Kukulkan's Realm

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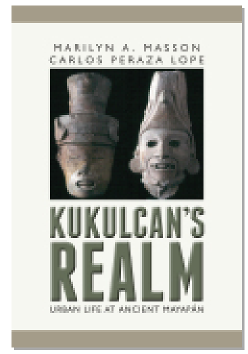

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6

The Economic Foundations

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Our research into the economic foundations of Mayapán has focused on the relationships of both commoner and elite producers and consumers across the urban landscape. Evidence for occupational specialization and interhousehold economic dependencies reflects economic interaction at the houselot, regional, and interregional scales. Determining the degree to which Mayapán households were provisioned by others residing within the city or far beyond its borders is crucial for reconstructing the complexities and impacts of market exchange. The importance of labor and labor's rewards in terms of affluence is closely tied to a continuum of craft production and value that incorporates the mundane at one end and the exquisite at the other. Many households produced items at Mayapán, and part of our task is to distinguish those houselots engaged in significant levels of goods manufacture that exceeded their own needs. Variation in systems of circulation such as gifting, tribute, and trade have long been assigned to differentially valued material goods in the Maya past, but we observe considerable overlap `in the modes of exchange for the array of desirables at Mayapán. In this chapter we compare the material assemblages of domestic and public contexts and provide the basis for inferring a complex economy at the city that was founded upon regional dependencies for raw materials and finished products and occupational specialization at the household level.

It is well known that the Mayapán state existed in the context of a well-developed system of commercial exchange. Ethnohistorical documents attest to the existence of marketplaces in Contact-era northern Yucatán of varied function, scale, and periodicity. A

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hierarchy of merchants and traders operated at various town, regional, and long-distance scales (Landa 1941; Tozzer 1941; Sabloff and Rathje 1975; Piña Chan 1978; Freidel and Sabloff 1984:185–90; Berdan et al. 2003). A full treatment of the systems of interaction in the Postclassic Mesoamerican world can be found in Michael E. Smith and Frances F. Berdan's (2003a) compilation, which details the variation among polities and regions in terms of the significance of international commerce. Many local and political networks were inextricably embedded in a network of exchange of information and goods that elevated the status and wealth of local elites in their quest for cosmopolitanism and legitimation (Smith and Berdan 2003b; Pohl 2003b). These networks stimulated producers, both noble and commoner, to provide basic goods and luxuries desired for exchanges. For example, royal women created fine woven cloth that was integral to political cohesion (Pohl 2003b). At the other end of the spectrum, commoners paid tribute in goods not made locally, which forced them to trade in marketplaces (table 6.1, Berdan 1988). Although the importance of Postclassic Period marketplace exchange has been generally accepted, the strongest evidence is documentary, and markets and their effects were not monolithic across a region within any time period (Blanton 1996; Smith and Berdan 2003a; Masson and Freidel 2012). More archaeological research is needed to refine knowledge for specific localities. Jeremy A. Sabloff and William L. Rathje (1975) attributed some key characteristics of Postclassic Maya society to the amplification of commercial exchange along maritime routes that shortened transport distances around the Yucatán Peninsula. This emphasis on commerce has been used to explain the weakened foundations of royal authority from the Classic to Postclassic Periods (e.g., Webb 1964; Sabloff and Rathje 1975; Rathje 1975).

This trade "amplification" is now dated to at least the Terminal Classic era (AD 800–1000) of Chichén Itzá (Kepecs, Feinman, and Boucher 1994; Kepecs 2003, 2007; West 2002; Braswell 2010). Zones of small polities that lacked major political centers such as Chichén Itzá or Mayapán also represented thriving commercial zones during the Postclassic Period (M. Smith 2003b). As for Chichén Itzá, Mayapán's trade network was facilitated by social, political, and ideological ties maintained by elites extending from at least coastal Honduras to coastal Tabasco (Ringle, Negrón, and Bey 1998; Ringle 2004). The importance and reach of Maya markets prior to the Terminal Classic Period merits more detailed study than it has received, and Mayapán's economic differences with the deeper Maya past were probably less pronounced than has been generally assumed (Masson and Freidel 2012). This point is an important one, as it bears on Mayapán's relevance for

Table 6.1 Economic specialization in Maya territories at the time of Spanish contact, according to Román Piña Chan's (1978:38–39) summary of the Lista de Tributos y Encomiendas 1549 (Paso y Troncoso 1939–1942).

Jurisdiction	*Economic attributes*
Ah Canul	Coastal strip, little agriculture, rich in saltworks and fish.
Calkiní	Tribute to Montejo in the form of corn, turkeys, honey, cotton.
Other towns	Tribute also included salt, fish, cotton.
Chakan	Tribute of salt and fish obtained directly from the coast or through intermediaries.
Cehpech	Tribute of salt and fish. The capital, Motul, also gave cotton mantles as tribute.
Hocabá	Constantly at war with neighbors, taking them as prisoners, perhaps selling them as slaves.
Maní	Agricultural zone, corn carried from Xul to Oxkutzcab (32.6 km). Annual feasts at Mani in honor of Kukulcan, a religious center.
Ah Kin Chel	High rainfall, cedar forests, northern coastal salt, rich in fishing. Cansahcab town sold salt to other towns. Town of Buctzotz captured people for slavery and produced cedar lumber. At Dzidzantun greenstones arrived through commerce.
Chikinchel or Chauaca	Rich in saltworks, produced fish and great quantities of copal for export. Other important towns, including Sinsimato, had copal monopoly.
Tases	Smallest, a group of towns. Capital of Chancenote had a road to Conil, important commercial centers.
Cupul	Agricultural lands and numerous cenotes, possibility of cacao plantations there. Town of Sodzil paid tribute of red beads, greenstones, corn, and wild turkeys to Lord Naobon Cupul, who lived at Chichén Itzá.
Cochuah	Controlled Bahía de Ascención. Temples in town of Ichmul, where lords of Chichén Itzá made offerings on trips to and from Honduras. Ichmul had cacao orchards. Halach uinic lived in Tihosuco, and he was of the Cochuah lineage, which had commercial agents in the Ulúa River towns.

continued on next page

Table 6.1—*continued*

Jurisdiction	*Economic attributes*
Ecab	Halach uinic lived in the town of Ecab. This town and Cachí were commercially important. Ports of Conil and Pole were in this jurisdiction. Encomenderos received salt, fish, corn, and ornaments from elsewhere in tribute. Isla Mujeres produced corn and salt. Cozumal center of pilgrimage and made honey and wax, paid tribute in salt and fish.
Uaymil	Forests of mahogany, cedar, Palo de Campeche, and copal. Roads from Bacalar to Cochuah and Ichmul. Bacalar was a port of embarkation for merchandise destined for interior, especially cacao. Mani went to Bacalar in search of cacao.
Chetumal	Exported corn, honey, cacao, maintained direct ties to Bacalar. Lord Nachan Kan had commercial agent on Ulúa River.
Campech	Good agricultural lands for corn and fruit trees, produced much cotton, maize, honey, and wax. Salt and fish given to Spanish for tribute.
Champotón	Produced large amounts of fish, ruled by halach uinic of Couah lineage. Commerce with interior via Río Champotón. Tixchel produced turtle shell objects and feather fans.
Acalan	Río Candelaria dominated by Acalan merchants. Commercial ties to Xicalanco, Tabasco, Petén Itzá, and Cimatán. Merchants barrio in Nito.
Cehache or Mazatlán	Forests, lakes, swampy land, riverine ties to Uaymil, Chetumal, and perhaps Belize, reached Petén Itzá via this jurisdiction.
Cimatán	Extended to Gulf Coast, ties with Tabasco along Río Grijalva and tributaries. Carried amber from town of Tatalapa to Tabasco.

diachronic comparisons in the Maya area. Postclassic Maya society's breaks with the past tend to be more greatly emphasized than its similarities, and this impedes the recognition of long-term patterns in the realm of political economy (Ringle and Bey 2001). But much variation in market-oriented impacts on daily life through time should be expected among different towns and cities across the lowlands in the Maya area, as prior studies have shown (A. Chase 1998; Chase and Chase 2001, 2004a; Fry 2003; Culbert 2003;

Dahlin et al. 2010). Greater concentrations of regional populations in earlier periods may help to explain the existence of multiple constricted ceramic style zones and spheres of exchange, whereas broader geographic networks of smaller towns promoted more outward-looking networks through time (Stark 1997; Masson 2001b).

The lack of hieroglyphic references to markets has little to do with whether or not they existed (Masson and Freidel 2012), and elite luxury good enterprises oriented toward accruing or maintaining social capital only represent a partial view of Maya economic systems (e.g., Houston and Stuart 2001; McAnany 2010). Merchants and their activities would have posed a potential threat to members of royal courts, and the exclusion of the mercantile realm in royally commissioned works of art may have been no accident (McAnany 2010). As for the Classic Period, the lords of Mayapán also circulated luxury items such as copper bells, polychrome vessels, exotic faunas or pelts, and similar goods.

