contrasting geology. A significant difference between bone and enamel $^{87}Sr/^{86}Sr$ is thus evidence for such a change in residence. Bone's turnover is slow, with a half-life of seven or more years depending upon the particular bone. Therefore, unless the individual moved at a sufficiently early age for the bones to fully equilibrate to the strontium ratio of the new location, bones will likely have a $^{87}Sr/^{86}Sr$ ratio intermediate between those of the two locations. Unlike enamel, bones are also easily affected by diagenetic contamination, absorbing strontium from the burial environment (Budd et al. 2000; Kohn et al. 1999; Lee-Thorp and Sponheimer 2003; Schoeninger et al. 2003).

In order to provide a brief background on the environments of Mesoamerica relevant to such strontium isotope studies of migration, we discuss the general geology of major regions of archaeological interest: the Maya area of the Yucatan, Guatemala, and Honduras. Following a brief description of analytical methods, we present several examples of how isotopic variation in these regions can be used to track human mobility.

Geology of Mesoamerica

Isotope patterns have been reported for the rocks, soils, and waters of the Maya area by Hodell et al. (2004) and in our own studies (Buikstra et al. 2004; Price et al. 2000, 2006; Wright 2005) of human and faunal remains from archaeological contexts throughout the region.

In the Maya area there is a south-to-north trend arising from characteristically low (0.704–0.706) igneous rocks in the southern highlands and higher ratios in the northern sedimentary rocks; the latter vary from the relatively older rocks in the southern part of this area (0.707) to the youngest rocks in the north (0.709). A similar pattern can be found in the Mexican central Highlands, which are characterized by a west–east trend with lower values in the western volcanic rocks (0.704) through the intermediate plateau (0.706) to the higher values along the Gulf Coast (0.709).

Farther south, the Sierra Madre del Sur (SMS) averages 0.7041, with Cenozoic volcanics, Mesozoic sediments, and more ancient metamorphic rocks, although we can expect substantial local variability due to the heterogeneous geology of this region.

The lowest $^{87}Sr/^{86}Sr$ ratios found in Mesoamerica are in the Quaternary volcanics of basaltic composition in the Tuxtla Mountains of Veracruz, in the range of 0.703–0.704, while the highest ones can be found in small pockets of relatively ancient rocks in the Maya Mountains of Belize where $^{87}Sr/^{86}Sr$ ratios were found in the range of 0.711–0.712 (Hodell et al. 2004).

Methods

In teeth less than a few millennia old, dental enamel is relatively robust against diagenetic alteration (Hillson 2005; Schoeninger et al. 2003). The permanent first molar is preferred for isotope analysis both for its consistency and the fact that the enamel of this tooth forms during late gestation and very early childhood. We lightly abrade the surface of a single cusp of a molar using a dental drill to remove surficial dirt and calculus and also the outermost enamel due to the possibility of contamination by diffusion. We then cut this cusp from the tooth with a crosscut blade, and remove dentine with a drill. If a cusp is not available, after abrading the surface we sample 5–10 mg of enamel from the side of the crown. In turn, for bone specimens, which have a greater risk of diagenetic contamination, we recollect a sample of ca. 250 mg from dense, cortical bone such as the mid-shaft femur. For detailed sample preparation and analytical procedure to obtain $^{87}Sr/^{86}Sr$ ratios, see Price et al. (2006).

Strontium Isotopes in Mesoamerica

Figure 11.1 presents $^{87}Sr/^{86}Sr$ data from Mesoamerica, collated by site, with the isotopic average for each site. Our regionally collated database (Table 11.1), including Teotihuacan (Price et al. 2008) shows the median value for each region together with the inter-quartile range comprising 50 % of the data.

Composite values derive from archaeological human remain and local fauna. The median/inter-quartile statistics are chosen because the data are not normally

Fig. 11.1 Map of Mesoamerica showing average $^{87}Sr/^{86}Sr$ values at various localities in Mesoamerica; data based on our ~500 measurements

Table 11.1 $^{87}Sr/^{86}Sr$ isotopic values in different regions of Mesoamerica

Region	Median $^{87}Sr/^{86}Sr$	Inter-quartile range (50 % of data)	Sample size
Volcanic Highlands (Guatemala)	0.7047	0.7043–0.7053	26
Metamorphic regions	0.7068	0.7064–0.7071	45
Central Maya Area	0.7080	0.7078–0.7082	168
Northern Lowlands	0.7089	0.7087–0.7090	93
Oaxaca	0.7075	0.7075–0.7076	10
Gulf Coast	0.7080	0.7076–0.7083	8
Tuxtla Mountains	0.7039	0.7036–0.7041	4
Mexico Valley	0.7047	0.7046–0.7051	86
Western Mexico	0.7039	0.7039–0.7040	15
Chiapas[a]	0.7074	0.7073–0.7077	10
Soconusco	0.7047	0.7046–0.7047	3
Guatemala, Pacific Coast	0.7041	0.7041–0.7044	9

[a] Values from Chiapas have been calculated without Soconusco

distributed, and can be skewed by possible immigrants. Large urban sites (e.g., Tikal, see for example Scherer and Wright, 2015) undoubtedly contain immigrants among the sample set. In such cases, if possible, the mean is determined from local fauna. When humans are included, site means approximate that expected from local geology, although uncertainty persists due to the bias of immigrants, to more complex local geology (Copan), or to consumption of non-local items high in Sr (Tikal) (Wright 2005).

The inter-quartile ranges within most regions are quite small (<0.001) while differences between regions are normally much larger. Many of these regions are not only geologically different, but are also highly culturally relevant for studies of mobility. For the above reason, isotopic measurements of individual teeth permit to identify geographic origins among these regions without the need for further, extensive baseline studies of samples from suspected places of origin. While there might be isotopic equivalence within a single region, the northern Maya Lowlands, the central Peten, and the Maya Highlands, for example, are isotopically distinct, which does not occur in other regions. For example, the Gulf Coast is similar to the central Maya area and the method would likely provide equivocal results in trying to distinguish them.

Diet increases the complexity in the interpretation of Sr ratios. The consumption of imported resources such as sea salt (Wright 2005), or materials used in food preparation (e.g., lime for the processing of maize; Burton and Wright 1995), or even the selective use of specific geologic terrains for agriculture can deviate dietary, and hence bioavailable, $^{87}Sr/^{86}Sr$ values from the expected regional geologic ratio. The effects of marine foods on the isotope ratios of coastal populations have yet to be determined. Nonetheless, we generally observe excellent correspondence among our biological $^{87}Sr/^{86}Sr$ ratios, those obtained from geological samples (e.g., Hodell et al. 2004), and ratios anticipated from knowledge of the local geology.

Case Studies

A summary of five case studies of human remains at the archaeological sites of Copan, Tikal, Palenque, and Campeche demonstrates the utility of strontium isotope analysis in Mesoamerica to detect nonlocal individuals.

Tikal

The city of Tikal, in the central part of the Department of Peten, Guatemala, was one of the largest Classic period cities, with an estimated population of 60,000 persons at AD 700 (Culbert et al. 1990). Archaeological excavations documented the rapid growth of the Late Classic city, and recovered a large series of burials spanning Tikal's history.

Architectural, iconographic, epigraphic, and burial data from Tikal document significant contact with Teotihuacan during the Early Classic, raising questions about the nature of this interaction. Recent epigraphic decipherments have suggested the possibility that Tikal's Early Classic king, Yax Nuun Ayiin I (First Crocodile), may have been the son of a Teotihuacan ruler (Martin and Grube 2000; Stuart 2000). The likely tomb of First Crocodile, named this way because of the presence of a crocodile in the tomb, which probably dates to the first two decades of the fifth century AD (Coe 1990), has been excavated at Tikal (Coggins 1975). The contents included a central, primary burial (Burial PTP-010) accompanied by sumptuous grave goods (Coe 1992) and the remains of eight children and one adult, presumably victims of sacrifice (Fig. 11.2).

Data from local limestone, snails, and rodents collected near to the park suggests that the local ^{87}Sr/^{86}Sr ratios for Tikal should average ca. 0.7078. Even excluding the evident outliers, Wright (2005) found a higher than expected mean value. One likely explanation for this offset is that it is due to the consumption of sea salt, produced in either coastal Belize or the northern rim of the Yucatan Peninsula, which has a ^{87}Sr/^{86}Sr ratio of 0.7092, so that 6 g of salt daily would be sufficient to account for the higher ^{87}Sr/^{86}Sr ratios of Tikal skeletons.

