Chapter 6
Odontometric Investigation of the Origin of Freestanding Shrine Ossuaries at Mayapan

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Abstract Mayapan was the largest and most densely populated city in the Maya area during the Late Postclassic period (ca. AD 1200–1450), but was it truly cosmopolitan? This question was investigated through biodistance and population genetic analyses of heritable dental metric traits, the first such study conducted at this site. The analyses concentrated on burials excavated from a diverse array of contexts, such as mass graves, residences, and plaza floors, with a particular focus on freestanding shrine ossuaries. The results of both univariate and multivariate analyses suggest individuals interred in freestanding shrine ossuaries are genetically distinct from contemporary and earlier populations from northwestern Yucatan, suggesting this new burial practice was introduced by foreigners. These findings also have implications for the larger question of whether pan-Mesoamerican elite identity formation in the Postclassic period (AD 900–1543) was accompanied by more intense long-distance mixing of populations, rather than just the exchange of goods and ideas. Given the important role played by exchange in the regeneration of sociopolitical complexity in ancient societies from different parts of the world (Schwartz, 2006), this study also contributes to the broader discussion of how cultures survive and respond to upheaval, as well as to a more nuanced consideration of the role of migration in culture change.

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Fig. 6.1 Map of Mesoamerica indicating location of sites mentioned in the text. (Modified from Avalon Basemap, copyright 2004)

6.1 Introduction

Mayapan was the capital of the largest regional Maya confederacy in the Late Postclassic period (Fig. 6.1; ca. AD 1200–1450). This success has been attributed to several factors, including its role as a market town, ties to Caribbean and Gulf coast trade networks, serving as a Quetzalcoatl cult center, *mul tepal* or joint rule, and a diverse population. Archaeological research conducted since the 1940s corroborates the existence of a cosmopolitan elite culture, although no conclusive evidence for the presence of foreigners or foreign enclaves has been found.

Although population movements feature prominently in discussions of social, political, and economic developments during the aftermath of the Classic collapse (e.g., Adams et al. 2004; Aimers 2007; Ball and Taschek 1989; Rice 1986; Suhler et al. 2004), the corroborating evidence has been largely limited to aspects of material culture. Analyses of the remains of Mesoamericans themselves traditionally have played only a minor role in this debate, although recent years have seen the appearance of a number of important bioarchaeological studies of migration and movement using diverse methodological approaches focusing on dental morphology (Aubry 2009; Austin 1978; Beekman and Christensen 2003; Cucina and Tiesler 2004; Pompa y Padilla 1984; Scherer 2004, 2007; Wrobel 2004; Wrobel and Graham forthcoming), mitochondrial DNA (González-Oliver et al. 2001; Ibarra-Rivera et al. 2008; Merriwether et al. 1997), isotopes (Freiwald et al., Chap. 5, this volume), and cultural modifications (Tiesler 2012). Integrating the investigation of mortuary practices and biological relationships can be particularly powerful in this

vein, as demonstrated by the emerging bioarchaeology of identity (Knudson and Stojanowski 2009). These studies harness social meanings encoded in treatments of the human body and examine how these are mediated by biological relationships.

Applying this approach to Mayapan's freestanding shrine ossuaries has considerable potential for the study of the formation of cosmopolitan elite identity at the site. This unusual mortuary practice appeared for the first time in the Late Postclassic period and, in the Maya area, was the most common at Mayapan. This study uses biodistance and population genetic analyses of heritable dental metric traits to test the hypothesis that freestanding shrine ossuaries were produced by foreigners—specifically, individuals that are morphologically distinct from others at the site. We begin with a review of the ethnohistoric and archaeological evidence for cosmopolitanism at Mayapan, and then consider the particular case of freestanding shrine ossuaries in detail. The univariate and multivariate methods employed are subsequently detailed, followed by a presentation of the results. Last, we expound upon the implications of these findings, while also highlighting the limitations of this study.

6.2 Cosmopolitanism at Mayapan

In Postclassic period Mesoamerica, interregional interaction, in the form of religious and/or sociopolitical networks and trade, intensified, resulting in the emergence of a pan-regional elite identity (Kepecs et al. 1994; Ringle et al. 1998; Sabloff and Rathje 1975). This may have been facilitated, in part, by greater reliance on efficient maritime transportation. Mayapan played an important role in this intensification of interregional interaction in the Late Postclassic, as exemplified by the appearance of a cosmopolitan elite material culture and colonial documents that specifically describe long-distance interactions by Mayapan's elites. Roys (1965) proposed that the northern Yucatan Peninsula during the Late Postclassic was divided into territorial provinces, the leaders of which resided at Mayapan and participated in *mul tepal*, or "joint rule." More recent interpretations, however, suggest these leaders ruled over towns in northwest Yucatan, and that they formed a ranked confederacy or served as powerful vassals in the city's court under the most powerful families, the Cocom and Xiu (Masson et al. 2010; Ringle and Bey 2001). A Cocom son is said to have mounted a trade expedition for cacao to the Ulua Valley of Honduras in the K'atun 8 Ahau (A.D. 1441–1461; Roys 1962). Individuals with Nahuatl names resided at Mayapan, including Cinteotl Chan, Tzontecome, Tlaxcallan Pantemitl, Xichihuehuetl, Itzcóatl, and Cacalacatl (Masson and Peraza Lope 2010; Tozzer 1941). An even clearer reference to foreigners, however, pertains to the Canul, mercenaries from Tabasco who were invited into the city by the Cocom in K'atun 1 Ahau (A.D. 1382–1401; Tozzer 1941; Masson and Peraza Lope 2010).

Mayapan's archaeological record shows influences of central and western Mexico, Oaxaca, and the Gulf Coast, as well as ties to various parts of the Maya area, including highland and Peten Guatemala, and the Yucatan Peninsula's west and east

coasts. Aside from architectural parallels between Mayapan's Temple of Kukulkan (Q-162) and Round Temple (Q-152), and Chichen Itza's Castillo and Caracol, respectively, these sites also share burial shaft temples, Venus platforms, colonnaded halls, shrines, and sacbes (Masson et al. 2006; Proskouriakoff 1962a). Some of these features are also seen at sites on the east coast of the Yucatan Peninsula. Similar colonnaded halls can be found at Tulum, Cozumel, El Rey, and El Meco; the latter also has the only example of a serpent balustrade outside Mayapan and Chichen Itza (Delgado Kú 2004; Milbrath and Peraza Lope 2003). Similarities have been documented as well in the Peten Lakes region of Guatemala. The site of ZacPeten, in particular, has dual hall temple assemblages similar to those near cenotes Chen Mul and Itzmal Chen at Mayapan (Pugh 2003).