In this chapter, we examine archaeological indicators of the importance of market exchange to daily life. The simplest approach to this problem is to determine where households were situated along a continuum defined by complete autonomy at one end and full-time occupational specialization and full dependency on others at the other end. Both of these extremes are unrealistic expectations for ancient agrarian states such as Mayapán (e.g., Wolf 1982:19). Dependency on the outside world is measured by two indices: To what degree were households making surplus products for exchange and to what degree do households' consumed goods reflect acquisitions from others? At the most basic level, residents of Mayapán produced some items with resources of local origin, such as clay for certain pottery types or white-tailed deer. Another correlate of trade's importance is the fact that a significant majority of households obtained an admixture of rarer finished items from distant lands—in Mayapán's case, serpentine axes from the Maya highlands or Gulf Coast Fine Orange pottery. The quantity of the most valuable goods and their distribution across social status lines is one important consideration for identifying the significance of market exchange (Hirth 1998). Reconstructing exchange at Mayapán is quickly complicated by the fact that crafting households relied on imported raw materials (shell, obsidian, cotton thread) for their surplus industries. Dependencies on the outside were layered, beginning with the raw material supply chain into the city and ending with the circulation of more valuable finished craft goods out of the city to smaller towns in the northern peninsula. All of these patterns observed for Mayapán are also reported for Tikal and other earlier prominent centers (Haviland 1963; Rathje 1971; Becker 1973; Fedick 1991; Masson and Freidel 2012). Identifying occupational heterogeneity at Mayapán, as outlined in the details of this chapter, represents fundamental evidence in our case for for a complex economy.

The study of currencies is an additional approach to reconstructing past economic systems. Although historical documents establish with clarity that monetary systems were in use at Postclassic Mesoamerican markets (including those of Yucatán), the archaeological study of potential monetary units has not been well developed for the Maya area, with the exception of studies of art or hieroglyphs (Stuart 2006; Freidel and Reilly 2010; Dahlin et al. 2010). The use of currencies is tied closely to the question of governing institutions. Who made and controlled Postclassic Maya currencies such as cotton mantles, copper bells, jade and shell beads, and cacao beans, and how were their values set in various regions according to their scarcity? David A. Freidel and his colleagues have argued for the importance of elite roles in the creation and valuation of currencies and their commercial worth from the Late Preclassic through Contact Periods (Freidel 1978:258; Freidel, Reese-Taylor, and Mora-Marin 2002; Freidel and Reilly 2010). Freidel and Justine Shaw (2000) propose that the use of durable currencies helped to resolve local crop shortages by providing the option to purchase grain. Corn could not be stored for long in the tropical Maya area, and as crop shortages are often locally experienced, trade across different rainfall zones was feasible. We know that ancient Maya polities, including Mayapán, regularly experienced such shortages (chapter 8).

Janet L. Abu-Lughod (1989:57–58) attributes the rise of prosperous market towns in late medieval times (e.g., Champagne and Bris) to the strategic successes of town authorities in attracting and securing passage for merchants and controlling luxury good supply networks. According to her, before institutions such as money lending were well developed, merchants would commission the production of fine textiles from producers to be picked up on their next journey. This study is illuminating in that it provides a historical example of complicated transactions during the premodern era (the twelfth and thirteenth centuries AD) prior to the adoption of more formal banking institutions in northern Europe.

Our analysis of shell objects in this chapter considers the distribution of different types of shell ornament manufacture in an effort to differentiate shell monetary units from other types of objects. Marine shell has been largely treated as a uniform material class in the Maya region, with the exception of *Spondylus* (Freidel et al. 2002, Graham 2002). We suggest that olive shells and beads and pendants of large, white marine gastropods (such as *Strombus*) also served as currency units; like *Spondylus*, they more commonly entered Mayapán in finished form and, in contrast to more ordinary marine bivalve objects, were not broadly manufactured at the city's shell workshops. This examination of shell debris and finished objects will hopefully provide a useful study for continued work on the manufacture of standardized shell ornaments of potential currency status at Maya sites.

This chapter's treatment of the multiple dimensions and scales of production and exchange contributes an important component of our overall argument for the complexity of Mayapán's urban life. The distribution patterns of various nonperishable items made and obtained by the city are considered individually, as each artifact class was positioned differently on the continuum of value in the city's economy. Archaeological recognition of the complexity of ancient Maya economies has not been fully realized despite the detailed testimonies found in ethnohistorical accounts (Masson and Freidel 2012).

RECOGNIZING ANCIENT ECONOMIC COMPLEXITY: ISSUES OF SIMPLIFICATION AND ELITE CONTROL

A tendency to oversimplify models of past market exchange, in addition to a preoccupation with the issue of elite control of production, has impeded archaeological reconstruction of regional economic complexity (C. Smith 1976; Pyburn 1997; Masson and Freidel 2012). The first issue is well articulated by Stephen A. Kowalewski (1990:54), who states, "What concerns me is that in current social science theories, millennia of change and variation are often subsumed under one typological concept." He argues that the search for variation, change, and reorganization should be of major concern to archaeologists and cautions against rendering "unto the tributary mode" as a default explanation for the economic underpinnings of ancient states (Kowalewski, 1990:55). "When we find scraps of information about the state or tribute," he asks, do we also consider the importance of other networks of exchange? (Kowalewski, 1990:54). As Kenneth G. Hirth (1998) points out, the development of complex economies is cumulative, and in complex systems, gifting, tribute, and marketplace exchange can coexist. It is a simple matter to acknowledge the existence of simple, informal, or barter markets, which are present even among nonstate societies, but priority should be given to determining when and where market exchange was a primary condition of life.

A second question that shadows the study of ancient economic systems is the question of elite control (Kowalewski 1990:54). The degree to which government is underwritten by the contributions of labor and tribute by supporting populations has been central to investigations of Mesoamerican political economies; some have focused primarily on whether control was centralized or decentralized, but this approach leaves plenty of unanswered questions (e.g., Blanton et al. 1996; Chase and Chase 1998; Aoyama 1999; King 2000; Scarborough, Valdez, and Dunning 2003; Braswell 2010). Market philosophy of the industrial era has led Mesoamerican scholars to view ancient market development primarily in juxtaposition to state control (Garraty 2010; Feinman and Garraty 2010). Some influential books within (Weiner 1992) and outside (Davis 2001) of anthropology address this flawed ideological standpoint in the context of traditional societies in greater detail than is possible here.

Marketplaces facilitate direct exchanges between producers, consumers, and a range of middlemen who are beyond the scope of direct elite supervision (C. Smith 1976; Berdan 1988; Hirth 1998). Some argue that markets counteract elite control in ancient settings by countermanding efforts to restrict luxury goods and allowing opportunities for entrepreneurism and affluence in ranks below the noble class (Eisenstadt 1980, 1981; Gailey and Patterson 1987). In extensive, relatively unbound geopolitical landscapes like the Maya area, top-down constraints on exchange would have been difficult to impose (M. Smith 2003b), but central market events hosted at core cities would have been the richest and most diverse and would have presented elites with opportunities for profitable exchanges or taxation (Berdan 1988; Blanton 1996; Masson and Freidel 2012). The study of ancient market exchange in Mesoamerica is now moving beyond simple dichotomous schemes of decentralized "free markets" versus centralized tributary systems (Feinman and Garraty 2010). The Mexica of central Mexico stand as the clearest example of a Mesoamerican civilization deeply invested in a market system, yet, as Kowalewski (1990:53) notes, studies of their economy concentrated for many years on the importance of tribute (with notable exceptions [e.g., M. Smith 1999, 2003b, 2010a; Blanton 1996]).

What material gains might elites have garnered from organizing and fostering major market events at central cities? Contact Period Maya literature on partially administered markets reveals that judges presided over weights and measures and resolved disputes. Trading was officially permitted only in the marketplace (Feldman 1978:12; Piña Chan 1978:40; Tozzer 1941:96). Markets themselves were differentiated by scale, periodicity, and content (Tozzer 1941:9; Piña Chan 1978:42; Freidel 1981:381). Merchants had sufficient incentives to undertake high-risk, long-distance voyages with assurances of state protection. Archaeological and documentary accounts also indicate that elite households produced as well as consumed wealth. Market exchange provided greater opportunities for converting one type of good into another (Berdan 1988). To what degree were elite production activities geared toward the generation of bride wealth and other inter-elite exchanges (e.g., Pohl 2003a) versus commercial profit?

The need to provision elite households with basic goods could also be augmented by regular local and diverse marketplaces. Pilgrimage market fairs and regularly scheduled more secular events are known from Contact Period historical accounts; archaeological features at Cozumel sites affirm these testimonies (Feldman 1978; Freidel 1981; Freidel and Sabloff 1984:186–87, 189). The concern of Classic Period monuments with periodicity and calendrical celebration certainly suggests that complementary opportunities for commercial exchanges at multifunctional gatherings would have been hard to ignore (P. Rice 2009g).

POSTCLASSIC MAYA ECONOMY—ETHNOHISTORY AND ARCHAEOLOGY

Documentary accounts provide snippets of testimonies concerning marketplaces, merchant/trader hierarchies, currencies, tribute demands, agriculture, property ownership, and occupational specialization for the Postclassic Maya realm. But these sources require comparison with empirical archaeological data. Here we summarize key pieces of information that provide a broader framework for understanding the meaning of the economic activities of Mayapán's households and the regional exchange system in which they were embedded.