Nonetheless, 8 % of all the Tikal burials sampled can be identified as migrants, having ^{87}Sr/^{86}Sr ratios far from the expected local value (Wright 2005) (Fig. 11.3). However, none of these come from Early Classic contexts associated with Teotihuacan iconography or material culture. The tooth sample from Burial PTP-010, that probably belonged to First Crocodile, falls in the centre of this local range, with a value of 0.70832, indicating that this individual cannot be from Teotihuacan, otherwise his enamel ratio should have been closer to 0.7046. Although Tikal is the most plausible childhood home for this skeleton, as Fig. 11.1 shows, many other sites in the Maya Lowlands have values that are consistent with this result.

This example also illustrates the importance of diet for the final value of ^{87}Sr/^{86}Sr in the enamel. Any regularly ingested, imported food with an isotope ratio that differs from the 'local' geological value will skew human values away from that of the local signal. Thus, better signals of the "local" ^{87}Sr/^{86}Sr ratios than geological samples are provided by bone and dental enamel of humans presumed to be local, because they average the local geological variation, and also reflect human diet. Further examples of this can be seen at the sites of Copan and Palenque.

Copan

The ancient Maya city of Copan is located along the Rio Copan in western Honduras. The site covers approximately 15 ha; it was founded during the Preclassic, but the major focus of occupation was during the Classic period (AD 300–900). Archaeological surveys and excavations have revealed much of Copan's history. One of the most fascinating aspects has been the discovery of a series of major

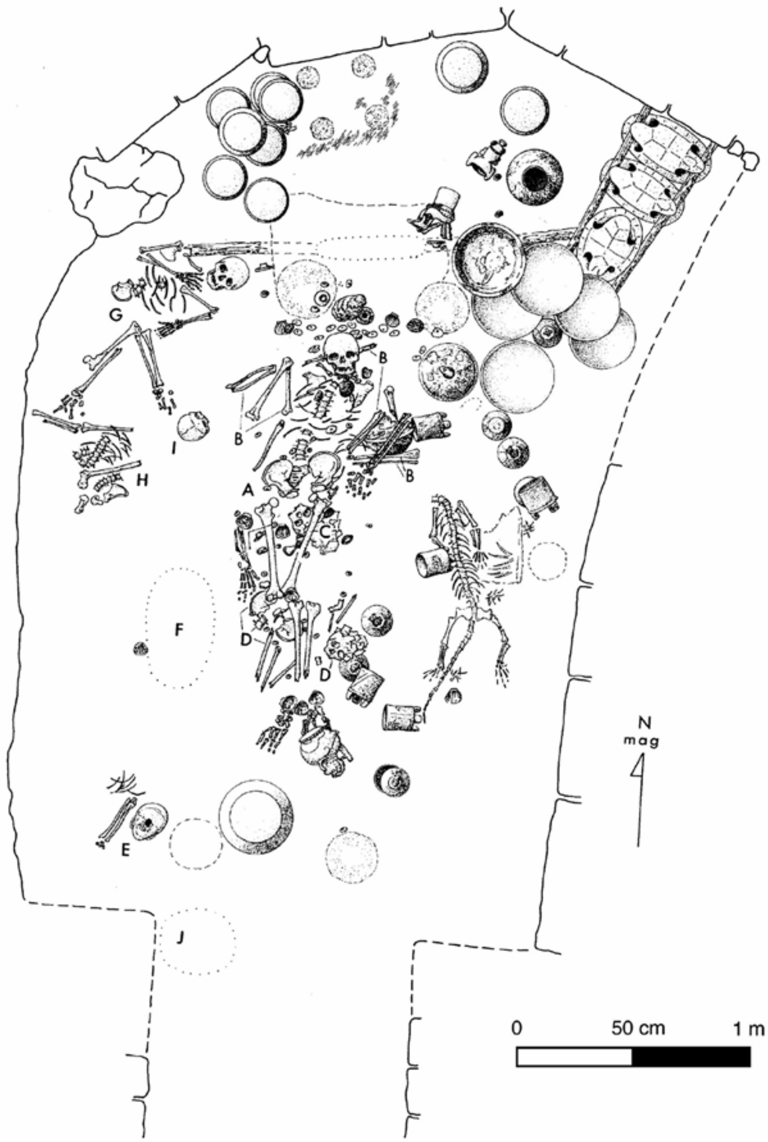

Fig. 11.2 Enumerated Burial 10 located beneath Structure 5D-34 at Tikal, the probable grave of Yax Nuun Ayiin I

tombs beneath the main acropolis that appear to represent the final resting place of Copan's earliest rulers (Bell et al. 2000; Sharer et al. 1999). Of particular interest, the so-called Hunal tomb contained the partially disarticulated remains of an adult male. The tomb's architectural and artifactual associations suggest that he was Yax

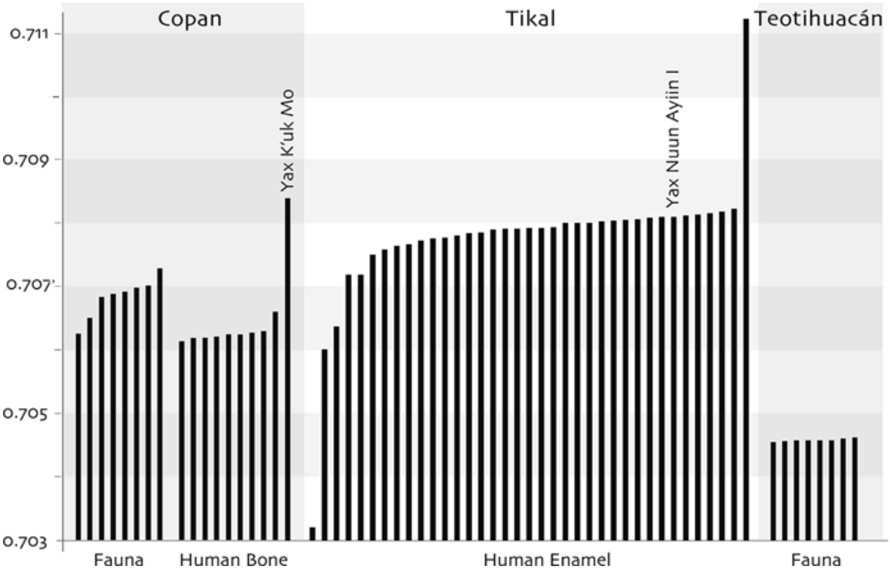

Fig. 11.3 ^{87}Sr/^{86}Sr data for Yax K'uk Mo and Yax Nuun Ayiin in comparison to Copan, Teotihuacan, and Tikal data

K'uk Mo, who is believed to have arrived and consolidated political power in Copan in AD 426 (Buikstra et al. 2004; Martin and Grube 2000; Schele 1990; Sharer et al. 1999), and that he had ties to Teotihuacan in central Mexico.

In order to try to identify the place of origin of the purported Yax K'uk Mo—whether he was indeed from central Mexico, a local resident of Copan, or from another part of the Maya region—we measured strontium isotopes in a number of samples from Copan. The local isotope ratio was determined from analyses of modern local fauna and from bone samples of other individuals from Copan with the presumption that bones gradually remodel toward the local isotope ratio. Local ratios determined from the fauna and human bones are 0.7068 (±0.0003) and 0.7064 (±0.0002), respectively. The slightly higher average in the fauna may be due to a wider range of geologies in terms of food sources. The range for local fauna at Teotihuacan is 0.70463 ± 0.00005. Enamel from the first molar of Yax K'uk Mo yielded an ^{87}Sr/^{86}Sr ratio of 0.708435, clearly higher than the range for either Copan or Teotihuacan (Fig. 11.3). This value is inconsistent with his origin at either site, but rather points to his origin in the Maya region north of Copan, matching the approximate value for the Miocene limestone of the southern Yucatan (0.7085). Given the possibility that sea salt consumption has enriched ^{87}Sr/^{86}Sr ratios at Tikal (Wright 2005), Yax K'uk Mo might well be also from an area around Tikal.

Palenque

Palenque is a Classic Maya site (AD 400–900) located in northwestern Chiapas, Mexico, at the northern edge of the southern highlands (Ruz Lhuillier 1973). Pakal the Great, one of the best-known Maya lords, ruled at Palenque from AD 615 to 683. He is believed to have spent his childhood at Palenque and ascended the throne at age 12, ruling until his death at age 80 (Schele and Mathews 1993).