Some aspects of elite residences are shared with those in central Mexico, such as quadrangular patios, various small rooms, and frontal galleries with adjoining courtyards, but are known from earlier Maya sites as well (Masson and Peraza Lope 2010). Domestic architecture shows additional parallels with central Mexico, including single- or double-wall foundations, cobble patio surfaces, clearing of bedrock surfaces, unroofed platforms, and platform houses (Masson and Peraza Lope 2010). House forms previously unknown at the site but common along the coasts stretching from the Caribbean to the Gulf as far north as Veracruz have recently been identified. These include large, square houses and rectangular multiroom alignments lacking benches and massive platforms (Masson and Peraza Lope 2010, p. 82). Of these, massive platform P-114 is the only example with rare pottery, in this case Palmul Incised, which is associated with Caribbean coast sites (Masson and Peraza Lope 2010). Imported ceramics recovered at the site also include Matillas Fine Orange Gulf Coast pottery, which is present in 60% ($N=152$) of house-lot contexts investigated by the Proyecto Económico de Mayapan (Masson and Peraza Lope 2010). The generally low quantities in which it is found, however, suggest some of it was obtained by commoners at the site's marketplace.

Effigy censers inspired by Mayapan's Chen-Mul-Modeled censers are common throughout much of the Maya area in the Late Postclassic period, including sites in northern Belize, such as Lamanai, on the east coast of Yucatan, in the Peten Lakes region of Guatemala, and on the Campeche coast at Champoton (Milbrath et al 2008, p. 110). Central Mexican deities, such as Tlazolteotl and Xipe Totec, seem to be relatively well-represented in censers from Mayapan compared to other Maya sites, although this only amounts to 3.8% of the collection (Masson and Peraza Lope 2010).

Most obsidian at Mayapan (98%) was obtained from highland Guatemalan sources (Ixtepeque, El Chayal, and San Martin Jilotepeque), although a small amount was also imported from Pico de Orizaba, Veracruz and Pachuca, Hidalgo (Escamilla Ojeda 2004). Projectile points and knives are similar throughout much of Postclassic Mesoamerica, although Mayapan's pointed bifacial knives come closer to central Mexican forms than do the knives of the Caribbean coast (Masson and Peraza Lope 2010, p. 97).

Central Mexican inspiration is suggested by several murals and sculptures. The atlantid columns of colonnaded hall Q-163, which is attached to the Temple of Kukulkan, bore life-size-modeled stucco figures depicting a variety of human fig-

ures and deities, including Xipe Totec and a possible representation of Xochipilli (Milbrath and Peraza Lope 2003, p. 26). A tenoned limestone head of Ehecatl was also found in association with this structure. The other large colonnaded hall attached to the Temple of Kukulkan, Q-161 or the Palace of the Solar Symbols, has murals executed in a style similar to that seen in Phase II murals of the Templo Mayor and other early Aztec art (Milbrath and Peraza Lope 2003, p. 29). Carnegie archaeologists uncovered an earth monster sculpture (H-18a) resembling Tlaltecuhtli in the outlying civic-ceremonial center associated with Cenote Itzmal Chen in the site's northeast corner (Taube 1992). More recently, INAH archaeologists excavated a stone sculpture resembling a central Mexican death god, possibly Cihuateteo or Mictlantecuhtli, in Structure Q-95, or the Temple of the Fisherman (Masson and Peraza Lope 2010; Milbrath and Peraza Lope 2003). In addition, polychrome murals from the Temple of the Fisherman may depict Quetzalcoatl, although the style of execution ties it, as well as the murals of the Temple of the Niches (Q-80), to the Postclassic Mixteca-Puebla style (Milbrath and Peraza Lope 2003).

Extensive excavations at Mayapan have identified myriad treatments of the dead (Ruz Lhuiller 1968; Serafin 2010; Serafin and Peraza Lope 2007), which, assuming mortuary practices served as markers of group identity, match expectations for a culturally diverse population. Contexts in which burials have been found include mass graves, temples, plaza floors, chultuns, cenotes, and residences. Many deposits are of a secondary nature. Primary burials are also present, usually tightly flexed on the right or left side, but ventral flexed, dorsal extended, and ventral extended have been encountered as well. Burning of select elements, especially crania, in otherwise unburned deposits was practiced, although actual cremation burials, common in central Mexico, have only been excavated in three contexts; these are X'Coton group oratory T-72 and elite residences Q-165 and Q-172 (Masson and Peraza Lope 2010). Furthermore, the latter two residential groups also utilized other burial practices.

As demonstrated by the preceding review, foreign styles are common among the elites at Mayapan but have dispersed distributions, pointing away from the existence of foreign enclaves and suggesting instead that elites emulated foreign styles. Whether population movements contributed to this diverse material culture has yet to be investigated, however, using the physical remains of the city's ancient inhabitants. Freestanding shrine ossuaries provide an ideal opportunity to do so and are considered in greater detail in the following section.

6.3 Freestanding Shrine Ossuaries

Ossuaries can be defined as reverential funerary treatment involving the collective, secondary deposit of skeletal material that is mostly, but not necessarily completely, disarticulated (Rost 1997). Although Ubelaker (1974, p. 8) specifies that this represents individuals initially stored elsewhere, we define this category more broadly to also include remains that received secondary treatment in their original place of

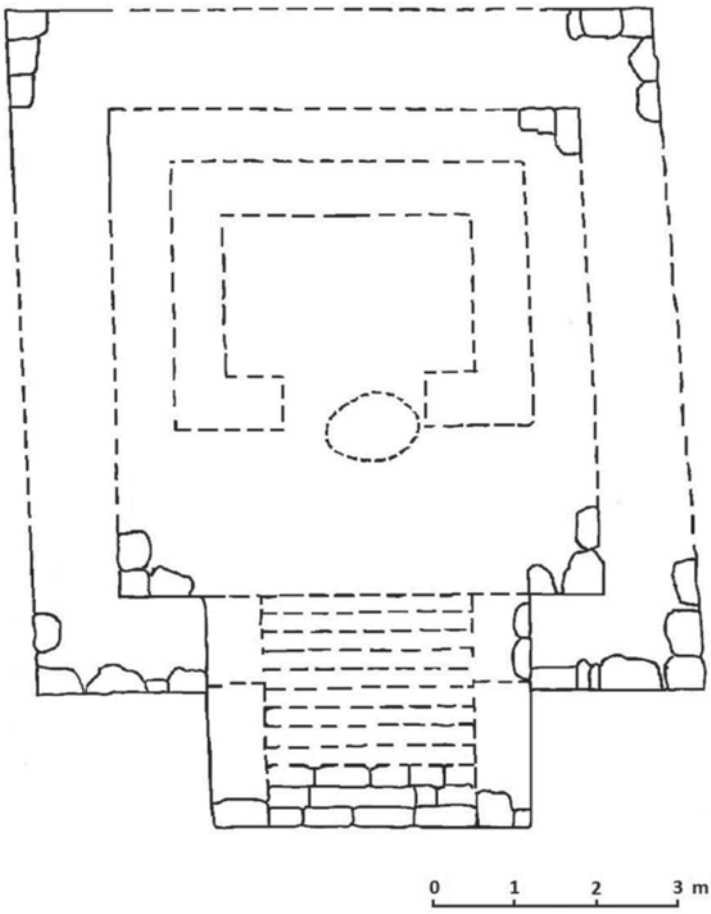

Fig. 6.2 Plan of raised shrine Q-90. (Modified from Adams 1953, Fig. 9.2b)

interment, as would be suggested by prevalence of small bones usually underrepresented in burials that have been transported.