Production Diversity in the Contact Period

Products made in the lowland Maya area may have been widely exchanged between neighboring territories and beyond. The resource heterogeneity of this region promoted community-scale specialization in surplus production for exchange well before the Postclassic era (Potter and King 1995; Masson 2003b). Román Piña Chan (1978:38–39) pored through the Lista de Tributos y Encomiendas de 1549 to identify goods associated with specific polities across the Yucatán just after the Spanish conquest of the northern Maya area (table 6.1). Figure 6.1 displays this product diversity for selected provinces and indicates how Maya settlements exploited different environmental zones in a manner that would have promoted exchange (from Piña Chan 1978:figure 12). The 1549 tribute list attests to community- and polity-scale economic specialization prior to Spanish arrival, although it is probable that more complexity existed during Mayapán's heyday. Salt and fish were provided from the following polities that were near the coast or within close coastal trading distances: Ah Canul, Chakan, Cehpech, Ah Kin Chel, Chikinchel/Chauaca, Ecab, Campech, and Chanputun (Champotón). Lumber came from Uaymil and Ah Kin Chel. The polities of Maní, Campech, Chetumal, Isla Mujeres, and Cupul were said to have had good agricultural lands for corn and fruit trees. Copal was made in quantity in Chikinchel/Chauaca, especially in the town of Sinsimato. Cacao production was significant for Chetumal, Ichmul (Cochuah polity), and possibly Cupul. Slaves, sometimes captured during warfare, were sold from Buctzotz (Ah Kin Chel polity) and Hocabá (table 6.1). Some towns paid tribute in trade objects obtained elsewhere, or they produced special luxuries. For example, greenstones were made in Dzidzantun (Ah Kin Chel polity), whereas Sodzil (Cupul polity) paid tribute in red beads, greenstones, corn, and turkeys to an overlord who resided at Chichén Itzá (table 6.1). Ecab provided Spanish *encomenderos* (estate holders) with ornaments of nonlocal origin, and turtle shell objects and feather fans were made in Tixchel (Chanputun). Cimatan carried amber from Tatalapa as far as Tabasco. Several places paid tribute in combinations of these goods along with fish, salt, honey, wax, copal, and cedar. Bacalar was a point of embarkation for goods destined for the interior and was known for its cacao merchants (Piña Chan 1978). Commercial agents resided at Ulúa River towns and at Acalan, Chanputun, and Chetumal. Piña Chan's (1978:41) discussion alludes to the conversion of raw materials into more valuable products for exchange—for example, at towns where carpenters converted wood into wooden effigies. It is important to note, however, that enmities among Yucatecan provinces sometimes impeded trade (Roys 1972:53), which may explain some of the overlap among territories that might have belonged to fluctuating alliance networks.

With the exception of coastal towns, all localities had significant agricultural production (Roys 1972:53; Piña Chan 1978:41), as is expected. Much salt was carried from the Yucatecan coast to Tabasco and beyond to central Mexico and Honduras (Kepecs 2003). Roasted fish was imported inland to a distance of 20–30 leagues and salted, dried fish could be traded farther into the interior. Principal exports from Yucatán were salt, cacao, wax, honey, cochineal, achiote, indigo, and cotton products, but as Piña Chan's (1978:42) analysis indicates, these originated from different peninsular towns. From the Gulf Coast locality of Xicalanco, Aztec traders obtained lowland Mesoamerican products of jaguar skins, turtle shells, jade, and salt and exotic items from highland Chiapas (Scholes and Roys 1938:318). Piña Chan emphasizes that northern Maya long-distance merchants served as middlemen by brokering a wide array of products, including those that did not originate in northern towns. Salt, made on

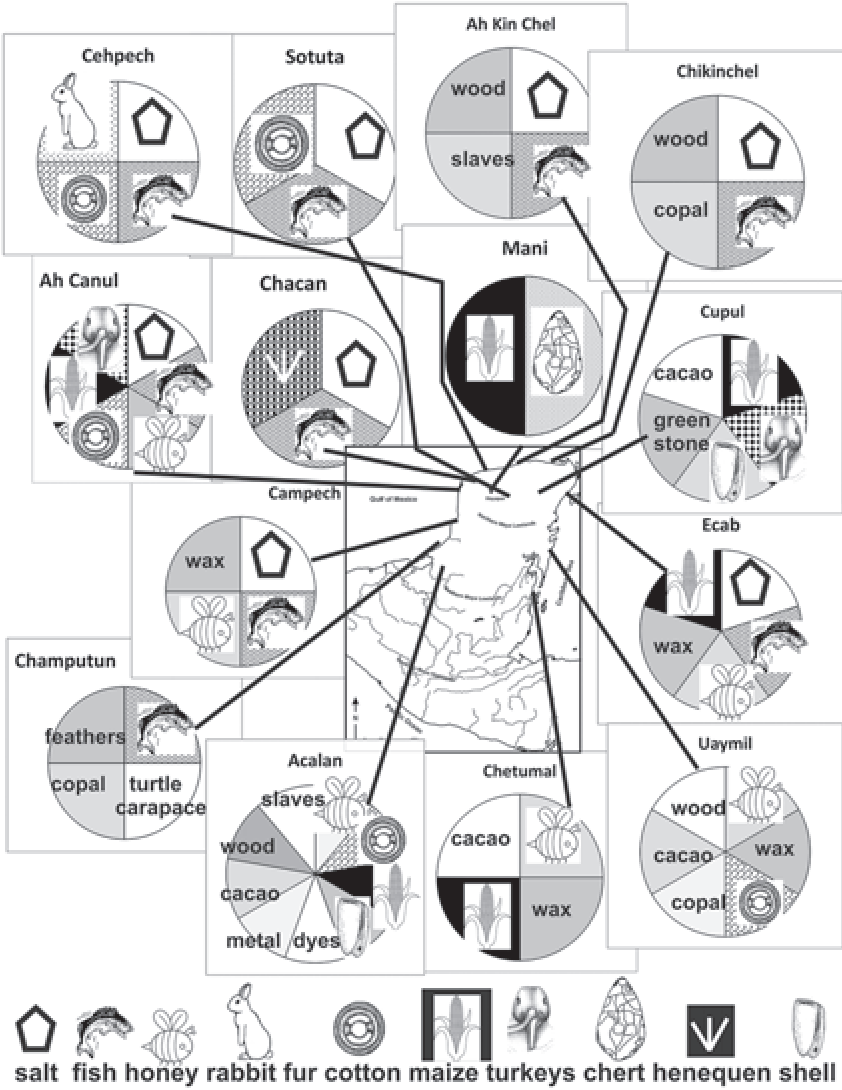

Figure 6.1. *Different provinces of the Contact Period paid tribute in different sets of products, as indicated graphically for selected territories in this figure; adapted from Piña Chan (1978:figure 12). This pattern illustrates regional scale productive heterogeneity that provided ideal conditions for market exchange and trading dependencies.*

the coast, would have been especially important for Mayapán's distant trading merchants, even though the city itself was in an area that offered access to few unique resources. Although cacao was grown in cenotes and other depression features, the currency needs of the city's markets would have required more than could be grown locally. Great quantities of cacao were imported to the northern peninsula from Honduras (and probably Belize) and Tabasco (Tozzer 1941:37). Frans Blom (1932:548) also notes that canoes departed from Yucatán for Ulúa, laden with clothing and other goods, and returned "loaded with cacao" (from Fernández de Oviedo y Valdés 1853:253).

Other items obtained from beyond the Maya area include *tuchumitl*, a woolen thread made of dyed rabbit fur, and wooden swords with "flint" (perhaps obsidian) edges. Products available at Xicalanco (Piña Chan 1978:42) include woven cloth, ornaments, slaves, and large greenstones, perhaps serpentine, used to make small axes common in the Maya area. Most of Mayapán's obsidian is from the Guatemalan highlands (especially Ixtepeque) and would have been traded northward along coastal routes. Slave trade apparently occurred into and out of the area, as Maya traders brought slaves along with salt and cloth to Tabasco in exchange for currency items, cacao, and stone beads (Landa 1941:94; Piña Chan 1978:43). It is possible that slaves from distant lands were more desirable in order to dislocate them from hometown connections that might have invited flight (e.g., Inomata 2001). The return voyage would have been relatively light in bulk, consisting of primarily currencies. Diego de Landa (1941:96) further notes these stone beads and cacao were reinvested—that is, these profits were used to buy slaves (presumably for further trade). Red shell beads were an especially valuable currency item (Blom 1932:546). As for many agrarian complex societies, functional overlap existed for shells valued as monetary units and personal jewelry (Blom 1932:546). Caravans of porters carrying merchandise also traveled overland via established trails between towns, and Mayapán represents one such inland location that relied on roads. One cacao transport route extended from the lower Río Hondo to Xiu territory in Yucatán, an aerial distance of 235 kilometers (Roys 1972:52). Francisco de Montejo went to Chichén Itzá and Ake via established roads and routes for merchandise transport connected Valladolid to Bacalar (Piña Chan 1978:40). Stopping places were often marked by roadside shrines honoring the North Star; such shrines have been found archaeologically (Blom 1932:546; Freidel and Sabloff 1984).

These accounts imply a complex commercial system in which different kinds of cloth were exchanged into and out of the Maya area along with other functionally overlapping goods such as pottery, greenstone, and slaves. Although the Maya highlands are a source for serpentine and other types of greenstone, diverse bead colors and stone types are observed archaeologically that suggest a variety of sources. Many houselots at Mayapán possessed at least one Matillas Fine Orange pottery dish of the type made by Maya groups of the Gulf Coast (Forsyth 2004).