To evaluate this information, we analyzed Pakal's lower right third molar, which, in contrast to the first molar, develops some years later during childhood (Hillson 2005). We also examined teeth from the Red Queen, an adult female laid to rest in Temple XIII-sub, adjacent to Pakal's own burial place inside the Temple of the Inscriptions, and two sacrificial victims who accompanied her.

The 'local' Palenque ratio, determined from the analysis of snail shells collected at the site, is 0.70780, in close agreement with the ratio of the local limestone (0.70784) (Hodell et al. 2004). However, Palenque is located on a limestone bluff, abruptly above an alluvial Miocene limestone floodplain, which was the location of the agricultural fields of Palenque (Stuardo 2002). Measurements of fauna from the floodplain yielded a mean $^{87}Sr/^{86}Sr$ ratio of 0.70874, within the range for Miocene seawater Sr (0.7085 ± 0.0005),

The value obtained from the third molar of Pakal is 0.70861. Although this seems to contradict the described local residency of Pakal, it is closely comparable to the measurements for the floodplain, which makes it consistent with his local heritage. Also the Red Queen and her two companions are all within the local range (0.7078–0.7086) and close to or within the range exhibited by their bone samples (Fig. 11.4). Therefore, we cannot conclude from this evidence that Pakal or the other three individuals were immigrants; reasonably, any of these individuals may have grown up in the general vicinity of Palenque, rather than specifically at the site itself. These results are somewhat surprising in the case of the Red Queen, more so if we consider her potential identification as Lady Ix Tz'akbu Ajaw, the wife of Pakal (Tiesler et al. 2004), who is epigraphically associated with another, unidentified site in the area. That association, however, is certainly feasible given the current resolution of our methods.

This study further emphasizes that it is the dietary strontium that determines the biological ratio and that great care must be taken to assess how well this bioavailable value matches, or differs from, the $^{87}Sr/^{86}Sr$ ratio that would be anticipated upon a strictly geological basis.

Campeche

Campeche, along the coast of the state of Campeche, Mexico, is one of the oldest colonial cities in the Western Hemisphere, founded in the early sixteenth century AD. In the year 2000, construction in Campeche's Main Park revealed an early colonial burial ground dating to the mid-sixteenth to the late-seventeenth century AD.

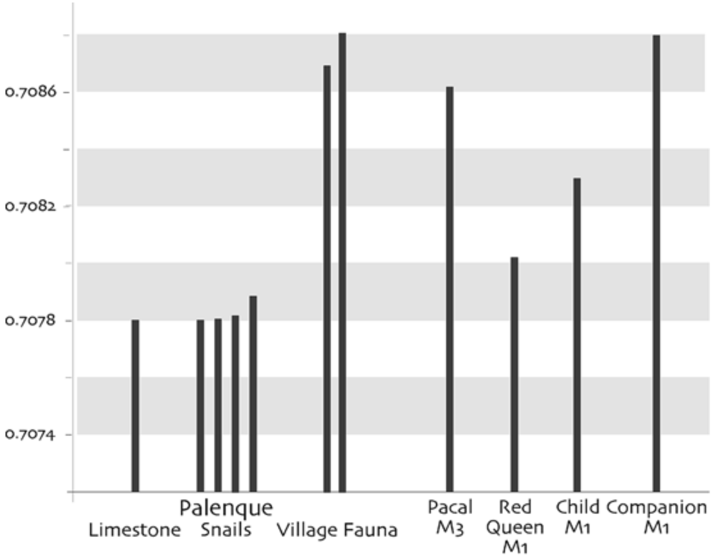

Fig. 11.4 $^{87}Sr/^{86}Sr$ data for Pakal, the Red Queen, and her companions in comparison to local Palenque data

Campeche is located in a region of Tertiary limestones. On the basis of known values for limestone of this age, we can expect local $^{87}Sr/^{86}Sr$ ratios of approximately 0.708 (which might be elevated slightly toward 0.709 depending on the importance of seafood in the diet). The analysis of strontium ratio of 42 individuals from this cemetery (Fig. 11.5) indicates that 25 of them fall within the expected local range and are very born in place. These may be native Maya persons, or the descendents of foreign-born colonists.

Four of the analyzed individuals exhibit values between 0.71 and 0.72, which are exceptionally high for Mesoamerica and unknown for the Maya region with the exception of the Maya Mountains of Belize. Nonetheless, these areas with high ratios are small and dispersed, so these places are unlikely to have been the source of the humans in the Campeche cemetery. On the contrary, a good option would be the Andalucia region of southern Spain from where many of the early European inhabitants of the New World came (Price et al. 2012)

The 13 highest values in our study, ranging from 0.72 to 0.733, are above any geological or archaeological measurement from Mesoamerica. They require a geological source that is very high in ^{87}Sr, i.e., a terrain that is both ancient (>1 billion years) and high in rubidium, like a granitic terrain in one of the ancient continental cratonic areas. They are very high in potassium, and hence high in rubidium. Consequently today they have extraordinarily high $^{87}Sr/^{86}Sr$ ratios (>0.730).

It is most likely that these individuals with high $^{87}Sr/^{86}Sr$ values, given the colonial era context, are from West Africa, a region of cratonic rocks characterized by high

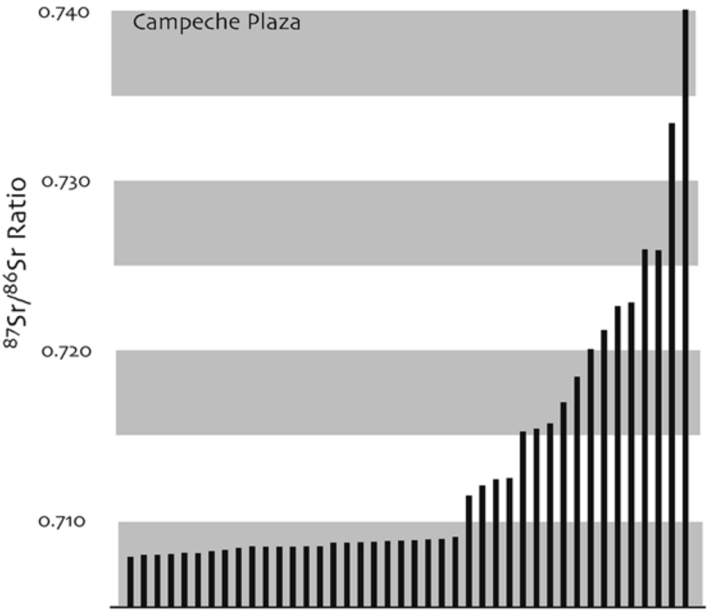

Fig. 11.5 $^{87}Sr/^{86}Sr$ data for colonial Campeche burials, contrasting those of European or African origin

$^{87}Sr/^{86}Sr$. Portuguese traders brought slaves to the New World from this region during the early seventeenth century and perhaps even earlier (Zabala et al. 2004). Goodman et al. (2004) similarly posited a West African origin for slaves in New York City's African Burial Ground, dating to the late 17th and the 18th centuries. They also analyzed well water from Ghana, which is underlain by the West Africa craton, and found isotope values of 0.7355. Thus the individuals at Campeche are likely to be the earliest human remains from the African diaspora.

The inference of a West African origin is supported also by the presence of distinctly West African dental modifications (Tiesler 2001, 2003). Three of the African foreigners had their teeth artificially shaped, thus identifying the practice as an autochthonous, native African tradition. Such tradition seems to have been discontinued in the Americas by the African descendants, at least in Campeche, since none of the individuals with local isotopic signatures showed any African dental modification..

Strontium isotopes have provided a number of insights concerning the early colonial cemetery in Campeche. It is clear that a large proportion of the inhabitants (17 of 42, or 40.5 %) were foreign born, and a high proportion of the individuals buried in the cemetery (at least 13/42, or 31 %) were born in Africa. Interestingly, local Maya people, probable European colonists, and native Africans were all buried in the cemetery together.

Conclusions

Strontium isotope ratios in teeth are demonstrably useful for identifying non-local individuals at prehistoric sites. Data reveal that in Mesoamerica strontium isotope ratios of human dental enamel can be reasonably inferred from the known geology. In the Maya region, rocks are found in a gradient from the lowest ratios in the volcanic region of the south Pacific coast to the highest values along the Yucatan coast. Ratios higher than 0.709 are rare in Mesoamerica; ratios that are much higher must have an origin elsewhere.