Ossuaries have been encountered in a variety of structures at Mayapan, including residences Q-94 and Y-43b (Peraza Lope et al. 2003), palace R-106 (Peraza Lope et al. 1998), oratory Y-8b (Smith and Ruppert 1956), and raised shrines in the monumental center, although the latter seem to have been expressly built for the purpose of housing this type of deposit (Adams 1953; Delgado Kú 2004). Proskouriakoff (1962a, p. 90) defined shrines as "small cell-like enclosures usually containing an altar or a statue," while raised shrines are those "which stand on independent substructures." Raised shrine substructures are platforms of one or two terraces that are square to subrectangular in outline, vary from 4.5 to 7.5 m on each side and 1.5 to 2.5 m in height, and have a balustraded staircase on one side (Fig. 6.2; Adams 1953; Delgado Kú 2004; Peraza Lope et al. 2005; Proskouriakoff 1962a). The shrines

Fig. 6.3 Eastern view of raised shrine Q-149

themselves occupy the posterior portion of the platform on which they stand, are rectangular, vary from 1 to 2 m in width by 1.5 to 4.75 m in length, and have walls up to a meter high. In general, shrine roofs were probably thatch, although that of Q-149 appears to have been beam-and-mortar (Fig. 6.3; Adams 1953, p. 92; Peraza Lope et al. 2005).

Ossuaries were housed within raised shrine platforms in round or oval, stone-lined cists between 45 and 90 cm wide at the opening, cylindrical or slightly bottle-shaped in cross-section, and from 1.25 to 2 m deep (Fig. 6.4; Adams 1953, p. 92; Delgado Kú 2004). The location of the cist within the platform varies; they have been found near, or in front of, the opening of the shrine room, as well as near the front and rear corners. Two cists were found in Q-89 but other raised shrines contained only one.

In each cist, the skeletal assemblage includes four to nine individuals. Adults of both sexes predominate but subadults are also present. The bones generally bear no trace of anatomical relationship, although the axial skeleton of one out of eight individuals represented in Q-149 was partially articulated. The seven skeletons interred in raised shrine Q-69 were also partially articulated, although this might be explained by the permanent sealing of the cist upon construction of the shrine which would have prevented further manipulation (Adams 1953).

Burial furniture recovered in raised shrine ossuaries is generally sparse or lacking entirely. The exception is Q-71 which had two small effigy censer cups (one of a frog), a fragment of a sculpted greenstone cat, two jade beads, five shell beads, nine fragments of unworked shell, three chert points, three obsidian blade fragments, a rubbing stone, and four bone needles (Adams 1953, p. 105). By contrast, the facades of the raised shrines commonly incorporated stone sculptures. These include three standing human figures, one of which holds a vessel possibly containing maize or copal, in Q-69; a sculpted feline head and foot in Q-71; nine tenoned skulls in Q-89; one unidentified sculpture in Q-90; two figures possibly holding offerings in Q-98; and several anthropomorphic figures, including a tenoned head of Ek Chuah, in Q-149 (Adams 1953; Delgado Kú 2004; Masson and Peraza Lope 2007; Peraza Lope et al. 2005; Proskouriakoff 1962a). Censer sherds are sometimes found within

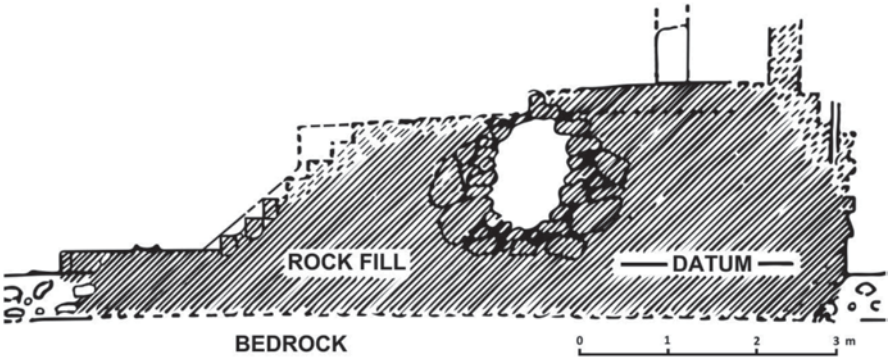

Fig. 6.4 Section of raised shrine Q-71. (Modified from Adams 1953, Fig. 9.3)

these structures and are common in the surface refuse around them, attesting to their ceremonial nature (Adams 1953, p. 93). This, together with their frequent position overlying one or more plaza floors, also suggests they were introduced relatively late in Mayapan's occupation (Adams 1953, p. 97; Proskouriakoff 1962a, p. 130).

Raised shrines often face into colonnaded halls, in which case they form part of a Basic Ceremonial Group (BCG; Proskouriakoff 1962a). It has been suggested that each colonnaded hall was associated with a major family or province under the control of Mayapan's confederacy, as the number of halls approximates the number of provinces in contact-period Yucatan (Proskouriakoff 1962a). Thus, it may also be possible that each raised shrine was associated with a different province. Raised shrines could also form part of a Serpent Temple Group (STG), when facing into a serpent column temple (Proskouriakoff 1962a). Ossuaries have been found within five raised shrines in BCGs (Q-69, Q-71, Q-89, Q-90, Q-98) as well as one raised shrine in an STG (Q-149; Fig. 6.5; Adams 1953; Peraza Lope et al. 2003, 2005). An ossuary was also found within Structure H-13, which appears to have been a raised shrine, in the outlying ceremonial Itzmal Chen group (Chowning 1955; Proskouriakoff 1962a, p. 128). BCGs and STGs may have been associated with different ethnic groups (Ringle and Bey 2001). In particular, Ringle and Bey (2001, p. 286) associate STGs with groups from eastern Yucatan and the Hall of the Chac Masks (Q-151) BCG, which includes raised shrine Q-148, with the Xiu faction, and, by extension, all BCGs with groups from western Yucatan. Q-148 stands out from all other raised shrines in BCGs or STGs, however, in lacking an ossuary (Peraza et al. 2005). Furthermore, as shrines were late additions, the nature of their association with nearby structures is unclear.