Nonperishable Products in the Archaeological Record

Archaeological information on production industries at Mayapán is limited primarily to nonperishable materials. Items made at Mayapán's houselots are known from production debris that includes debitage, tools discarded in manufacture, and cores of raw material. Our best data reveals industries that made chert or chalcedony stone tools (bifaces and projectile points), obsidian blades and projectile points, animal bone objects, a variety of pottery vessels and effigies, shell implements and ornaments, stucco sculptures, and copper artifacts. Some tools that reflect the production of perishable industries are also found. Spindle whorls, bone tools, flake tools, and informal bifaces reflect production of cotton thread, weaving, embroidery, or hide working. Bifacial axes and grinding stones indicate agricultural cultivation and food processing. Imported small greenstone axes were likely used to carve wooden objects. Plaster used to surface architecture, sculpture, and friezes was in high demand, and its production was a major undertaking requiring much fuelwood (Russell and Dahlin 2007). Carlos Peraza Lope's team found a cache of plaster-working tools beneath a floor of one hall (Q-72) in Mayapán's monumental center (Peraza Lope, Delgado Kú, and Escamilla Ojeda 2002:101). Evidence for fine plaster work was also found at an effigy censer workshop at House Q-40a, where a vase filled with plaster and a smoothing tool was found (M. Delgado Kú 2012b). Animal use represents an additional production industry at Mayapán; white-tailed deer, turkeys, and dogs were raised in the city's houselots, and a range of other animals were hunted, fished, or obtained through trade (Masson and Peraza Lope 2008). Game was an important export of Sotuta during the Contact Period (Landa 1941:40), and artifacts of bone and antler are ubiquitous at the site.

Clearly, Landa's (1941:23–26) account is accurate in stating that Mayapán's lords brought people to the site to "perform services." Local production activities met many basic needs, but the city was not self-sufficient. Chert/chalcedony, weaving, obsidian, and marine shell industries relied on raw materials that were not local to the site. Mayapán's tribute list suggests that the city also needed to import cotton mantles, fish, salt, and other basic goods (Landa

1941:26). Although one cave has been found that may reflect clay quarrying (Clifford Brown, personal communication, 2003), we do not know to what degree local sources supplied Mayapán's pottery industry, as some slip and paint colors show considerable diversity (Brown 1999; Cruz Alvarado 2012a). Local resources included plaster, some proportion of wood and agricultural products, animal meat and hides, and orchard fruits. We argue that cotton thread production at Mayapán was low based on the scarcity of spindle whorls compared to other Postclassic sites, but mantles were probably woven and embellished (Masson, Hare, and Peraza Lope 2006). Spatially segregated phases of textile production may have occurred at different towns, with significant quantities of spun thread traded to Mayapán for later stages of manufacture. Colonial-era dictionaries are specific about textile-making tasks that individuals performed, including cotton carding, thread spinning, weaving, and further embellishment. Twenty-one different terms are found in the Motul dictionary for grades and thickness of thread along with twelve terms for cloth (Clark and Houston 1998:37–38). Spindle whorl holes can sometimes indicate whether maguey or cotton was spun in central Mexico (Feinman and Nicholas 2007), and this should be true for the Maya area as well. Different fibers were specified for making brooms, mats, or baskets (Roys 1972:46; Clark and Houston 1998:36). Residents at the city had a robust appetite for trade goods, as the distribution of obsidian, greenstone axes, copper bells, and Matillas Fine Orange pottery indicate. Perishable products that are described by Piña Chan, including fine dyes, pigments, beautiful wood, salt, honey, and cacao, would have entered the city's market along with more conspicuous durable objects. Mayapán was a place where raw materials or basic goods were often converted to more valuable finished products.

Market Institutions at Spanish Contact

Montejo observed abundantly supplied markets in the towns of Ecab, Cachi, Chauaca, and Sinsimato during his 1528 entrada (Piña Chan 1978:41). Staples and other goods were obtainable at Cachi, which had a "great market or plaza with many traders and much merchandise" (Piña Chan attributes this quote to Oviedo y Valdés 1853). The beach town of Ecab had fairs in conjunction with commerce (Piña Chan 1978:43, referring to Martyr de Anglería 1892). Although Piña Chan claims that Mayapán had a "house of commerce and trade to which the merchants repair with their merchandise" so that items could be purchased by stewards of governing elites, we were unable to find the original passage describing such an interesting facility in the 1938 Spanish publication of Landa's *Relacion de las Cosas de Yucatán* (Rosado Escalante and Ontiveros 1938, cited by Piña Chan 1978:43). Piña Chan (1978:43, referencing Fernández de Oviedo y Valdés 1851:55), describes the existence of inspectors of weights and measures at the Cachi market who served as judges to litigate disputes in a building at the end of the plaza. Aztec markets also had presiding judges (Blom 1932:545). Perhaps the most vivid description is that found by Blom (1932:545) in *Historia de la Provincia de San Vincente de Chiapa y Guatemala de la orden de predictadores* (Ximenez [1929] 1999, I:94); Blom's translation is as follows:

> The rulers took great pains that there should be held great and celebrated and very rich fairs and markets, because at these come together many things; those who are in need of something will find it there and can be exchanged with those other necessary things: they held their fairs and exhibited what they had for sale close to the temples. The selling and buying is to exchange which is the most natural form of trade; they gave maize for black beans and black beans for cacao, exchanged salt for spices which were *aji* or chile . . . also they exchanged meat and game for other things to eat; they swapped cotton cloth for gold and for some hatchets of copper, and gold for emeralds, turquoises and feathers. A judge presided over the market, to see that nobody was exploited. He appraised the prices and he knew of everything, which was presented at the market.

Blom (1932:545) emphasized the importance of religious festivals, pilgrimage, and commerce and suggests the antiquity of these institutions at sites like Chichén Itzá and Cozumel. He anticipated the pilgrimage/market fair model elaborated on by Freidel and Sabloff (Freidel 1981; Freidel and Sabloff 1984), in which large market events were regularly scheduled within the festival cycle to augment the backdrop of smaller, routine markets.

Archaeological signatures of marketplaces can be difficult to discern, but cases made for some Classic Period cities are compelling. At these sites, central plaza features with nonresidential basal alignments or soil signatures suggest their use as market plazas (recently reviewed by Dahlin et al. 2010; Masson and Freidel 2012; Shaw 2012). Evidence for a potential market plaza in Square K at Mayapán is outlined in chapter 4. In this space, floor level alignments are found and a massive platform is present; these do not resemble domestic architecture. The Square K platform is unique for the site, with the potential to represent a house of weights and measures or some other oversight facility. Also anomalous is Structure P-114 (chapter 5), located in a residential zone to the west of the site center, where residential and warehousing activities may have occurred. Until these structures are investigated, we can only speculate about their function. Other large nonresidential platforms are also suggestive of warehousing and storage linked to market exchange. Freidel and Sabloff (1984:190–92) review the location of possible warehouse platforms in the Maya area, including those from Ulúa, Naco, coastal Veracruz, and Monte Bravo and Vista Alegre (eastern coastal Yucatán); some are up to 70 meters in length and 20 meters wide. Storehouses are sometimes mentioned in documentary accounts; Tiquibalon, Yucatán, had them for wax and honey (Piña Chan 1978, citing Landa in Rosado Escalante and Ontiveros 1938).

Merchants and Traders

Hierarchies of traders existed across Mesoamerica during the Postclassic Period (Berdan et al. 2003). Professional merchants were known as *ppolom*, and traveling merchants were known as *ah ppolom-yoc* (Piña Chan 1978:43); the latter stayed at inns along their routes. Some merchants who traveled were armed. There is reason to believe that merchants were skilled hunters and warriors (Bill 1997:144). In the Madrid Codex (page 95b) they hold pointed knives identical to those found archaeologically at Mayapán (Bill 1997:115, figure 4.5), and they are sometimes linked to captive sacrifice (Bill 1997:144). God "M" is thought to represent the merchant deity Ek Chuah. He is portrayed with a black-painted face, projecting nose, hollowed eyes, whiskers, or a scorpion tail (J. Thompson 1957; Taube 1992; Bill 1997:144). Merchant figures have been identified on mural segments of Chichén Itzá's Temple of the Warriors; they travel along a coastal road and have striped bodies, tumplines, or walking sticks (Kristan-Graham 2001:356). Mayapán sculptures also portray this entity (chapter 7).

Merchant houselots have not been particularly easy to identify at Mayapán, but the distribution of imported pottery hints of their existence. Distinctive ethnic or foreign merchant enclaves of the type identified at Teotihuacan (Millon 1981) and Matacapan (Santley et al. 1987) are not evident in the residential zones explored by our project, at least as indicated by small test pit samples. Assemblages from contexts with higher proportions of imported pottery or effigy sculptures with international iconography also have a majority of local pottery and images (chapter 5; Masson and Peraza Lope 2010). There is also little co-association of atypical dwellings with distinguishing attributes such as high quantities of Matillas Fine Orange pottery, rare cremation burials, or effigies of Aztec gods (Masson and Peraza Lope 2010). While some typical houses with greater quantities of imported pottery or rare, local pottery (Buff Polbox) may have been those of merchants who retained some of the exotic vessels that they vended, this is difficult to verify. Such cases are not limited to elite contexts. Craft production houselots in general were also affluent and tended to have slightly higher proportions of Matillas Fine Orange (Masson and Freidel 2013:figure 8.11).