Most importantly, variation in $^{87}Sr/^{86}Sr$ within individual regions in Mesoamerica is generally substantially less than variation among different regions. Consequently, as the case studies demonstrate, measurements of $^{87}Sr/^{86}Sr$ allow strong constraints to be placed upon human provenience.

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Chapter 12
House or Lineage? How Intracemetery Kinship Analysis Contributes to the Debate in the Maya Area

William N. Duncan and Jon B. Hageman

Introduction

Two models of ancient Maya social organization have been prominent in the literature over the past 25 years: the lineage and the house. Both are based on ethnographic models, the first by structural-functionalists in Africa (e.g., Evans-Pritchard 1940; Fortes 1945) and the second by Claude Levi-Strauss (1982, 1987) for the northwest coast of North America. Though most archaeologists agree that no single model of social organization was likely present in the pre-Columbian past (e.g., Sharer and Traxler 2006:65), modeling social organization has been a topic of often heated discussion. For the Maya, the house-lineage debate hinges in part on the role of biological kinship in society. In this chapter we review Mesoamerican intracemetery analyses, focusing on the Maya area, and focusing on what, if any, insight they might offer regarding the house-lineage debate. We suggest that, while biological distance analyses will not (of course) resolve the debate, increasing use of intracemetery analyses in the future will help illuminate the circumstances in which biological kinship was emphasized in Maya society.

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Lineage and the Ancient Maya

Different researchers have typically defined specific versions of various lineage models for application to their research. The lineage was most famously described for east African pastoralists (Evans-Pritchard 1940) and West African agriculturalists (Fortes 1945). Groups described as lineages were organized into exogamous clans composed of various named segments whose members were linked through the patriline, internally ranked, held corporate property, and venerated ancestors of at least three generations (Evans-Pritchard 1940:192–193, 196, 201–202; Fortes 1945:26, 227).

Based on ethnographic analogy with Benin (Sanders 1992:281) and Yoruba (Sanders 1989:99), Sanders argued that the incipient stratification observed at Copán was based on the royal lineage controlling a great deal of agricultural land (Sanders 1992:282). An examination of ceramic data allowed Hendon (1991:913) to conclude that the Las Sepulturas barrio of Copán consisted of several ranked households arranged around patio groups, each representing a localized lineage. Fash (1983) also suggested that the nucleated clusters of mounds across the Copán Valley may have been the corporate territories of lineages. In a comprehensive examination of ancient Maya social organization, McAnany (1995) explored the connections between ancestors, corporate land tenure, and intensive agriculture in her argument for the existence of lineages in the pre-Columbian Maya Lowlands and the subversion of kinship by an emerging noble class. Finally, Hageman (2004) documented a Late Classic (AD 600–900) lineage territory in northwestern Belize, finding evidence of practices consistent with creating and maintaining a group identity, a corporate resource, a lineage head, and ancestor veneration.

Critiques of the lineage model have largely aimed at its theoretical underpinnings rather than at a poor fit with the data. Prominent criticisms describe the lineage as overly dependent on normative rules of descent, succession, and inheritance. Anthropological theory has long since shifted from emphasizing structure to focusing on process, and thus began to consider notions of descent more as guidelines than determinants of social action (e.g., Gillespie 2007; Hutson et al. 2004). Instead, a model that explicitly accommodates the messiness of human social action was proposed, one founded on more process-oriented, poststructuralist perspectives (e.g., Bourdieu 1977). The result was not the application of contingent, agent-based approaches to the lineage, but rather to a much less frequently used model developed by Claude Levi-Strauss: the house.

Levi-Strauss, the House, and the Maya

Levi-Strauss (1982, 1987) developed the house model as a better fit for societies that lacked regularized patterns of descent, inheritance, and succession, while placing emphasis on strategic marriage as a means of perpetuating the group. The house maintains an estate through the selective implementation of various strategies, including endogamous and exogamous marriage and inheritance of property or titles through one or both lines. An evolutionary element runs through the original formulation of the house, as Levi-Strauss (1982:186) saw this form as in a “situation where political and economic interest, on the verge of invading the social field, have not yet overstepped the ‘old ties of blood.’” In other words, this was a transitional stage in the shift from primarily kin-based relations to class-based relations within a society.

The house and lineage models are similar in many ways. Both houses and lineages own property, are usually ranked internally, and can legitimize their existence through links to a founding ancestor. The primary difference is the perceived greater degree of flexibility in descent and authority for the house (Watanabe 2004:160–161). Houses are often found in the upper levels of society, where sufficient resources can be accumulated to ensure the long-term survival of the house (Gillespie 2000a:477, b:33; Waterson 1990:140, 1995:67).

The house model has been applied to pre-Columbian Maya contexts, most often heuristically rather than taxonomically. Joyce (2000) argued that caching behavior and glyphs on grave goods recorded house history, and reinforced the effectiveness of these goods as signs of material achievement. Ringle and Bey (2001) suggested that parentage expressions in Terminal Classic texts and the *Cronica de Calkini* emphasize both parents rather than unilineal descent. At Chunchucmil, Hutson et al. (2004) examined architectural renovations at three multifamily house lots for evidence of succession of leadership within the groups that resembles what would be expected of house organization. The construction of lands and buildings is indicated by Joyce (2007) as evidence for the construction of enduring personal and group identities in Formative Honduras.

Arguments for the house model claim kinship cannot be operationalized archaeologically (e.g., Gillespie 2007:33–34), and the house is therefore considered preferable to kinship-based (typically unilineal) models of social organization such as the lineage. Still, the house was originally defined by Levi-Strauss (1987:152) as being composed of a “real or fictive line held as legitimate, expressed by the language of kinship or alliance, though most often of both together.” The house, then, may feature varying degrees of biological and nonbiological, or social, kinship at different times during its existence. House model proponents downplay the role of descent and kinship as organizing principles in society, pointing to the use of the “language of kinship” in justifying kin-based and non-kin-based strategies and practices. Kinship is still a prevailing ideology in house societies though practice may differ very widely from ideology through the use of nonbiological (social) kinship.

In addition, critics of the lineage concept mischaracterize the degree to which kinship studies continue to be prescriptivist in nature. Normative studies of kinship lost their centrality in anthropology in the mid-1980s, when Schneider (1984) convincingly argued against the universality of the Euro-American, biologically based understanding of kinship. Researchers are increasingly aware that the nature and manifestation of kinship can be quite idiosyncratic. Since the 1990s, however, ethnographers have recognized that kinship is still important, and that some reconfiguration of how we study kinship is necessary. For example, kinship categories are no longer prescriptive and are instead "fuzzy" or "fluid," and kinship has been recognized as a key component of various social systems rather than an autonomous domain (Faubion 1996:70, 91; Watanabe 2004). Ethnographers have recognized that kinship is primarily a social phenomenon, which may unevenly covary with biological relatedness. Scholars supporting the house model set up kinship as a straw man—the normative, pre-Schneiderian is what is critiqued, rather than post-Schneiderian kinship studies that consider kinship as a much more nuanced phenomenon. Lineage is much more fluid and flexible in descent, succession, and inheritance than house proponents have claimed.

For the Maya case in particular, some have critiqued the house model based on its fit with the data. Houston and McAnany (2003:37–38) suggest that evidence is rare or lacking for the house model among Classic royalty. The emphasis on long genealogical sequences in hieroglyphic texts suggests bloodlines, kinship, and descent were indeed critical to Classic rulers. Not considering kinship means overlooking relevant (and perhaps central) evidence for ancient practices. As an alternative, Houston and McAnany (2003:37) suggest that the model may be more appropriately applied to non-elite Maya society, where the house seems to be a long-term, durable container for group and personal identity.

In contrast, Hageman (2007) suggests the house is a poor fit for non-royal Maya society. As part of examining the role of ancestors among Classic-era commoners, Hageman (2007) suggests the house better describes the Maya nobility, based on the strong and consistent links between the model and royal or noble houses cross-culturally (e.g., Gillespie 2000a:477, b:33; Waterson 1990:140, 1995:67) and the uniformity of adult males in rural ancestral burial contexts. The house model emphasizes the high-stakes *realpolitik* of an unusually wide range of often unconventional strategies needed to maintain the estate in the face of competition with other houses. This includes a subversion of kinship as part of an emerging noble class (e.g., McAnany 1995) and a correlated appeal to supernatural justifications of separateness, distinction, and cosmological origin (e.g., Helms 1998). Regardless of the perspective one espouses, it seems that biological relatedness was often a part of defining ancient Maya identity. Maya rulers left sometimes lengthy descriptions of antecedents (many of which were patrilineal, e.g., Copán Altar Q), both parents (Martin and Grube 2008), and generations of grandparents (e.g., Janaab' Pakal's sarcophagus). The degree to which this relatedness was biologically based has not been widely studied.