An ossuary was also found within annexed shrine Q-88c (Peraza Lope et al. 1999). Although Q-88c abuts two neighboring structures and sits directly on the plaza floor, it is similar to the raised shrines discussed above in being a largely freestanding structure with a small enclosed space located in a public ceremonial context.

Structures similar to raised shrines located in the site's residential zone have been referred to as altar shrines (Smith and Ruppert 1956) or, alternatively, as group

Fig. 6.5 Map of Mayapan's monumental center indicating location of shrines mentioned in the text. *1* Q-71, *2* Q-88c, *3* Q-89, *4* Q-90, *5* Q-98, *6* Q-149. (Modified from Proskouriakoff 1962c, map inset)

shrines (Smith 1962, p. 222). Group shrines tend to have smaller platforms than raised shrines, and their surfaces are largely filled up by the shrine itself. Two group shrines had beam-and-mortar roofs and one had a corbelled roof, but, as with raised shrines, most probably had thatch roofs (Smith 1962, p. 222). Out of the approximately 40 group shrines identified by Carnegie archaeologists, in only one, Structure K-52c, has a burial been reported, in this case a single adult inside a burial vault (Smith 1962). Despite these differences, the distinction between raised shrines, group shrines, and annexed shrines such as Q-88c is largely subjective, echoing the observation by Andrews and Andrews (1975, p. 56) that it is "difficult to draw a distinction between a shrine and a temple on the east coast, and in the literature both terms have often been used for similar kinds of structures." Hanson (2008) addresses this issue by using the general term "shrine" for all such structures; here we use the term "freestanding shrine" to distinguish these structures from the cell-like

enclosures commonly found within residences, oratories, and other structures at Mayapan that also often contained burials.

Interpretation of ossuaries in freestanding shrines is not straight-forward. Even among Carnegie archaeologists there was disagreement. Proskouriakoff (1962a, b) considered raised shrines to be sacrificial based on certain similarities to the burial shafts in Temples Q-58, Q-95, and T-72: The ceremonial nature of the contexts, the round, confined spaces involved, and the paucity of grave goods. Adams (1953), on the other hand, seemed to favor an interpretation of elite funerary behavior. Although Thompson and Thompson (1955) based their argument for ancestor worship on multiple burials in oratories, a similar argument can be made for freestanding shrine ossuaries. Oratory burials and freestanding shrine ossuaries are associated with high proportions of Chen-Mul-Modeled effigy censer sherds and, hence, likely served similar ritual functions. They contained the bones of both sexes and of mainly adult age, thus matching the expected demographic profile for individuals who had attained ancestor status. Furthermore, analysis of skeletal remains from freestanding shrines did not find direct evidence of violence, supporting the interpretation that these deposits represent funerary behavior (Serafin and Peraza Lope 2007). What distinguishes freestanding shrine ossuaries from oratory burials, other than greater evidence for secondary manipulation, is their concentration in the site's monumental center in structures whose main function was funerary. This suggests they resulted from worship of communal or lineage ancestors, who were presumably members of the city's most powerful social groups. Such worship may have involved giving offerings and making petitions, perhaps in agricultural fertility rites (Lorenzen 2003, 2005), although the diversity of associated stone idols suggests more varied rituals took place.

Ossuaries have been found in various regions and time periods in the Maya area, such as cave sites in Moxviquil, Huxjal, Lago Lacandon and San Felipe in Chiapas, Oxkutzkab in the Puuc, and Copan and Talgua in Honduras, the last of which dates the practice back to the Early Preclassic (Blom 1954; Brady et al. 1995; Ruz Lhuillier 1968). Wrobel and colleagues' contribution (Chap. 4) in this volume also discusses recently discovered ossuaries at various caves in central Belize. Ossuaries within structures became common in the Late Postclassic period, particularly at Mayapan and east coast sites, as seen, for example, at Cozumel (Rathje and Phillips 1975) and Tulum (Vargas and Santillán 1990). Shrines are common at contemporaneous sites throughout the Maya area, but again they are the most numerous in northern Yucatan and the east coast (Andrews and Andrews 1975; Delgado Kú 2004, p. 157; Hanson 2008; Pugh 2001). The number and diversity of shrines at east coast sites in particular suggests this is where this type of architecture originated (Hanson 2008). Only one freestanding east coast shrine, however, has been found thus far to contain an ossuary: Structure C-II at Playa del Carmen (Marquéz Morfín et al. 1982). Thus, based on present data for the Maya area, freestanding shrine ossuaries were the most common by far at Mayapan.

Freestanding shrines are common throughout Mesoamerica during the Late Postclassic period but those containing ossuaries are rare, with the exception of central Veracruz where they are typical of Late Postclassic sites associated with the To-

Fig. 6.6 Quiahuiztlan tumba replica in Museo Nacional de Antropología, Mexico

tonac (Izquierdo 1986). Among the numerous sites in central Veracruz where these features have been found are Tacahuite, El Bernalillo, San Isidro, Boca Andrea, Rancho del Niño, Cerro Tres Picos, Arroyo Mariano, Cerro Mariano, Cerro Cercado, Morro, Oceloapan, and Cempoala, although they are the most common at Quiahuiztlan, where 77, referred to as "tumbas con mausoleos," "tumbas miniaturas" or simply "tumbas," have been identified (Izquierdo 1986). As at Mayapan, they are located in Quiahuiztlan's civic-ceremonial center. Their arrangement differs, however, in that they do not face into other structures but instead are clustered into several "cemeteries." The tumbas generally consist of a low platform of one to three terraces with a balustraded staircase on one side and a superstructure with a beam-and-mortar roof (Fig. 6.6). In some cases, the platforms were decorated with stucco sculptures of frogs, felines, or lizards (Izquierdo 1986). Secondary deposits of human remains were placed in rectangular or oval cists located within the platforms. Burial furniture generally consisted of pottery but could also include artifacts of jadeite, obsidian, coral, copper, gold, and other materials (Medellin Zeñil 1951, in Izquierdo 1986). The smaller and more numerous tumbas measure approximately 1.5 m in length, 1 m in width, and 1.5 m in total height, although the most imposing examples, Tumba 1 and Tumba 2, are similar in size to Mayapan's raised shrines but only retain the foundations of a superstructure (Arellanos Melgarejo 1997). The ubiquity of this mortuary practice in central Veracruz suggests that this is where it originated, although radiocarbon dates to confirm this are lacking. It is also possible that future archaeological work will demonstrate it to have been more widely practiced in Mesoamerica than the evidence presently suggests.