Currencies and Exchanges

Currencies in use at Spanish contact (figure 6.2) included cacao beans, cotton, cotton thread, cotton cloth, red stone or red shell beads (known as *kan*), white shell beads, greenstone beads (*tun*), copper bells, and axes (Landa 1941:96; Scholes and Roys 1938:612). Blom (1932:542) notes that quetzal feathers were used for money in Verapaz. These items had different values according to geographic location, which was probably determined by their availability and other factors of local economies (e.g., Blom 1932:538). No copper axes, for example, have been recovered at Mayapán.

Currency exchange values vary in the scarce Contact-era sources (table 6.2). According to Piña Chan (1978:43), 200 cacao beans equaled one Spanish *real*, a *contle* was a unit of 400 cacao beans, *xiquipile* units equaled 1,800 beans, and a carga was 24,000 beans. These Yucatecan equivalencies differ from figures cited by Blom (1932:538) from central Mexico, where a real was worth 80–100 cacao beans (one-eighth of a peso) and a carga (about fifty pounds) was worth 28–30 pesos (or 3.5–3.75 reales). Other equivalencies are listed in the Relación de Valladolid (Rosado Escalante and Ontiveros 1938:237–38). Jars (of unknown size) of cacao or beads were used for trade, as payment for hired labor, and to purchase slaves. Such jars were worth strands of beads of one or two fathoms (about 6 feet) in length. Coral-colored (*Spondylus*) beads of a length of one handspan (*jeme*, or *cuarta*) were valued at one *tostón* (four reales) according to the Relación de Valladolid, and this is consistent with values reported by Ralph L. Roys ([1943]1972:52). The Relación states that some shell beads were cheaper or more expensive, and this was probably based on color, with *Spondylus* worth more than other shell beads.

Copper bells may have had different values according to size (Piña Chan 1978:43; Tozzer 1941:231n418), and woven cloth of certain sizes and grades also corresponded to monetary standards (Blom 1932:541; Reents-Budet 2006). The existence of weights and measures inspectors at some marketplaces suggests that weight, volume (jars), and lengths may have been important in calculating value, in addition to counts. Factors such as shape, form, raw material, and craftsmanship may have further distinguished currency value, as qualitative variation is evident among shell, greenstone, and copper bells.

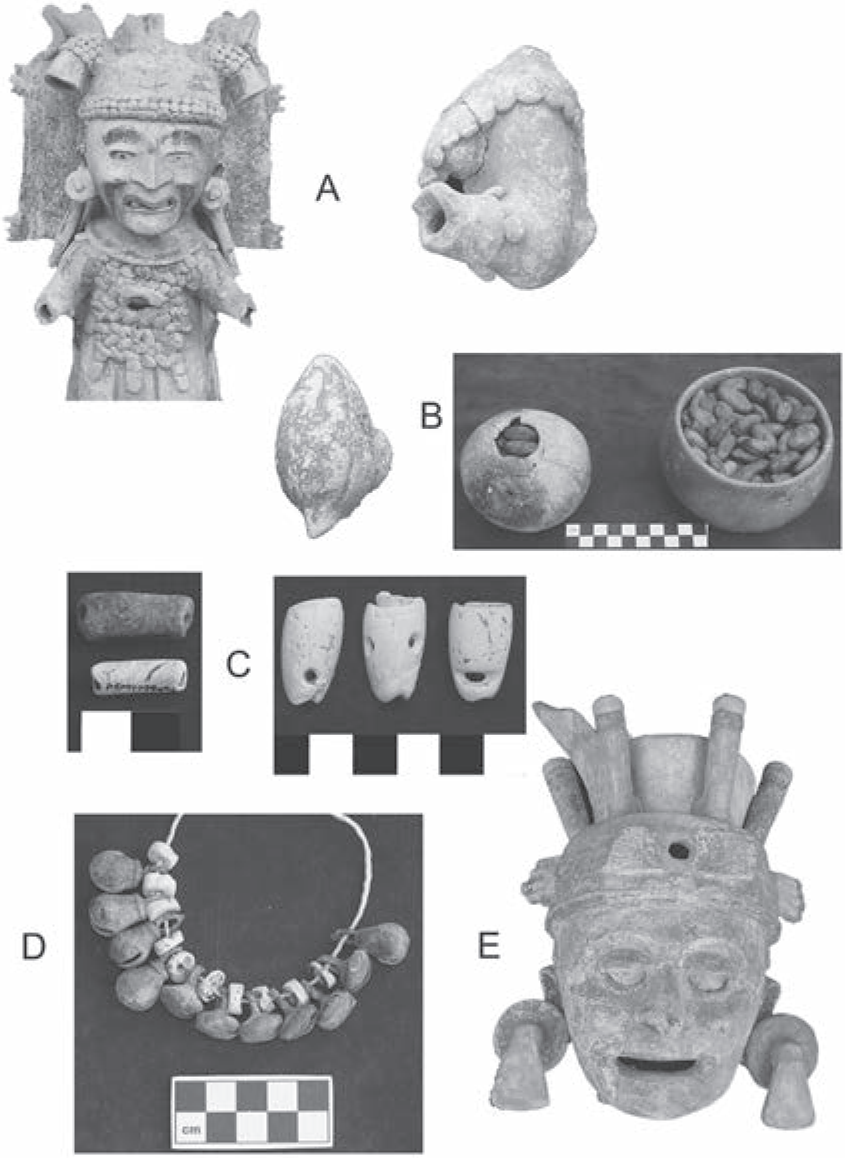

Figure 6.2. *Currencies in use at the Contact Period: A) cotton mantles, B) cacao, C) greenstone and shell beads/ornaments, D) copper bells and white shell beads (as found in a burial at dwelling Q-39), E) red and white shell beads and greenstone beads (stacked in headdress of Itzamna effigy).*

Table 6.2 Examples of equivalencies among currency units of the Contact Period in the greater Maya area.

Spanish Real	*Peso*	*Cacao beans*	*Contle*	*Xiquipile*	*Carga ~50 lbs*	*Shell beads (white?)*	*Shell beads (red)*	*Toston*	*Source*
4	1/2	–	–	–	–	–	Handspan, ~18 cm	–	Roys (1972:52)
4	–	–	–	–	–	–	–	–	–
1	–	200	–	–	–	–	–	–	Piña Chan (1978:43)
–	–	400	1	–	–	–	–	–	
–	–	1,800	–	1	–	–	–	–	
–	–	–	–	–	–	–	–	–	
–	–	24,000	–	–	1	–	–	–	
1	1/8	80–100	–	–	–	–	–	–	Blom (1932:538)
3.5–3.7	–	–	–	–	1	–	–	–	
–	–	Jar	–	–	–	1–2 fathoms (~182 cm)	–	–	Rosado Escalante and Ontiveros (1938:237–38)
4 (or 1 silver real de a cuatro)	–	–	–	–	–	–	Handspan, (jeme, cuarta, ~13.9–20 cm)	1	

The best information on cacao bean value is from Nicaragua, although these beans were widely used across the Aztec, Mayan, and Nicaraguan regions and as far as Panama. Blom reports from Gonzalo Fernández de Oviedo y Valdés's (1851:316–17) account that a rabbit was worth 10 beans, a chicotlzapotl fruit was worth 4 beans, a slave cost up to 100 beans, and a prostitute could be hired for about the price of a rabbit (8–10 beans). Blom (1932) points out that the greater scarcity of cacao in Nicaragua gave it more worth than in Mesoamerica. In the Maya area, sacrificial victims were purchased at a price of 5 to 10 red shell beads per person (Scholes and Roys 1938:612). Cotton mantles were used as units of exchange across the Maya lowlands (Tozzer 1941:94), the Maya highlands (Feldman 1985:21–23), and other parts of Postclassic Mesoamerica (M. Smith 2003c:124). According to Landa (1941:96), merchants "gave credit, lended, and paid courteously and without usury." Blom (1932:549) reports from the Tulan Tabi documents that one money lender (Francisco Quen) advanced cacao beans on credit to two others (Diego Huchim and Francisco Chim). Units of exchange may have been relatively stable, if Gaspar Antonio Chi's testimony is to be believed: "With provisions there was no bargaining, because the prices (were always) . . . in the same way, except for maize which sometimes (rose in price when the crop failed, and) it never went above the price of one *real* or a little more (per load)" (Tozzer 1941:231).

Labor

Corvée military service was requested by the Mayapán state of its subjects (Roys 1962:50), and authorities also demanded corvée service for agricultural or other labors in the Contact era (Roys 1972:62). Slaves were essential for major fishing industries, agriculture, and canoe travel, and as porters for overland goods (Tozzer 1941:190n995; Roys 1972:35; Kepecs 2003:267). Large numbers of laborers were required seasonally for factory-scale industries such as salt production (Kepecs 2003:265), but it is not known whether such services were obligatory or compensated. In the early Contact Period, Blom (1932) reports that native carriers were paid wages of 100 beans per day in "Mexico." Montejo paid his troops in cacao beans in Yucatán (Blom 1932:538). Women spinners or weavers were also sometimes hired and paid in cacao beans, corn, or raw cotton, as John E. Clark and Stephen D. Houston (1998:37–38) infer from terms in Colonial dictionaries. Men sold their labor to clear, till, plant, weed, and harvest agricultural fields (Clark and Houston 1998:38). Although there is little direct evidence that wage labor had pre-contact origins, the possibility exists due to the fact that such arrangements were prevalent early in the Contact Period (mid-sixteenth century). The payment of a prostitute, as mentioned previously, provides one example of currency given for services. Midwives, curers, porters, and other service providers may have been similarly paid, as claimed in the Relación de Valladolid (Rosado Escalante and Ontiveros 1938:237–38).