Biological Kinship Analysis in Mesoamerica: A Review

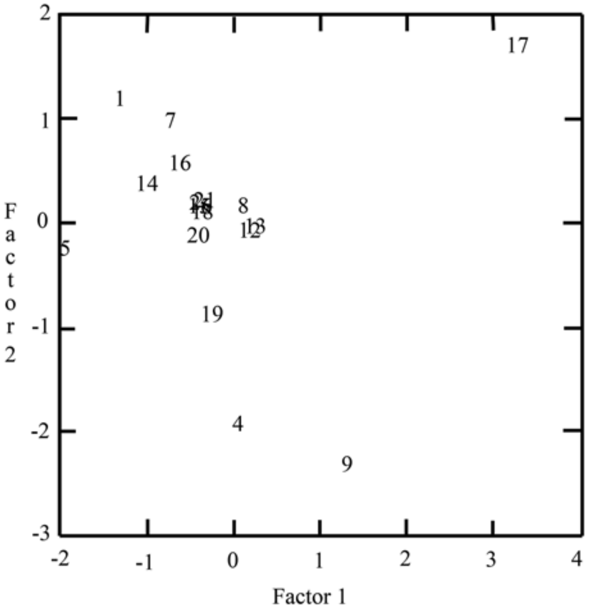
In the 1970s, biological distance studies on small geographic scales began to emerge, focusing on postmarital residence (including Spence's [1974] work at Teotihuacan), evidence of kinship (see below), and time- and age-structured variability (Konigsberg 2006; Stojanowski and Schillaci 2006). Given the importance of kinship and descent to Mesoamerican cultures, and particularly the Maya, it is somewhat surprising that more attempts have not been made to investigate the nature of corporate groups through biological distance analyses and to discuss how they might inform the house versus lineage debate. A review of intrasite biodistance studies from Mesoamerica suggests that biological distance analysis will certainly not solve the house-lineage debate, but particularly when considered contextually it can inform on circumstances in which biological descent appears to have been important. Hammond et al. (1975) similarly suggested that high levels of homogeneity among the dental traits in a tomb at Lubaantun were consistent with the scenario that members of the same family were buried over time (also see Christensen 1998a). Other more formal studies, such as Jacobi's (2000:186–189) examination of the burials in the Tipu church, found little phenotypic patterning within an entire cemetery, but did identify evidence of rare or low frequency traits.

Analysis of nonmetric dental traits from a series of skull rows and pairs found in a temple at the site of Ixlú in Peten, Guatemala (Duncan 2011) found similar results as Jacobi's (2000) study. The skulls were arranged in pairs on the east-west axis of a small temple while the skulls in rows were found in the middle of the temple. All of the skulls were adolescent and adults; those for whom sex could be assessed were males and were deposited in two episodes of construction for the temple (see Duncan 2011 for description of the archaeology). Duncan (2005) collected data for 61 traits on 17 individuals and analyzed them in a principal components analysis to determine if biological patterning corresponded to the skulls' placement in rows and pairs, or episode of deposition (Table 12.1). Due to space limitations, the methods and materials are described in Duncan (2005), but Fig. 12.1 shows no pattern corresponding to whether or not the skulls were buried in pairs or rows, or episode of deposition. However, the skulls with hyperdontia (Skulls 1, 7, 16)

Table 12.1 Location and episode of deposition for individual skulls from Ixlú, Guatemala

Skull	Pair/row	Episode of deposition
1	Pair	2
2	Pair	2
4	Pair	1
5	Pair	1
6	Pair	1
7	Row	2
8	Row	2
9	Row	2
12	Row	2
13	Row	2
14	Row	2
16	Row	2
17	Row	2
18	Row	2
19	Row	2
20	Row	2
21	Row	2

Fig. 12.1 Extracted factors 1 and 2 showing the patterning of individual skulls from Ixlú



cluster together. The heads were taken from sacrificial victims who were likely obtained from a raiding party, and supports the notion that membership in such a raiding party may have been based in part on biological kinship.

Other, more formal analyses have also identified limited biological patterning throughout sites. Rhoads (2002) considered the biological patterning from the site of Copan. She found no evidence of isolation by distance in the Copan pocket (a 24 km^2 area). However within barrios, Rhoads (2002:216) noted that patio groups tend to cluster together, bolstering other arguments based on archaeological data (see above). She also suggested informally that some rare traits may have reflected evidence of kinship at Copan (Rhoads 2002:167). Rhoads (2002:217) also identified two “lineages” on the basis of tooth size (though not morphological data). Her reasoning for labeling these as lineages is primarily due to the fact that they cut across status lines and within patios with both groups represented, lineage members are buried near one another. The incongruity between metric and nonmetric data call this into question somewhat, but even if the patterning seen in the odontometrics meaningfully reflects kinship, calling the groups lineages in the absence of several additional, archaeologically identifiable traits of social organization seems to be a loose sense of the term.

Serafin (2010) (see also Serafin et al. 2015) used both nonmetric and metric dental data to analyze relative phenotypic variability among local, elite, and mass grave contexts, the latter of whom were victims of violence. Odontometric analysis found relative homogeneity in all three contexts but suggested that the mass grave was the most distinct sample. Nonmetric analyses, on the other hand, found the local sample to be distinct from the elite and mass grave samples, but no difference between the latter two.

Both Serafin's (2010) and Rhoads' (2002) analyses found limited evidence for biological patterning, but also some contradictory results from metric and nonmetric dental data. Neither provided conclusive evidence for an emphasis on biological descent at their respective sites. However, recently researchers in Oaxaca, Mexico identified correspondence of biological and spatial patterning of burials that they argue directly reflect a focus on descent and household organization (Paul et al. 2013). In Coastal Oaxaca Late and Terminal Formative (300 BC–AD 300) cemeteries were found in public areas. Although it is unclear if they were phenotypically structured, they are currently thought to be "communal cemeteries" (Paul et al. 2013:220). By the Late Classic period (ca. AD 600–900), mortuary practices were dramatically different, with single burials associated with residential structures rather than within public spaces (Paul et al. 2013:220). This shift is interpreted as a change from a communal emphasis to one "projecting individual, residential, or kin group identity" (Paul et al. 2013:220). Examination of the Early Classic (AD 300–600) cemetery from the site of Charco Redondo found biological patterning to correspond to various mortuary variables within the cemetery (Paul et al. 2013). This highlights a shift toward a more biologically kin-based emphasis within society. Future studies may add biological data to further historicize such shifts in the region.

Conclusion

Given the house-lineage debate, it is somewhat surprising that Mesoamerica has seen a small number of intrasite biological distance analyses relative to other regions. The reluctance of researchers to pursue more analyses of this kind may stem from the fact that some attempts produced relatively little positive evidence of biological patterning (e.g., Jacobi 2000; Scherer 2004). This has led to some belief that biodistance analysis has limited potential in Mesoamerica (Wrobel 2004:165–167). Their points are well taken; relative to some areas (e.g., Illinois, see Konigsberg 2006) Mesoamerica has produced relatively few biodistance studies with results that are easily interpretable in terms of the archaeological record. This may stem from the fact that a principal challenge to studying kinship with metric and nonmetric osteodental traits is that the presence of phenotypic patterning implies biological kinship while the inverse is not the case. Failure to reject a null hypothesis is normally not interpreted as evidence supporting its validity, but in the case of biodistance, researchers are still discovering the developmental processes that translate genotype into phenotype (Thesleff 2006). Alternatively, mating patterns within some Mesoamerican contexts may confound our ability to identify meaningful patterns. Christensen (1998b) used genealogical data from Mixtec codices in Oaxaca to estimate the likely level of inbreeding among royal Mixtec families. He suggested that inbreeding would have been sufficiently high to impact biological structure.

With these caveats in mind, the biological distance studies that we have seen certainly have not produced convincing evidence that biological descent was a widespread organizing principle in Mesoamerica or for the Maya particularly. This may reflect greater emphasis on house style organization for these cases, but as described above, both the change in how kinship is considered ethnographically and challenges of concluding an absence of close biological kinship from an absence of clear phenotypic patterning hinder our ability to make definitive statements. Rather, these studies have identified some limited examples in which biological patterning makes sense in light of contextual data, and in so doing suggest that future biodistance studies may help explore contexts in which biological descent was an important organizing principle in Mesoamerican societies.