The foregoing discussion suggests that freestanding shrine ossuaries can be added to the list of cosmopolitan features in Mayapan's material culture and strengthens the evidence for interaction with the east and Gulf coasts in particular. We do

not yet know, however, if this was due to innovation or emulation by elites local to northwestern Yucatan, or whether it was introduced by foreigners who had immigrated and attained positions of prominence in the city. In the case of the latter, archaeological evidence suggests this mortuary practice could have been brought in from the east or Gulf coasts by Maya or non-Maya. Another possibility is that each freestanding shrine ossuary was associated with a different province or town under the control of Mayapan's confederacy, and that the remains pertain to provincial leaders or their ancestors. It has been suggested that each colonnaded hall represented a different province under the control of Mayapan's confederacy, as the number of halls approximates the number of provinces (Proskouriakoff 1962a), and shrines often face into halls. The fact that shrines seem to postdate the halls they face (Adams 1953 p. 92), however, casts doubt on this possibility. Fortunately, the human remains that form intimate components of these contexts also provide the opportunity to obtain more direct evidence on the origins of this particular aspect of Mayapan's cosmopolitan elite culture. In the case of introduction by foreign, non-Maya immigrants, we would expect individuals interred in freestanding shrine ossuaries to exhibit numerous significant differences in mean tooth size and large biodistances with contemporary as well as earlier populations from the region. In addition, this group should exhibit the greatest extralocal gene flow. On the other hand, if freestanding shrine ossuaries were introduced by nonlocal Maya, we may not necessarily find significant differences; earlier work suggests extensive gene flow among the ancient Maya, which would have served as a homogenizing force that diminished or prevented regional genetic differences from developing (Scherer 2007). The specific materials and methods used to test these hypotheses are discussed below.

6.3.1 Materials

In order to investigate the research question posed above, the Mayapan burial sample was divided into the following subgroups: Shrine Ossuary, Elite Other, Commoner, and Nonfunerary. In addition, a Classic period sample from the northwestern part of the Yucatan Peninsula was included. The contexts making up these subgroups are described below. The sample sizes noted in this section refer to the total MNI for each subgroup. As most individuals were missing at least some teeth, the number of teeth available for each measurement was considerably smaller than this figure. As a result, subgroup sample sizes are provided separately for each statistical analysis.

The Shrine Ossuary subgroup is made up of seven deposits representing the remains of at least 27 individuals. Most are adults, although adolescents are present in three (Q-71, Q-88c, Q-149) and a child with an age-at-death of approximately 6 years is present in one (Q-88c). Six deposits were found in round cists in raised shrines (Q-71, Q-89, Q-90, Q-98, and Q-149), which are located in plaza interiors (Delgado Kú 2004; Peraza Lope et al. 2005). Burial 33 in Shrine Q-98 consists partly of cremated remains. One cranium from the burial cist in Shrine Q-71 excavated by Carnegie archaeologists was available for study. Adams (1953, p. 96) implies

this cist was reentered multiple times but is not specific on the extent to which the remains were articulated. From the burial cist in Shrine Q-90 INAH archaeologists recovered the skeletal remains of Burial 38 (Peraza Lope et al. 2003), representing at least four individuals, one of which is an adolescent. This feature was also excavated earlier by Adams (1953), who reports recovering the remains of three adults and two adolescents. In some cases, Carnegie archaeologists may have reinterred burials where they had been excavated. This may be the case with INAH's Burial 38. Burial 26 was recovered in annexed Shrine Q-88c (Delgado Kú 2004). It consists almost solely of crania ($N=9$) and maxillary teeth, although the presence of four mandibular teeth and a fragmentary humerus, tibia and pelvis suggests that additional parts of the skeleton may have originally been present (Serafin and Peraza Lope 2007). Taphonomic analysis detected cut marks in a subadult temporal bone (ibid.). However, INAH archaeologists interpreted a Mama Red cajete tripod and a grindstone as burial furniture (Peraza Lope et al. 1998). A funerary interpretation of this deposit may be further aided by Friar Diego de Landa's account of the funerary treatment reserved for deceased Cocom lords in which they were decapitated and the back of the head was removed. Although the subadult temporal bone clearly did not belong to a lord, the fine slicing marks on the posterior mastoid process suggest careful removal of the head from a corpse rather than violent decapitation of a living victim (Serafin and Peraza Lope 2007; Tozzer 1941).

The Elite Other subgroup consists of all elite burials other than freestanding shrine ossuaries. This subgroup is made up of 18 deposits representing the remains of at least 44 individuals. Ten of these deposits, representing the remains of at least 30 individuals, were encountered in round or rectangular stone-lined cists in residences outside of the monumental center. Six are multiple, and five of these exhibit postmortem disturbance due to burial reentry and/or protracted funerary rituals. The other multiple burial, from Palace R-106, is an ossuary (Peraza Lope et al. 1998). These burials exhibit the richest and most plentiful grave goods. Also included in this subgroup were eight deposits of human remains representing 14 individuals associated with colonnaded halls in the monumental center; these were generally located off-mound under plaza floors nearby. Six of these are single primary or possibly bundle interments, whereas the two multiple interments exhibit signs of postmortem disturbance from burial reentry.

The Commoner subgroup consists of 27 deposits representing the remains of 39 individuals, all of which were excavated in or near residential structures. Fourteen deposits were excavated in the monumental center near small Structures Q-92, Q-93, Q-94, Q-67, and Q-68, and are single burials. Nearly all are primary, although a small number seem to have been disturbed when additional burials were added. Q-94 also contained an ossuary (Burial 36). The 12 deposits associated with residential structures in outlying areas (K-67a, L-28, R-112, R-199, Y-44, and Milpas 1a, 7, and 11) represent the remains of 19 individuals (Brown 1999; Masson and Serafin 2008; Peraza et al. 1998). Most burials encountered near small residential structures, whether in the monumental center or in outlying areas, were single, primary, and lateral flexed. Two additional lateral flexed burials associated with outlying Structures Y-54 and Y-56 were excavated by Brown (1999) but were not

available for study. Burial 12 from Structure Y-44 consists of partly articulated skeletons that appear to have been primary originally but were later disturbed when additional individuals were interred (Peraza Lope et al. 1998). One of these additional individuals is represented by an adult female skull burned completely black. An additional case of a reentered multiple interment with a burned adult skull was encountered in outlying Structure S-133b (Smith and Ruppert 1956), although the latter was not available for study. As can be seen above, both low and high status burials are within the monumental center as well as outside it. This concurs with Chase's (1992) demonstration of a lack of fit between the concentric model of site organization implied by Landa (Tozzer 1941) and the spatial distribution of large residences and masonry burial vaults identified by archaeologists of the Carnegie Institution of Washington.

The Extrafunerary subgroup consists of 13 deposits representing the remains of at least 69 individuals suspected by the excavators to be victims of violence. This diverse group is composed of deposits from public, ritual contexts associated with Structures Q-79a and Q-162, or the Temple of Kukulkan, as well as the site's second largest concentration of civic and ceremonial architecture near Cenote Itzmal Chen in the site's northeastern corner. The Extrafunerary group includes fully articulated skeletons as well as isolated skulls. What these anomalous burials have in common is that all evidence of perimortem violence and nearly all evidence of postmortem tool marks documented at the site were found in these remains (Serafin 2010; Serafin and Peraza Lope 2007).