Tribute in the Documentary Sources

Tribute sent to Mayapán included birds, maize, honey, salt, fish, game, cotton mantles, exotic stones, and "everything produced in the country" (Landa 1941:26; Tozzer 1941:30n159). Mayapán's nobility who lived at the city were exempt from tribute, if Chi's testimony is accurate (Tozzer 1941:230; Roys

1962:64). Northern coastal zones provided salt to towns of the interior, and this included Mayapán prior to its demise, according to Chi (Tozzer 1941:230). Trade would have also occurred. Landa (1941:40). describes game and fruit as commodities exchanged by the Cocom with coastal Ah Kin Chel after the fall of Mayapán from their home near Sotuta. Archaeological data reveal a significant deer husbandry industry at Mayapán that calls to mind the "game" traded by the Cocom as mentioned by Landa (Masson and Peraza Lope 2008).

The nature of Mayapán's oversight of cacao production in distant lands of Honduras (including Belize) is not described in detail, but this practice implies hierarchical rights that may have been part of the tribute system (Roys 1962:50, 55–60; Tozzer 1941:37n179, 94n417). A mural segment at the Temple of the Warriors at Chichén Itzá displays cotton mantles, a feather headdress, bowls, and copal or jade beads; the scene resembles aspects of the Aztec Codex Mendoza and likely portrays goods received in tribute (Kristan-Graham 2001:356, figure 12.14) that overlap with those demanded later by the Mayapán state. Another Temple of the Warriors mural emphasizes links between pilgrimage to the great cenote and tribute payment (Kristan-Graham 2001:356), and these activities may also have been complementary at Mayapán.

The term *tribute* was commonly used by Spanish Colonial chroniclers for payments that more closely meet the definition of taxation (M. Smith 2010c). Michael Smith (2010c) argues that payments to the Aztec empire were delivered consistently at regularly timed intervals and more appropriately represent taxes. The Codex Mendoza reveals such explicit expectations of subject polities. In contrast, Smith points out that tribute payments tend to be variable and delivered in the context of specific occasions. Regular requests for disbursement of goods to Mayapán (and other Postclassic Maya political centers) by the same criteria may also have constituted taxes. The line is blurred, however, if payments were timed with pilgrimage occasions (more like tribute). This distinction in terminology is important, as European classifications may be biased (M. Smith 2010c). Unfortunately, there are few other records available that permit a more objective evaluation of this form of state support for Mayapán.

Property Ownership

The issue of Postclassic Maya land ownership is considered by Freidel and Sabloff (1984:181–83) in the context of field wall systems at Cozumel sites that suggest a high degree of control and use by specific groups. Nobles frequently administered land rights and oversaw the use of lands across Contact Period Mesoamerica, but land ownership can be described as both communal and held by villages or towns (Freidel and Sabloff 1984:183). The products of labor or other improvements to land, such as cacao or fruit orchards, may have been privately owned (Roys 1972:37; Piña Chan 1978:37, 41; McAnany 1995). Cases of family property ownership can be found upon close examination of the documents. For example, Susan M. Kepecs (2003:259) observes that members of the Euan family owned certain salt beds in Chakan. Roys (1972:37) also reports family ownership of domestic properties and lands. He suggests that in pre-Spanish times, houselots and their gardens were considered to be private property, and this was probably true for the walled houselots and fields of Mayapán (chapter 5).

Matthew Restall's (2001) characterization of the *cah*, a town and its network of affiliated villages and territory, reveals that boundaries were fluid at the time of Spanish contact. But authorities were quite concerned with affirming the boundaries of polity territories, as suggested by rites of circumambulation that were regularly timed with calendrical celebrations (P. Rice 2004:79, 147). The maintenance of boundary shrines and a suite of other landmarks also reinforced concepts of place and belonging (P. Rice 2004:79, 147). It is probable that legal affiliations of social groups to land were complex and variable during the time of Mayapán's regime.

Economic Goods at Rituals and Feasts

Lavish feasts occurred at Mayapán. Priests and high-ranking political elites hosted them at public buildings on a variety of occasions. The presence of rich middens next to certain colonnaded halls and other ceremonial buildings (Q-97, Q-127, Q-151, Q-213) at Mayapán's center attest to these consumption activities (Strömsvik 1953:140; Shook 1954b; Shook and Irving 1955:322–23). Animal foods and maize breads were consumed and gifts of cotton mantles, food, and ceramic vessels were given to guests with the expectation of eventual reciprocity (Landa 1941:92). Landa outlines multiple occasions for gifting, including rites of passage for boys and girls (Landa 1941:106), calendrical festivals (Landa 1941:141), or deity festivals such as the *Chic Kaban* rite for Kukulcan (Landa 1941:158). Food offerings for rituals were often divided among the guests during ensuing feasts. At some temple events, gifts brought by guests were exclusively distributed among high-ranking participants, including lords, priests, and dancers (Landa 1941:158).

At Mayapán, it is not always useful to characterize goods or their production contexts in the dichotomous categories of luxury and utilitarian items, although differences are evident at the extremes of the continuum. Many types of items given at feasts and festivals overlap with goods also transferred as tribute or exchanged in markets. Patronage of certain fine craft production is documented at Mayapán for copper bells and effigy censers (Cruz Alvarado et al. 2012; Paris 2008; Paris and Cruz Alvarado 2012). The distribution of speleothems in household contexts is limited and may be related to commissioned sculpture industries. Speleothems helped form the skeletal framework around which anthropomorphic plaster sculptures were molded; these are found in halls, temples, oratories, and shrines (e.g., Adams 1953:153; Shook and Irving 1955:131). Other limited crafting materials include pigment-mixing shell cups and ceramic palettes.

Elite sponsorship of luxury item manufacture at Mayapán is a pattern with great time depth in Mesoamerica (Feldman 1985:23; Ball 1993; Reents-Budet 1994; Inomata and Stiver 1998; Freidel, Reese-Taylor, and Mora-Marin 2002; Foias 2002:229, 239). At Mayapán, although elites had more objects of the highest value, many classes of valuables are widely distributed across contexts of varying social status. Small, portable valuables, including shell ornaments, greenstone beads, serpentine axes, or (to a lesser extent) copper bells are found in most commoner contexts in low quantities (figure 6.3).

Scales of Production and Consumption at Mayapán

The importance of marketplace exchange is evident at Mayapán in the degree to which residents were heavily dependent on others for goods deemed essential to daily life. Patterns at individual houses exhibit much variation in part-time work activities and in the amount of surplus created at crafting houselots. Production of crafts at Mayapán clearly occurred on a part-time basis, but differences exist in the quantity of debris at domestic workshop localities where surplus production was clearly intended. We infer part-time production at Mayapán due to the fact that the amount of debris is lower than at other Mesoamerican crafting sites where estimations of the number of objects made per year also suggest part-time production. For example, at Colha, lithic debitage from certain workshops is estimated to have densities of 603,000 pieces of debris per cubic meter or higher, yet it is possible that each flintknapper made around 150 or so of each of four tool types per year over occupations as long as 250 years (Shafer and Hester 1991:83). As the most dense lithic workshops at Mayapán fall considerably short of this quantity (e.g., 16,993 and 9,850 flakes per cubic meter at I-57 and Z-120), presumably these craftsmen made fewer tools than at Colha in a quantity that would not have entailed a full-time commitment. But multi-crafting was common at

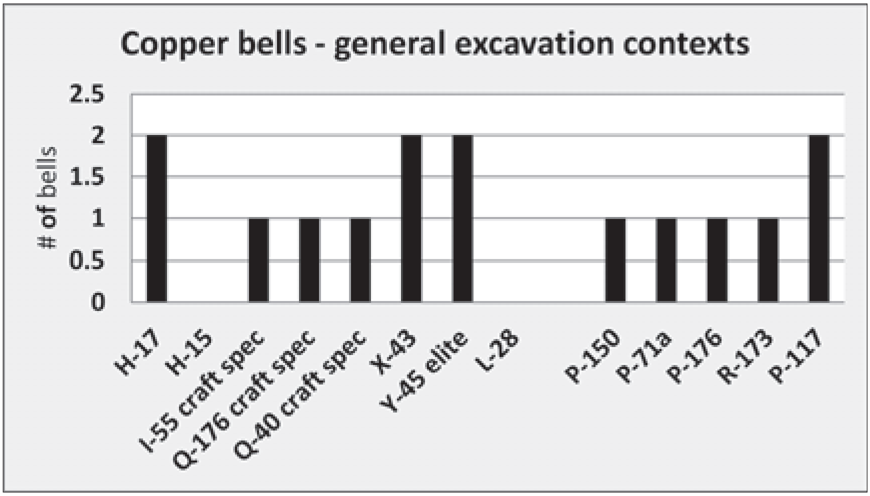

FIGURE 6.3. *Copper bells were recovered in similar amounts in general excavation or surface collection contexts across social status categories and domestic or nondomestic localities, suggesting that these valuables were widely accessible.*

Mayapán's houselots, as at domestic contexts such as Ejutla, Oaxaca (Feinman and Nicholas 2000), which means that the total output of all kinds of surplus goods would sometimes double or triple that of a single product. Occupants of House Q-176 made pottery vessels, figurines, shell objects, and obsidian blades, as we discuss later in this chapter.