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Chapter 13
Shifts in Artificial Head Forms, Population Movements, and Ethnicity Among the Postclassic Maya

Vera Tiesler

Introduction

This chapter sheds light on cultural integration and population dynamics from the perspective of the artificial shaping of infant heads and their visible outcome among those peoples who shared the Maya territories toward and during the Postclassic period. Before the European contact, head shaping was a deeply rooted, generation-bridging tradition in all parts of Mesoamerica (Tiesler 2014). The long-standing motives for this highly visible body practice lay in "straightening the head of the baby out" and in reducing the occipital prominence, deemed potentially harmful to the integrity of the little ones (Tiesler 2012). The still volatile living essences of the little organism had to be secured and strengthened before it could become a person properly (Duncan and Hofling 2011; Tiesler 2012, 2014). Quotidian procedures involved head wrapping and compression and were implemented by female kin who prepared their minors for their posterior social integration and, for some Mesoamericans, to signal the group identity of their bearers.

This last notion makes a convenient point of departure for this essay. Here I wish to examine the shifts in head modeling under the light of population movements and the pan-Mesoamerican orientation that characterizes the Postclassic period. To this end, I will examine the gradually shifting preferences in technique and form in Maya skeletal collections from the Terminal Classic and Postclassic periods, as part of a more general study on shifting Maya head looks (Tiesler 2012, 2014; Tiesler and

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Cucina 2010; Tiesler and Ortega 2013). This approximation links with other approaches in this compilation, as it permits to address questions on population dynamics, regional changes, and ethnicity from the (bio)archaeological record, especially given the emblematic role of native head shaping practices as highly visible identifiers of group affiliation and social identities, possibly ethnicity, and emulation of the sacred (García Barrios and Tiesler 2011; Houston et al. 2006). "Ethnicity" is understood here as belonging to a population in which the members regularly identify each other based on genealogy and a common ascendance, or on other historic ties (Hicks 2001). Group affinities that fall in this category often express cohesion through autochthonous cultural practices, shared speech, or religious beliefs. In regards to the ancient Maya, these aspects have been examined almost exclusively through iconographic, ethnolinguistic, and archaeological approaches (Culbert and Rice 1990; Lacadena and Wichmann 2002; Mora-Marín et al. 2009; Sharer and Traxler 2006a).

Materials and Methods

The following paragraphs survey the shifts and twists of head shaping practices in the Maya cultural tapestry against the backdrop of sociocultural change during and after the so-called collapse an historic process that brought with it a destitution of the dominant political and ideological hegemonies of the Classic era and the abandonment of large segments of the inland lowlands. As we shall see, these changes also found their expression in the preferences of culturally induced cephalic shapes.

The data collection that supports this review was conducted on short of two thousand skulls from different parts of the Maya area and chronological periods, and is described extensively in other works (Tiesler 2012, 2014). Chronological assignments were used to chart the general development of the Maya tradition and its expression throughout the centuries of the Prehispanic era. Metric and nonmetric parameters express the presence, degree, and type of cranial modeling, following the classification established by Imbelloni (Dembo and Imbelloni 1938) and successively adapted by Romano (1965) and Tiesler (2014) (Fig. 13.1). This taxonomy distinguishes between the annular morphologies, achieved by the use of constriction bands, ropes, bandages, or other wrappings, as opposed to tabular forms resulting from the application of rigid compression instruments. Free rigid tablets were either tied directly on the calotte to produce oblique tabular forms (Fig. 13.1a), or were part of cradleboards and resulted in head shortening (tabular erect forms) (Fig. 13.1b). The overall degree of modification is the combined outcome of the postpartum timing of the procedures and the force and duration of the pressure. Note that hard compression devices were sometimes combined with constricting bandages or could be cushioned by pads.

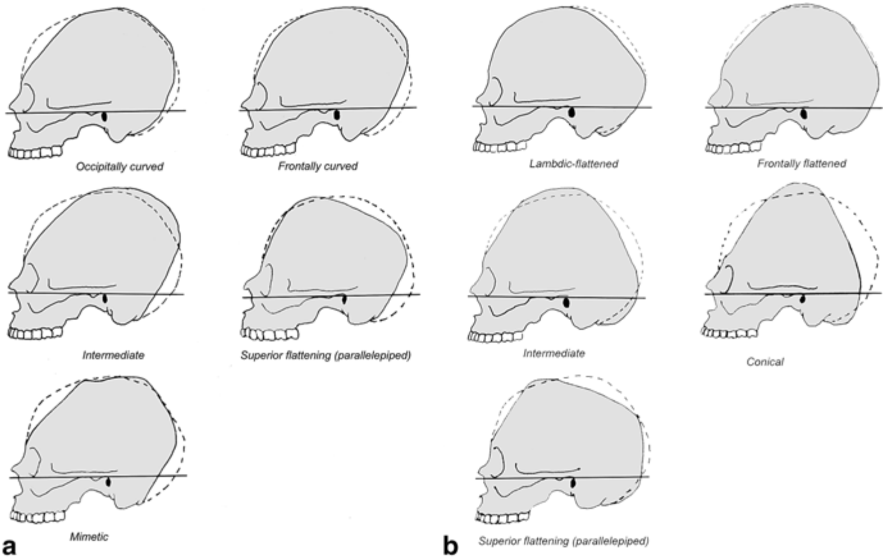

Fig. 13.1 Formal variants of (**a**) tabular oblique and (**b**) tabular erect cranial modifications, adapted from the taxonomy by Imbelloni (Dembo and Imbelloni 1938; Tiesler 2014:74–79)

The Classic to Postclassic Interstice

The processing of all skeletal series indicates that still during the Classic period a host of different modeling techniques were in vogue across the Maya sphere, expressed in a repeated variety of forms in each locale (Fig. 13.2; Tiesler and Cucina 2010). Head morphologies also fluctuate over the cultural geography. A preference for erect forms is apparent by the second half of the first millennium AD among the trader communities of the Quintana Roo and Belize's Caribbean coast, while a clear predilection for reclined and tubular head morphologies (oblique tabular in its pseudo-annular form) characterizes the communities of the Western Peten corridor and across the Usumacinta river. Still further west and rising toward the territories of the Highlands of Guatemala and Chipas, broad, artificially shortened heads predominate the collective look.

These variations reflect still deeper cultural divisions, including most probably ethnic divides, as argued in other work (Tiesler 2012, 2014). These divisions echo some of the vernacular (spoken) language bifurcations during the first millennium AD (Lacadena and Wichmann 2002; see also Mora-Marín et al. 2009 for a broader discussion on vernacular languages). In this combined craniolinguistic geography, Yucatecan was spoken in the northern lowlands whose populations bore similarly diverse head forms as the Ch'olan speakers of the eastern, central, and southeastern

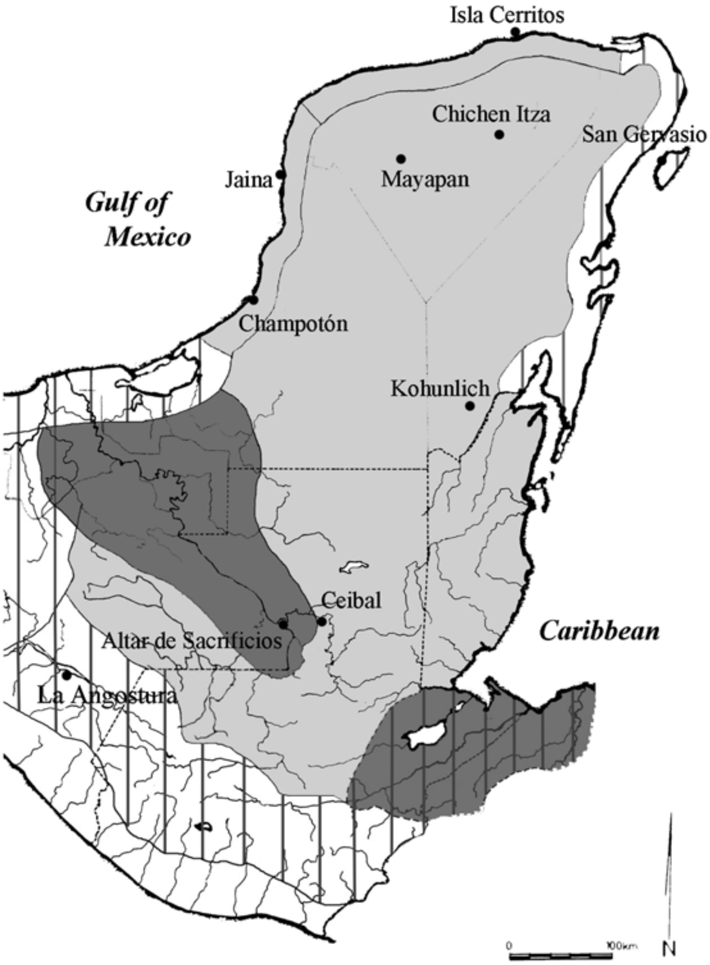

Fig. 13.2 Distribution of head forms across the Maya area during the Classic Period (adapted from Tiesler 2012, 2014). Areas with a strong preference for of head elongation (over 70 % tabular oblique crania) appear in dark grey, those with an more equal distribution of head shortening and elongation in light grey. Other areas, which display a strong preference for shortened head morphologies (more that 70 % of tabular erect crania) are striped vertically