A Classic period sample from the northwestern part of the Yucatan Peninsula representing the remains of 18 individuals was also included. Half of the remains in this sample were excavated in an elite residential sector of Oxkintok, while the remainder comes from commoner residential contexts at several small sites in the vicinity of present-day Mérida.

Before describing the methods employed, it is necessary to describe the limitations of this study. No samples from outside northwestern Yucatan are included. As a result, individuals from other parts of the Maya area and non-Maya cannot be distinguished. In addition, no single shrine has produced a burial large enough to be treated separately in statistical analysis, although each may have represented a distinct social group. Despite these shortcomings, determining whether individuals interred in freestanding shrine ossuaries were relative newcomers to northwestern Yucatan represents a significant advancement in our understanding of these enigmatic deposits.

6.4 Methods

Metric dental traits have a high heritable component and can be used to investigate biological relationships at the global, regional, local (intrasite), and familial levels (Adachi et al. 2003; Dempsey and Townsend 2001). Recently, odontometric studies of identity, ethnicity, and ethnogenesis have also appeared (Klaus and Tam 2009;

Nystrom 2009; Stojanowski 2001, 2004, 2005, 2009, 2010). Teeth are particularly useful in the Maya area because they are often preserved, despite the generally poor skeletal preservation. Crania are often in fragmentary condition and/or artificially modified (Tiesler 1998), as is the case at Mayapan. Few ancient DNA analyses have met with success given the generally poor state of preservation (González-Oliver et al. 2001; Merriwether et al. 1997). Odontometric analysis has its own limitations, such as inter- and intraobserver error, preservation, dental pathologies (i.e., caries, attrition, and antemortem tooth loss), and cultural modifications. At present, however, teeth are the best source of data on biological relationships among ancient Maya populations. Isotope analyses complement these studies by identifying migration at the level of the individual. Migration can play an important role in shaping an individual's identity but it is also tied to larger social processes (White et al 2009), some of which are amenable to odontometric investigation. Furthermore, isotope analyses cannot identify descendants of immigrants, whereas odontometric analyses can. Despite this potential, dental metric analyses of biological relationships among the Maya were nonexistent until very recently (Cucina and Tiesler 2004; Jacobi 2000; Rhoads 2002; Scherer 2004, 2007; Scherer and Wright 2010; Wrobel 2004; Wrobel and Graham, forthcoming).

This chapter presents results of the first analysis of metric traits from the human dental remains of Mayapan. T-tests, Mahalanobis's generalized distance (D^2), and Relethford and Blangero's (1990) approach to R matrix analysis were utilized to test the hypothesis that the mortuary practice of shrine ossuaries was introduced by individuals who had immigrated into the region. Expectations were to find significant differences in the means, as well as significant Mahalanobis distances, between the Shrine Ossuary and other subgroups. In addition, R-matrix analysis was expected to reveal higher extralocal gene flow for the Shrine Ossuary subgroup.

Tooth diameters were measured with Paleo-Tech™ Hillson-FitzGerald dental calipers for all permanent and deciduous teeth, although only permanent teeth are discussed here. Mesiodistal crown diameters were measured with the caliper's sharpened tips to fit between teeth still in the jaw (Hillson et al. 2005). For buccolingual crown diameters the caliper's beam was held parallel to the occlusal surface of the tooth while the broad flat caliper arms were applied to the crown's buccal and lingual sides (Hillson 1996). Mesiodistal and buccolingual diameters were measured on all 32 permanent teeth, resulting in a total of 64 measurements. Small sample sizes did not permit the analysis of tooth areas, which is calculated for each tooth by multiplying the mesiodistal and buccolingual diameter.

It was first necessary to test for errors and other confounding factors before analysis of the metric data could be performed. A subset of measurements was taken on two separate occasions to facilitate testing for intraobserver error. T-tests were performed to identify measurements that differed significantly between the two sessions. The average intraobserver error for all measurements combined was 0.00613 mm (SD = 0.34004), which is comparable to that found by other workers (e.g., Scherer 2004; Stojanowski 2001). The mesiodistal diameter of the maxillary first molar exhibited statistically significant intraobserver error and was excluded from further analysis.

Table 6.1 Tooth diameters excluded from analysis and reason for doing so

Diameter	Intraobserver error	Sex	Nonnormal	Age
I^2 b-l			x	
P^2 m-d				x
M^1 m-d	x			
I_2 m-d		x		
I_2 b-l		x		
C_1 b-l		x		
P_2 m-d		x		
P_2 b-l			x	
M_1 m-d			x	

To maximize sample size, measurements for the left and right sides were used. When available, the left side was used, and in cases in which only the right tooth was available, its measurement was used instead. This method assumes that side asymmetry is random. In addition, sexes were pooled for all samples. Four measurements exhibiting statistically significant sex differences were identified using the t-test and excluded from further analysis: mesiodistal and buccolingual diameters of the mandibular lateral incisor, buccolingual diameter of the mandibular canine, and mesiodistal diameter of the mandibular second premolar. The statistics employed here require data exhibiting normal distributions. To identify measurements whose data were not normally distributed, the Kolmogorov-Smirnoff Test was used with Lillifors Significance Correction. Three measurements exhibited nonnormal distributions and were eliminated: buccolingual diameter of the maxillary second incisor, buccolingual diameter of the mandibular second premolar, and mesiodistal diameter of the mandibular first molar.

Measurements that were significantly correlated with age were also eliminated. During data collection, every effort was made not to take measurements that might have been affected by tooth wear, which would be negatively correlated with age. In addition, studies have shown that, in some populations, individuals who died as subadults have smaller teeth (Guagliardo 1982; Simpson et al. 1990). If nutritional status had significantly affected tooth dimensions in the sample under study here, a positive correlation with age would be expected. Pearson's correlation coefficient was used to test for significant correlations between age, scored as subadult or adult, and each of the remaining 56 tooth diameters. The one measurement found to be significantly correlated with age, mesiodistal diameter of the upper second premolar, is negatively correlated indicating that it may be affected by wear. Table 6.1 lists the nine tooth diameters that were excluded from further analysis and the reason for doing so.

The multivariate analyses used in this study require complete datasets. However, in fragmentary and secondary remains, such as those in this study, almost every individual had missing data. As a result, these missing values had to be estimated using the multiple imputation technique following the methodology of Scherer (2007). First, individuals missing most measurements were eliminated from use in the multivariate analyses. Second, the measurements with the smallest sample

sizes were eliminated. This resulted in a dataset in which no individuals were missing more than one third of their data. Third, using this revised dataset, the program NORM was used to create formulae that would estimate missing measurements for each individual based on the measurements that were present (Schafer 1999).