The household has long been recognized as an activity group and a locus of production, consumption, and reproduction (Wilk and Netting 1984), although it is important to remember that members of a household can be spatially dispersed and do not necessarily reside within a spatial cluster of dwellings. Nonetheless, residential groups represent a logical starting point for studying the work activities of individuals related by blood or other ties. Domestic refuse represents the cumulative debris of a "household series" (M. Smith 1992:30) and is thus the result of sequential occupation in the same location that may surpass a single generation.

Quantifying and explaining surplus craft production has long concerned scholars of the Mesoamerican past. Although Prudence M. Rice (2009h:125–26) objects to archaeological uses of the terms *craft specialization* and *craft workshops*, in favor of more neutral terms such as *craft production*, the concept of craft specialization remains useful if employed with a quantitative approach and a set of well-defined expectations (e.g., Clark 2003). Identifying specialization or surplus production is a matter of degree (Costin 1991:4). For Mayapán, the key distinction is between craft producers making low numbers of objects and those engaged in making significant surplus quantities beyond those necessary for their own use. Surplus production of selected goods represents choices made by residents to specialize in crafting over other work options, at least for some of their time.

Cathy Lynne Costin's (1991) influential multidimensional crafting typology underestimates the importance of both scale and intensity at the household level, which is ranked below other levels of nonresidential workshop or attached production contexts. But as some attached artisans produced low quantities of exquisite goods (e.g., Inomata and Stiver 1998), scale in some attached contexts is small compared to that of a flinknapper who made hundreds of tools annually from his home. Gary M. Feinman and Linda M. Nicholas (2000:136, 138, 2004:170, 187, 2007:209, 2010) have effectively illustrated the importance of intensive production activities at household contexts and the adequacy of this scale for provisioning some thriving regional market systems in ancient Mesoamerica. Context types and scale do not always fit neatly into the scheme proposed by Costin. Patterns that Feinman and Nicholas report for Ejutla for the production of shell objects and figurines closely resemble those of the domestic workshops that we have documented at Mayapán in terms of intensity and scale. At Mayapán, one nonresidential workshop has been documented, but activities at this segregated context (residences are located nearby) differ little from workshop deposits that are within houselot enclosures (Kohut et al. 2012). General overlap in scale and intensity is also observed at isolated (nonresidential) workshop deposits and residential workshops at Colha (Shafer and Hester 1983; Hester and Shafer 1984; Masson 2001c). These findings negate the importance that has been assigned to nondomestic workshops in typological schemes (e.g., Santley and Kneebone 1993:table 1). The expectation that nonresidential production is accompanied by a scalar increase is not necessarily true.

Michael Deal's (1998:23) ethnoarchaeological study in modern Tzeltal communities defines three scales of production. At the domestic scale, activities merely replace a household's inventory; the elementary scale involves production beyond a household's needs; and the artisan scale involves year-round work (Deal 1998:23–25). Of these three, Mayapán workshops most closely match the elementary scale. Similarly, Mayapán's patterns match descriptions of a "household industry," where part-time production is undertaken for surplus exchange, as described by Robert S. Santley and Ronald R. Kneebone (1993:table 1). Deal emphasizes that greater investment in crafting (in his case, at the artisan scale) represents a necessary strategy to supplement household income for those with poor access to agricultural land. These artisans tended to be poorer than agriculturalists. This scenario contrasts with our data from Mayapán, which indicates that surplus crafting households tend to exhibit greater affluence than houselots engaged in more generalized activities that presumably included cultivation. The same pattern is reported from the Classic Period sites of Chunchucmil (Dahlin 2009:353) and Colha (Potter and King 1995:28; Shafer and Hester 1986:163).

In general, primary debris is rare at Colha (Shafer and Hester 1983; Hester and Shafer 1984) and the large urban center of Tikal (Fedick 1991). A focus on late-stage production seems to have characterized some larger towns and cities of the Maya area. At Mayapán, this pattern is also the norm. The majority of chert and chalcedony workshop debris reflects late-stage biface production. Cores are rare at the site and preforms were probably brought to the city. Segregation of stages of production may have been relatively common between sites and regions of Mesoamerica. This process correlated with an increase in commodity value (such as cloth) with each transfer and embellishment (Berdan 1988). Mayapán imported much of the raw materials it needed for its household craft industries; similarly, houses at Ejutla, in the landlocked portion of the Valley of Oaxaca, produced surplus objects made of imported Pacific coast marine shell (Feinman and Nicholas 2000).

Commoner household contexts at Mayapán vary in terms of productive activities but can generally be grouped into two categories: crafting houses that made significant surplus quantities of shell, stone, or pottery goods and non-crafting houses where such surpluses were absent. The locations of crafting houses thus far identified are illustrated in figure 6.4; five crafting houses (figure 6.5) and three non-crafting houses (figure 6.6) were fully excavated. While many houses at the city engaged in low levels of production, as suggested by low quantities of flakes or shell debris, crafting houses were identified arbitrarily as those with debris in outlier quantities beyond one standard deviation above the mean—and in many cases at levels far beyond this measure (table 6.3). Material assemblages of non-crafting houses reflect a range of general activities (H-11 and L-28) or specialized activities other than crafting, such as domestic (Z-42b) or military or corvée service (X-43).

Engendered Crafting

Julia A. Hendon (1996:48) calls for a consideration of craft production and other work activities within dwellings that may identify gender-specific

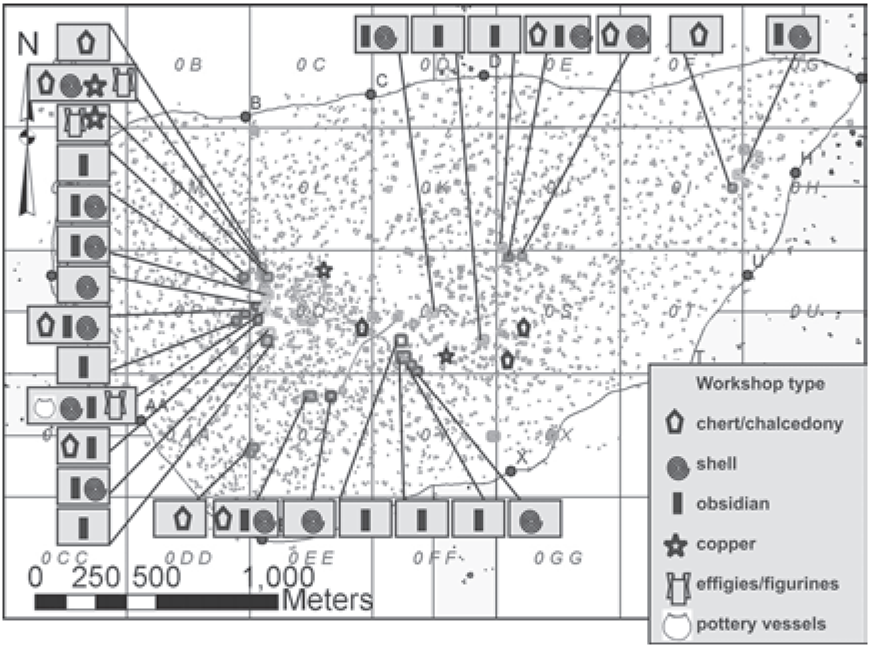

Figure 6.4. *The location of surplus crafting household workshops identified in PEMY research in the Mayapán settlement zone is indicated by gray boxes and arrows. These localities had workshop debris in quantities at least one standard deviation above the mean. Three additional localities are identified by icons plotted on the map (two copper and three chert); these were not investigated by the PEMY project (table 6.3).*

undertakings. Ethnohistorical sources provide limited information. To what extent did the burdens of food acquisition, processing, cooking, and child rearing permit female involvement in crafting (Clark and Houston 1998:34)? Such factors probably depended on family size and whether groups of women in a household shared routine tasks. Making thread, weaving, and embroidery represented a female domain across Mesoamerica, as implied by figurines (Hendon 1996:56), women's activities in the Maya codices (Vail and Stone 2002), and historical documents (Clark and Houston 1998:34; McAnany 2010). Raising domestic game and fowl was also primarily the responsibility of females (Landa 1941:127; Ardren 2002; Masson and Peraza Lope 2008).

Landa's description of the Contact-era rite of *Yolob u dzab kam yax* (thought by Alfred M. Tozzer [1941:n814] to mean "ceremony of the blue color") involves smearing the tools linked to specific occupations with blue pigment.