lowlands. Different was the tongue heard across the western Maya hemisphere, where settlers in and around the Usamacinta Valley communicated in western Ch'olan. These communities also stood out from their Maya neighbors by their uniformly elongated, reclined head silhouettes. Still further west and south of the Usumacinta basin, western Ch'olan speakers fringed with shortheaded Tzeltalan and Quiche peoples from the adjacent highlands.

While most of the Classic period territories that make up the Maya landscape still witnessed a myriad of artificial head shapes (Fig. 13.1a and b), the six hundred

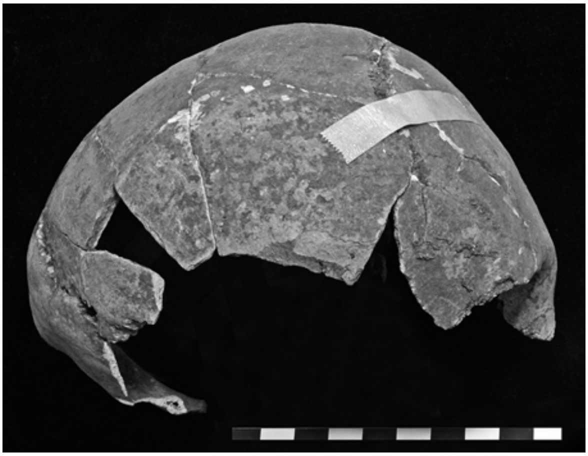

Fig. 13.3 Postclassic period neurocranium from the site of San Gervasio, Cozumel Island, Quintana Roo, displaying strong superior flattening (DAF/INAH; photo V. Tiesler)

following years saw a gradual but consistent drop in technical and morphological diversity and a replacement of anachronic head morphologies. This process did not proceed uniformly nor did it progress in similar time frames across the Maya world, as we have documented in other work (Tiesler and Cucina 2010).

In fact, changes in head morphology become apparent already during the middle of the first millennium AD. This is when shapes with strong superior flattening begin to be seen along the coastline of Yucatan, a modality that seems to have been used initially among populations along the Gulf Coast of Veracruz and in the Middle Classic period Istmic area (Romano 1977; Tiesler et al. 2010). In the mortuary record of the Classic period Maya area top-flattened heads still characterize mostly men with distinctive grave goods (Fig. 13.3; Tiesler 2012). These people were buried in trader settlements like Jaina and Xcambo, and time later in Isla Cerritos and San Gervasio on the east coast. We may cautiously assume therefore that the superior flattenings, which bear resemblance to anthropomorphic portraits of the God L (the patron force of merchants), were carried by the new generations of coastal trader folk, coined by scholarship alternatively as Putun, Gulf Coast people, Chontal or "Mexicanized Maya" (see Cobos 2013, 2015 for further discussion). Beyond the ongoing academic debate regarding their political importance in the inlands, it is clear that these groups played an important role already before the end of the first millennium AD, which saw shifts in trading networks and the gradual rise of new hegemonies in northern Yucatan. This includes the new capital of Chichen Itza, where we have registered an abundance of top-flattened head silhouettes in the series recovered for the Sacred Cenote.

In all likelihood, the political and economic shift in northern Yucatan also had a direct bearing on the acute social and population readjustments that occurred in the aftermath of the so-called collapse further south. Deep within the Central Lowland heartlands, irrevocable social changes occurred with a gradual disintegration that lasted for decades or centuries. This process witnessed massive destruction of site cores and the gradual abandonment of large inland territories, with population movements heading toward the Maya Highlands and toward the north (Sharer and Traxler 2006b). We may wonder in this doomed scenario, if central lowlanders would adopt those head stylel ask that would become a common denominator in the second millennium (i.e., broad and shortened shapes)?

In order to analyze the era of replacement and catastrophe from the perspective of cranial forms, we consulted those Central Lowland sites that remained occupied for decades and centuries after the general decline, such as the area of Río de la Pasión in western Guatemala with its continuous occupation up to the Postclassic. Still before the "collapse", most of the inhabitants of Ceibal and Altar de Sacrificios show oblique tabular shapes (7 of $N = 11$; 3 of 4 in Ceibal). Head elongation keeps on being popular also during the Bayal Phase of the Terminal Classic period (with 13 of $N = 19$). This continuity is actually surprising, considering epigenetic and epigraphic interpretations that speak of a reoccupation of the site by foreigners (Austin 1978; Martin and Grube 2008:226–228). Also the last inhabitants of Altar de Sacrificios, specifically those who were buried during the onset of the Postclassic period (during the Jimba phase) show a continued preference for elongated and reclined heads of their infants, with oblique shapes representing twice the number of erect shapes ($N = 6$). Despite the reduced sample size, the overall results, reproduced here for the two Peten sites, lay out a panorama not of cultural or populational substitution but rather of continuity and permanence of its settlers, including centuries after the "collapse." We follow that only the final abandonment must have put an end to the old local ways of head modeling.

A slightly different panorama from that of Río de la Pasión settlers is expressed among those villages in and near the east coast of the Yucatan peninsula that experienced a continuous occupation between the two horizons. Residents of Kohunlich, for example, still tended toward oblique forms during the Late Classic period (68 %; $N = 16$). Then, toward the end of the Terminal Classic and throughout the Early Postclassic periods, without completely abandoning the oblique shape, the locals seem to adopt cradleboarding as a sole infant treatment, with the majority of the late dwellers displaying short and broad head morphologies (69 %; $N = 13$). These changes in form are statistically relevant ($p = 0.038$), pointing toward a stronger cultural substitution in the northeastern communities than in those of the Río de la Pasión on the other side of the Maya interior world in the course of abandonment.

Still further east lies San Gervasio on the island of Cozumel, where six of seven individuals dated to the Classic period show the tabular erect modification. A total of 42 evaluable local skeletons from the later Postclassic period exhibited this same form (with $p = 0.302$ in the comparison between the phases). These numbers, similar to those documented in other coastal series in the regional survey, appear to indicate that the tabular erect form was already established as the preferred shape well before the decline at the end of the Classic period, marking a cultural separation between coastal and inland sites during the second half of the Classic era (Fig. 13.4). This idea (of separation) is also sustained by the pattern of the propagation of superior flattening during these centuries, which is likewise limited to coastal populations and does not seem to have been adopted by the populations further inland (Tiesler et al. 2010).

Fig. 13.4 Different views of a young female skull from the Island of San Gervasio, Quintana Roo, displaying strong anteroposterior flattening. Postclassic period (DAF/INAH; photo V. Tiesler)

Regional Changes During the Postclassic Era

The burial record shows that also on the broader regional level, head-modeling techniques and forms were gradually homologated toward the beginning of the new millennium just like many other cultural expressions. Note that the "collapse" of the Maya culture and the changes in population did not result in the abandonment of cephalic practice itself; on the contrary, if 80–90 % of Maya had been marked by a cultural modification during the Classic era, now the frequency rose to close to 100 %. The growing uniformity in presence and modeling techniques becomes obvious when comparing Terminal Classic and Early Postclassic Maya preferences in head looks, and is still more evident when contrasting those with Middle and Late Postclassic head styles (Table 13.1). Toward the first and second half of the Postclassic era, the use of cephalic tablets begins to decline in the Maya territories to finally be completely abandoned together with the use of circular head wrappings, as the values from different epochs show (Table 13.1). This cultural replacement proves to be highly significant statistically speaking if we compare the use of erect and oblique types between the Early and Late Postclassic periods ($p = .001$).