In addition, to minimize size differences due to sexual dimorphism and allometric effects, Q-mode correction of the data was carried out as suggested by Corruccini (1973). This maximizes shape differences and produces more biologically meaningful results. For each skeleton, an individual size reference variable was obtained by calculating the geometric mean of all the dental measurements for that individual. Each measurement was then divided by this reference variable.

6.5 Results

Once the data had been prepared as described above, univariate (t-tests) and multivariate (D^2 and R matrix analysis) statistical analyses could begin. The presence of significant differences between subgroup means were tested for using t-tests. T-tests were conducted for all 55 remaining measurements and for all pairings of subgroups using the entire dataset, allowing for the largest possible sample sizes. As expected, comparisons involving the Shrine Ossuary subgroup exhibited the greatest number of significant differences in measurement means (Table 6.2). By contrast, none of the other comparisons produced more than two significant differences in subgroup means. The sample that revealed the greatest number of significant differences with the Shrine Ossuary subgroup was the Classic subgroup, which differed significantly for seven measurement means.

For multivariate statistics, a complete Q-mode transformed dataset (i.e., with no missing values and size differences minimized) was used consisting of six maxillary tooth diameters measured in 50 individuals. The means and standard deviations of these measurements are provided in Table 6.3. Dividing these 50 individuals among the Shrine Ossuary, Elite Other, Commoner, Extrafunerary, and Classic subgroups produces sample sizes of 9, 14, 9, 8 and 10, respectively. It must be noted that these samples, due to their small size, may not be representative of the archaeologically defined subgroups from which they come. As a result, additional analyses will be needed to corroborate these findings once larger samples become available.

Mahalanobis distances were calculated on this complete, Q-mode transformed dataset between the Shrine Ossuary, Elite Other, Commoner, Extrafunerary, and Classic subgroups. Following the methodology of Defrise-Gussenhoven (1967), distances greater than $\sqrt{(2t-1)}$ are significant, where t = number of variables. Six measurements were used in the final analysis, such that D^2 values $\geq \sqrt{(11)}$, or 3.3, are significant. As demonstrated in Table 6.4, the three largest biological distances involved the Shrine Ossuary subgroup, conforming to our expectations. The only comparison reaching statistical significance, however, is that between the Shrine Ossuary and Commoner subgroups.

Table 6.2 Results of t-tests for tooth diameters that showed a significant difference with the Shrine Ossuary subgroup

Diameter	Comparison (*N*)	*t*	*df*	*p*
I^1 m-d	SO (11) × CO (20)	−2.265	29	0.031
C^1 m-d	SO (12) × CL (14)	−2.131	24	0.044
C^1 b-l	SO (12) × CO (17)	−2.838	27	0.009
C^1 b-l	SO (12) × CL (15)	−2.369	25	0.026
P^1 m-d	SO (14) × EO (16)	−2.885	28	0.007
P^1 m-d	SO (14) × CL (13)	−2.158	25	0.041
P^1 b-l	SO (13) × EO (16)	−3.482	27	0.002
P^1 b-l	SO (13) × CO (20)	−3.698	31	0.001
P^1 b-l	SO (13) × EF (14)	−2.317	25	0.029
P^1 b-l	SO (13) × CL (13)	−3.904	24	0.001
P^2 b-l	SO (8) × CO (15)	−2.196	21	0.039
M^1 b-l	SO (16) × CL (18)	−2.272	32	0.030
M^2 b-l	SO (10) × EO (14)	−2.094	22	0.048
M^2 b-l	SO (10) × CO (12)	−3.537	20	0.002
M^2 b-l	SO (10) × CL (18)	−2.330	26	0.028
C_1 m-d	SO (6) × CL (10)	−3.123	14	0.007

SO Shrine Ossuary, *EO* Elite Other, *CO* Commoner, *EF* Extrafunerary, *CL* Classic

Relethford and Blangero's (1990) approach to R matrix analysis permits the calculation of extralocal gene flow and Wright's F_{ST}, a population genetic statistic for measuring population differentiation, from phenotypic quantitative traits. It is generally applied at the regional level, although it can be instructive for intrapopulational analyses as well. R matrix analysis was performed using the RMET 5.0 computer program, kindly made available by John Relethford (Relethford et al. 1997). To carry out the analysis, a heritability estimate must be provided. Heritability refers to the relative amount of population variation in a particular trait that is due to genetic factors, with 1.0 being the highest possible value and 0.0 the lowest. A heritability estimate of 0.55 was used to enable comparison with the results of Scherer (2007) for Classic period Maya. Effective population sizes for the Shrine Ossuary, Elite Other, Extrafunerary, Commoner, and Classic Period subgroups were posited to be in the ratio of 1:1:1:10:20, respectively. This is in accord with the hypothesized origins of each. The same dataset used for the Mahanlonobis distance computations was used for R matrix analysis.

Calculation of F_{ST} using all five subgroups produced a relatively high value of 0.066. Repeating R matrix analysis after excluding Classic burials produced a higher F_{ST} value of 0.086, indicating that most of the variability at Mayapan is present in this earlier sample.

The residual values from the Relethford-Blangero analysis, which serve to assess extralocal gene flow, are presented in Table 6.5. The Shrine Ossuary subgroup exhibits the largest residual value, whereas the Commoner subgroup exhibits the smallest. This suggests extralocal gene flow is greatest for the Shrine Ossuary subgroup and lowest for the Commoner subgroup. This gene flow could have been from another region, another site within northwestern Yucatan, or from an as yet

Table 6.3 Mean and standard deviation for measurements used in multivariate analyses

Measurement	*N*	Mean	SD
P^1 mesiodistal diameter	50	7.43	0.53
P^1 buccolingual diameter	50	9.30	0.61
P^2 buccolingual diameter	50	9.20	0.44
M^1 buccolingual diameter	50	11.62	0.51
M^2 mesiodistal diameter	50	9.78	0.70
M^2 buccolingual diameter	50	11.52	0.69

Table 6.4 Mahalanobis distances between Shrine Ossuary, Elite Other, Commoner, Extrafunerary, and Classic subgroups

	Shrine Ossuary	Elite Other	Commoner	Extrafunerary
Elite Other	1.8325			
Commoner	4.2047[a]	1.6715		
Extrafunerary	2.9227	0.9178	1.2301	
Classic	2.4245	0.6750	1.6999	2.1899

[a] significant at $p < 0.05$

Table 6.5 Relethford-Blangero analysis results

Subpopulation	r_{ii}	Observed variance	Expected variance	Residual
Shrine Ossuary	0.487806	1.017	0.568	0.449
Elite Other	0.023119	0.923	1.083	−0.160
Commoner	0.035745	0.718	1.069	−0.351
Extrafunerary	0.160095	0.944	0.931	0.013
Classic	0.000000	1.269	1.108	0.160

r_{ii} distance between population i and the regional centroid

unsampled sector of Mayapan. Relethford-Blangero analysis was repeated on measurements that have not been Q-mode transformed to determine whether this procedure was masking genetic variability. This resulted in an even greater residual for the Shrine Ossuary subgroup (0.847). Although these results are intriguing, it is also possible they are unrepresentative of the subgroups from which these samples come, owing to the small sample sizes and differing excavation strategies employed.