This cultural shift toward head shortening predates Postclassic human occupations not only on the east coast but also in the (supposedly) Itza-dominated north territories toward the Postclassic. Back-flattened erect head styles already dominated the hegemonic site of Chichen Itza (even if we do not include the sample from the Sacred Cenote given the lack of secure contextual information). Chichen Itza seems to be the frontrunner of the new inland Postclassic by turning to head shortening through cradleboard use, as all individuals from our revised series already display shortened heads, shaped in intermediate degrees. Also later, in the Cocom ruled capital of Mayapan, the only head style is the erect one; this center had replaced Chichen as the seat of peninsular power in the Mid-Late Postclassic period. All crania from this site show tabular erect modifications in degrees similar to those seen in Chichen, although two of them also present sagittal grooves, the result of a compression band that exercised an anterior–posterior pressure on the calotte (Serafin 2010; Tiesler 1998).

Table 13.1 Percent frequencies of different culturally produced head morphologies among the ancient Maya during the Late and Terminal Classic period, and during the Early and Late Postclassic period [sample size in parenthesis]

	Late Classic	Terminal Classic	Early Postclassic*	Middle/Late Postclassic
Frequency (%)	79.59 [N=681]	92.06 [N=126]	91.42 [N=70]	92.91 [N=127]
Frequency of wraps	24.86 [N=346]	41.54 [N=65]	21.21 [N=33]	0 [N=70]
Sagittal constriction	29.38 [N=354]	29.03 [N=62]	34.38 [N=32]	34.33 [N=67]
Tabular oblique vs. erect forms	64.95 [N=388]	54.35 [N=92]	21.43 [N=51]	0 [N=115]
Superior flattening	6.94 [N=346]	0.79 [N=126]	2.86 [N=70]	3.15 [N=127]
Average flattening degree [0–4]**	1.89 [N=404]	2.19 [N=98]	2.1 [N=64]	1.9 [N=118]

*This series does not include the skulls recovered from the Cenote Sagrado of Chichen Itza
**Only adult crania were taken into consideration

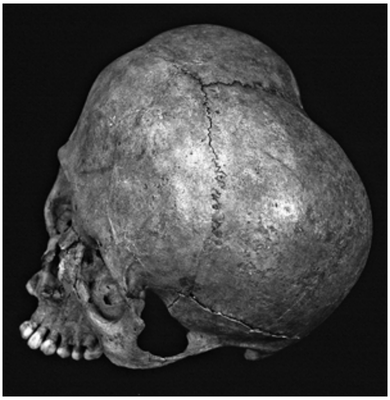

Fig. 13.5 Cranium from La Angostura, Chiapas, with strong sagittal grooving (bilobular variant). Postclassic period (DAF/INAH; photo V. Tiesler)

Down the Campeche coast lies the Postclassic settlement of Champotón, a port city for centuries before the Spanish conquest. Also its local folk shows shortened head silhouettes, achieved through the use of cradleboarding, just like those in the two groups described earlier. Also further south, up to the mountain ranges of Chiapas and Guatemala, tabular erect forms prevail, born by all evaluable individuals (Gervais 1989; Stewart 1953; Tiesler 1998). Some of the artificially reproduced local shapes are extreme, and in some cases they were combined with strong sagittal grooves, leading to visible bipolar division of both parietal lobes (Fig. 13.5).

However, within the general homogeneity perceived during the Postclassic period, there is, indeed, some minor variation from household to household and from area to area, expressed in differences in the positioning of the compression boards, for example (Tiesler and Ortega 2013). Such is the case also for the use of the sagittal band, documented in one third of the Postclassic skulls sampled for this study. In most cases, this type of sulcus appears as a slight depression between both parietal bones, perhaps an unforeseen effect of tying the child in the cradle. In other settlements, as we have noted for La Angostura in the Chiapas Highlands, the calotte was actually dramatically divided into two bipolar lobes.

Also a new morphology among the tabular erect morphologies makes its appearance in the Postclassic registry, although it remains infrequent. This shape combines two straight planes that meet at the vertex of the calotte, forming the profile that Arturo Romano refers to as the conical cap of Quetzalcoatl (Romano 1980). This shape is patent in nine individuals who died in Chichen Itza and in the coastal strips of Cozumel and Tulum.

Discussion

As we have argued, Classic period Maya families reproduced a myriad of artificial head shapes in their infants (Fig. 13.1a, b). Their geographic distribution finds parallels with vernacular language divides and most probably connote different ideological identifications, as argued for the Maize God. Toward the close of the milenium, head preferences begin to shift, a trend which is first perceived along the coast of Yucatan, and later also in the central northern Peninsula, whose populations sport increasingly shortened and top-flattened heads, displacing former head elongation from their cultural repertoire. This metamorphosis in head looks opposes the continuity among central and southern lowlanders, who keep on practicing their old head models—namely, reclined, tubular forms—until their final exodus in the Early Postclassic.

The five hundred following years saw a gradual but consistent drop in technical and morphological diversity. Despite the variety in head looks achieved through the still diversified use of compression cradles, the implements themselves are seen to become uniform among Postclassic Maya households. This homologation finds parallels in second millennium imagery that begins to portray human heads as consistently high and flattened just like the heads of all Postclassic period gods (García Barrios and Tiesler 2011; Tiesler 2012). Even the God of Corn, previously portrayed with a distinctively lengthened and reclined skull, appears represented in Postclassic murals and codices with a high forehead and a calotte shortened in the back (Taube 1992:41–50; Tiesler 2014). The top flattening, identified by us in other works with the God of Merchants during the Postclassic era, appears to have been abandoned also from the cultural heritage in the three centuries preceding the arrival of the Spaniards. At the dawn of the Spanish conquest, Maya heads were just as uniformly flattened as in many other territories of the great Postclassic Mesoamerica. In the sixteenth century, these culturally produced head silhouettes were still noted by the Spanish newcomers, who recognized them more as a side product of the active head maneuvers than by the head form itself (Tiesler and Zabala 2011; Zabala 2014).

This pulls us back to our initial questions regarding group belonging and corporal expression. I wonder if the Postclassic-period trend toward uniformity of head form could have denoted a new, vague ideological Pan-Mesoamerican identification. Perhaps the old–new look of erect and shortened heads was apt to denote the omnipresent cult and impersonation of Quetzalcoatl, emblem and axis of the dominant ideology of the new order (López-Austin 1989:470–471; Ringle et al. 1998). For now, this idea awaits systematic scrutiny by scholarship.

Alternatively, I wonder if the process toward uniformity could reveal—more than a new global identification of cephalic modeling—the gradual loss of identification with visible ideological entity, turning into a daily customary habit over time, lacking any defined purposes or meanings beyond protection and the elimination of the physiologically convex occipital bun, as noted in other work (Tiesler 2012). I recall in this regard that during the first centuries of the second millennium, the Peninsula experienced a regionalization or "balkanization" process of its hegemonic structures that resulted in the dispersal and decentralization of the all Yucatencan speaking territory. Now, Yucatecans were identified with the names of the governing families, such as the Xiu, the Cocom, or the Itza (Cobos 2013; Sharer and Traxler 2006b). Cephalic forms evidently did not adhere to the political–cultural map of Yucatán at the eve of the conquest and we think that by then, head form should have lost its former emblematic connotation as ethnic identifier.

Conclusions

In closing, this work has related *long durée* head practices and their visible results to the cultural geography and geodynamics of Maya populations and their cultural belongings. The slowly shifting kaleidoscope of cephalic shapes in the Maya territories dramatically expresses the dynamics of the exodus of Classic hegemonial control and language changes over the centuries. Techniques that turned anachronic were abandoned for good, while the imposition of new social vectors were echoed by a growing uniformity in head looks. This trend continues also when centuries later, the hegemonies centered in Chichen Itza see their replacement and dispersion. By then, the former emblematic notion of head shapes, per se, should have vanished altogether out of the collective identity or was replaced with vague visible connotations of being Mesoamerican, a condition that is indeed evident in most of Mesoamerica on the eve of conquest.

From all of the above, it is clear that the culturally reproduced cephalic shapes of the ancient Maya mark *long durée* processes that all but random. As we have seen, they express deeper historic and cultural conditions, ingrained with ideological identifications, spoken language and group identity, explored in this study here for Maya contexts of the Terminal Classic and Postclassic periods. I hope this new look on the ancient Maya, their mobility and sociocultural dynamics, not through the artifactual record but directly through what the Maya themselves communicate through their bodies, may inspire new research along this line.

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