6.6 Discussion

Assessing site-wide F_{ST} provides a valuable point of departure for interpreting our findings. An F_{ST} value for the Mayapan sample as a whole of 0.066 was calculated. This is substantially greater than values found for Classic period Maya samples from the Belize (0.019), Pasión (0.018), and Central (0.003) zones, as well as for the Classic Maya as a whole (0.018; Scherer 2007, Table 6.6). Although these find-

ings may not be directly comparable owing to differing levels of analysis, time spans, and measurements, they suggest less among-group gene flow and greater among-group genetic differentiation. These results point toward a relatively heterogeneous population at this site. The fact that excluding the Classic subgroup produced a higher F_{ST} value of 0.086, however, indicates that most of the variability at Mayapan is present in this earlier sample. This argues against wholesale population replacement between the Classic collapse and Mayapan's apogee in the Late Postclassic period.

Univariate analyses allowed the entire dataset to be used, resulting in larger, more representative samples. Comparisons involving the Shrine Ossuary subgroup exhibited the greatest number of significant differences in measurement means. In particular, the comparison between the Shrine Ossuary and Classic subgroups identified seven measurement means that differ significantly. These results suggest the Shrine Ossuary subgroup does in fact represent the remains of immigrants, or their descendants, who arrived in the region at some point after the Classic period collapse.

Mahalanobis distance analysis revealed a statistically significant distance between the Shrine Ossuary and Commoner subgroups. Applying Relethford and Blangero's (1990) approach to R matrix analysis sheds light on the meaning of this difference. The Shrine Ossuary subgroup exhibits the largest residual value, whereas the Commoner subgroup exhibits the smallest residual value. This indicates that extralocal gene flow is greatest for the former and lowest for the latter. These results suggest the new burial practice of freestanding shrine ossuaries was brought in by foreign elites, which is also supported by univariate analyses utilizing larger sample sizes. Thus, elite participation in the Postclassic Mesoamerican world system appears to have involved the actual exchange of people, not just ideas. This may have served to reinforce the power of the city's elites. Although nonelites likely also participated in the intensified interaction sphere in Postclassic Mesoamerica, as indicated for farmers at Laguna de On in northern Belize (Masson 1997), our results suggest that at Mayapan this was largely through emulation.

Interestingly, the comparison between the Elite Other and Classic subgroups produced the smallest Mahalanobis distance. A recent dental nonmetric analysis by Cucina et al. (2010) produced a parallel finding in which a subsample from Mayapan consisting mainly of burials from the Elite Other subgroup clustered with Jaina rather than with other Postclassic sites. These results suggest that elites practicing more traditional funerary rituals had a longer history in the region.

Although this study was focused on a single site, these findings have implications for reconstructions of the Classic-to-Postclassic transition. The greater scale of long-distance exchange in the Postclassic may have been accompanied by greater gene flow with more distant regions. Dental morphological analysis by Austin (1978) found evidence for biological discontinuity at Seibal during the Terminal Classic period. Wrobel's (2004) analysis of dental metric and nonmetric data from northern Belize also found evidence of biological discontinuity, although in this case it occurred in the Early-to-Late Postclassic transition. Using a cranial geometric-morphometric approach to analyze samples from central Mexico,

González-José et al. (2007) found greater than expected genetic variation in the Early Postclassic (AD 900–1200) sample from Azcapotzalco, suggesting population replacement occurred during the Classic-to-Postclassic transition. Beekman and Christensen's (2003) cranial nonmetric study also found evidence for Early Postclassic biological discontinuity in central Mexico, and identify regions to its north and west as sources of gene flow. These findings suggest the Epiclassic initiated a period of "cosmopolitan capitals" and increased extraregional interaction (Kepecs et al 1994, p. 142–143).

Although our findings at Mayapan may be reflecting just such a transformation, it is also possible that they are the result of regional differences. Northwest Yucatan may have had greater gene flow with regions outside the Maya area prior to the onset of the Postclassic. Hutson et al. (2010) suggest the region's large populations and low agricultural potential necessitated extensive long-distance trade, which may have been accompanied by gene flow. In fact, a recent study found greater genetic diversity among present-day Maya of northern Yucatan than among the Quiche or K'aqchikel of Highland Guatemala (Ibarra-Rivera et al. 2008). Odontometric analysis revealing Classic period Xcambo to be a consistent outlier compared to contemporaneous Peten sites may indicate considerable time depth to these regional differences.

In the case of Mayapan, more specific mechanisms for gene flow outside the region may be hypothesized. The greater genetic diversity found in freestanding shrine ossuaries may stem from *mul tepal* political organization, with each deposit representing a different town or province under Mayapan's control. Alternatively, this diversity could derive from immigrants from further afield. The magnitude of the differences encountered more strongly supports the latter scenario, although whether these represent individuals from Yucatan's east coast, the Gulf coast, or elsewhere in Mesoamerica cannot as yet be determined. Ongoing biodistance studies and analyses of strontium and oxygen isotope data will aim to distinguish non-Maya and individuals from other parts of the Maya area.

6.7 Conclusion

Odontometric analysis was performed to investigate population structure at the Late Postclassic regional Maya capital of Mayapan. Although the sample sizes utilized in the multivariate statistics were small, the results are broadly comparable to those produced using univariate statistics with larger sample sizes. These analyses revealed several significant intrasite differences as well as a relatively high value of F_{ST} for the pooled sample, suggesting that social divisions within Mayapan's society did in fact correspond to some degree with biological differences. Relethford-Blangero analysis found that individuals interred in freestanding shrine ossuaries exhibited the most extralocal gene flow, indicating that these elites were cosmopolitan not only in their material culture but in their geographic origins as well. Although the bitter Cocom-Xiu feuds and Kowoj claims of origins at Mayapan attest to the importance of ethnicity and polity (Jones 2009, p. 60; Masson and Peraza

Lope 2010), respectively, participation in the Postclassic Mesoamerican world system also shaped social identity. As demonstrated by our study, this appears to have involved the actual exchange of people, not just ideas. Our findings suggest that the greater scale of long-distance exchange in the Postclassic period was accompanied by greater gene flow with distant corners of the Maya area or possibly even regions outside it. Although much work remains to be done, these findings contribute to a more nuanced view of the complex population movements that occurred in the Postclassic period.

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