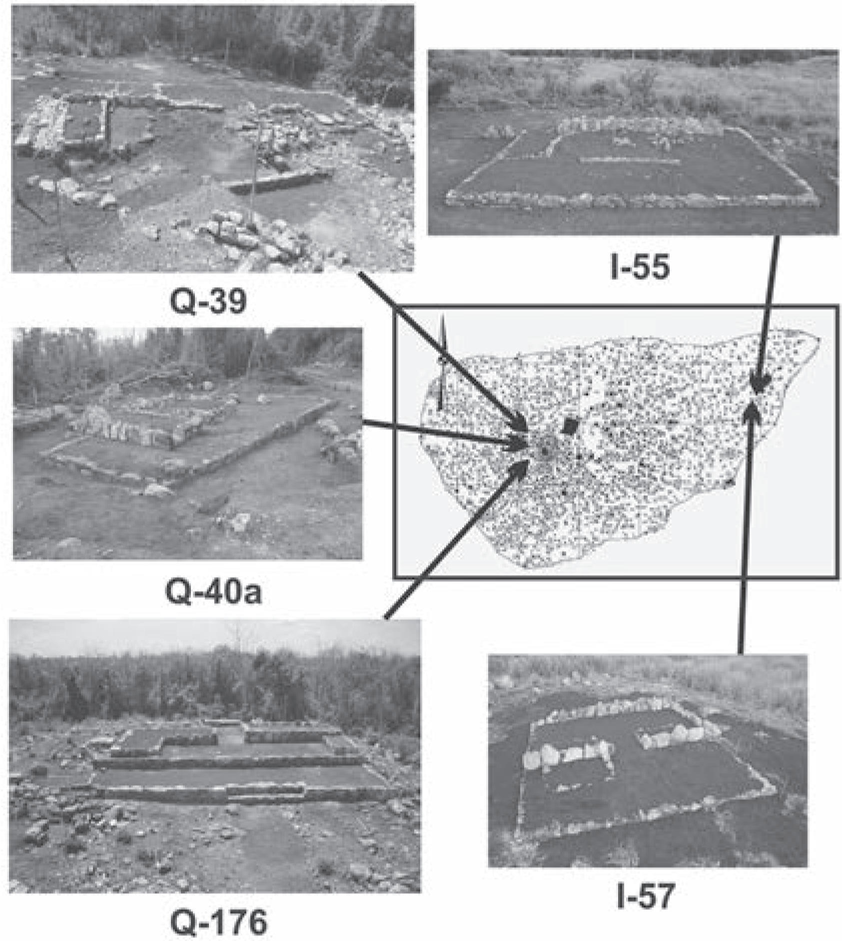

Figure 6.5. *Localities engaged in surplus craft production fully excavated by the PEMY project. All were dwellings except for I-57, a special-purpose shelter (in its own enclosure next to House I-56) associated with chert and chalcedony flaking debris. House I-55 made obsidian blades and shell products; House Q-39 made chert/chalcedony and shell products; House Q-40a made effigy censers, copper, and shell items; and House Q-176 made pottery vessels, obsidian blades, and shell items.*

Such tools ranged from articles used by priests to spindles used by women in weaving. Boys and girls were struck lightly nine times on the backs of their hands, a ritual linked to their future involvement in the hereditary occupa-

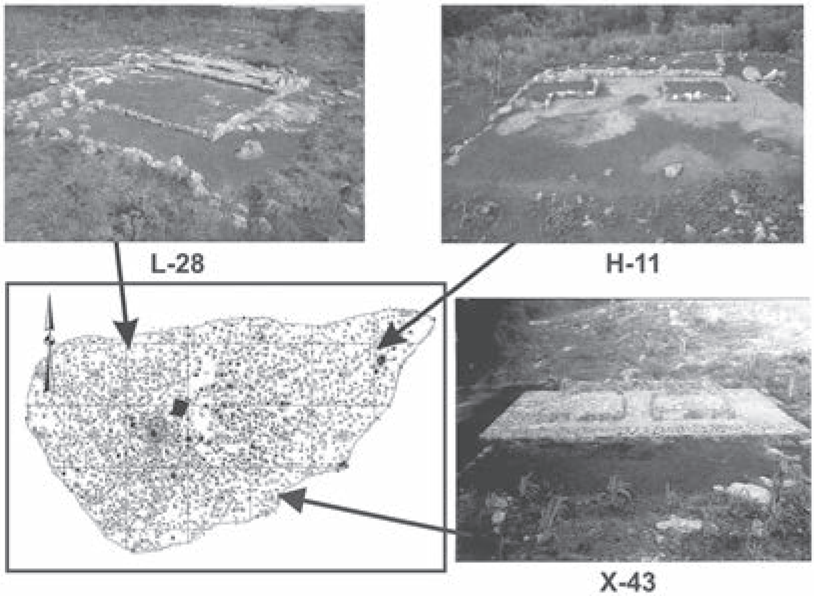

Figure 6.6. *Dwellings fully excavated by the PEMY project not associated with surplus craft production. Houses L-28 and H-11 were associated with a range of general activities and low levels of shell crafting while House X-43 was briefly occupied, lacked a full domestic assemblage, and contained a higher proportion of projectile points that may suggest it was occupied by males who were performing military service for the city.*

tions of their parents (Landa 1941:159). This rite was geared toward artisans (Tozzer 1941:n813) and recalls similar role-bestowal rites for children that are featured in the Codex Mendoza (Berdan and Anawalt 1992). Crafting and other occupations were described as "oficios" by some chroniclers, which may signify a role, a calling, or a duty (Clark and Houston 1998:34–35). As these authors note, men's responsibilities included farming, fishing, hunting, bee-keeping, and forest resource extraction; women raised children and animals, prepared food, and made thread, cloth, and clothing (Clark and Houston 1998:35). Genders sometimes overlapped in certain forms of curing or sorcery and a few crafts (perhaps pottery making), but complementary participation in productive activities was common. It is possible that increased demands on women to create cloth tribute in the Colonial era led to a greater focus on textiles than before (Clark and Houston 1998:38). The section that follows

Table 6.3 Craft production workshops identified in PEMY sample areas in Mayapán's settlement zone through systematic surface collection, test pits, or full excavation. Fully excavated contexts are indicated with an asterisk.

Neighborhood/Structure/Product		*Neighborhood/Structure/Product*	
Barrio Itzmal Ch'en (Milpa 16)		Crafts Barrio Downtown (Milpa 1)	
I-57*	Chert	Q-39*	Chert, shell, copper, figurines
I-55*	Obsidian, shell	Q-37	Chert
–	–	P-115	Obsidian
Mid-city east (Milpa 15)		P-24	Obsidian
S-12	Chert, shell	Q-196	Obsidian
S-10	Obsidian, chert, shell	P-114	Obsidian, chert, shell
J-130	Obsidian	Q-188	Obsidian, chert
–	–	P-28b	Obsidian, shell
Downtown (Milpa 2)		Q-303	Obsidian, shell
Z-39	Obsidian, chert, shell	Q-46a	Obsidian, shell
Z-47	Shell	Q-176*	Obsidian, shell, pottery vessels, figurines
Z-43	Shell	Q-40a*	Pottery effigy censers, copper
Downtown (Milpa 32)		Q-183	Shell
R-177	Shell	–	–
R-173	Obsidian	–	–
R-174	Obsidian	–	–
Mid-city east (Milpa 10)		–	–
R-137	Obsidian	–	–
Downtown (Milpa 11)		South between center and wall (Milpa 4)	
R-155	Obsidian	Z-119	Chert, shell
R-110b	Obsidian, shell	Z-120	Obsidian, chert, shell
Workshops known at Mayapán (not investigated by PEMY)			
S-139 (mid-city east, near Milpa 10)	Chert	Brown (1999:459)	
S-82/S-129 (mid-city east, near Milpa 10)	Chert	Masson, personal observation, 2002	
Q-242 (downtown next site center)	Chert	Masson, personal observation, 2002	
R-183 (downtown near Milpa 32)	Copper	Paris and Cruz Alvarado (2012)	
Q-92 (in site center)	Copper	Paris and Cruz Alvarado (2012)	

Note: Z-119/Z-120 are adjacent houselots and are not fully divided by walls. They form part of the same residential group presents the archaeological data from Mayapán that reveals a complex record of production and consumption activities at the city.

MAYAPÁN'S PRODUCTION INDUSTRIES

Mayapán's location is not physiographically unique for the northwestern Yucatán plains. The city was not situated in a place that offered special agricultural, aquatic, or other natural resource advantages. Its location is most likely due to specific political and historical contingencies that have yet to be identified. The city was centrally located and could have taken advantage of inland routes across the confederacy and it was not prohibitively distant from the northern coast of the peninsula. The ability to attract an artisan work force would have been essential for establishing and maintaining its position of political importance. Residents of the urban center were busy and productive: crops were cultivated; game, fish, and fowl were hunted and raised; and raw materials were converted into more useful and valuable craft items at the city's houselots. The acquisition of money, in the form of cacao beans, shell beads, and other items (figure 6.2) was an essential component of trade that fostered houselot dependencies (e.g., Freidel, Reese-Taylor, and Mora-Marin 2002; Freidel and Shaw 2000).

Textiles

Spindle whorls are scarce at Mayapán compared to other Postclassic Maya sites near the Caribbean coast (figure 6.7). Ratios of ceramic spindle whorls to ceramic sherds are less than .00003 for Mayapán in contrast to those from the small Belize sites of Laguna de On and Caye Coco, with .002 and .0001, respectively (Masson, Hare, and Peraza Lope 2006). A high number of 76 whorls is reported from Cozumel samples (Phillips 1979). This low ratio for Mayapán was consistent in data examined from the Carnegie, INAH, and PEMY projects. From our test pit excavations, three spindle whorls were found in a sample of over 100,000 sherds, and similarly, the Carnegie project publications (Masson 2009) report thirteen spindle whorls despite the recovery of a sample of 390,144 sherds analyzed by Robert E. Smith (1971:table 1a). Of the nineteen total spindle whorls recovered from INAH and PEMY project investigations through 2009, two are of Terminal Classic slate pottery and predate the city (Shiratori 2008:table 16.1). Molded forms recovered include flat, biconvex, hemispherical, and "cupcake" cross-sections (Shiratori 2008:table 16.1). Sampling issues are not responsible for the paucity of whorls

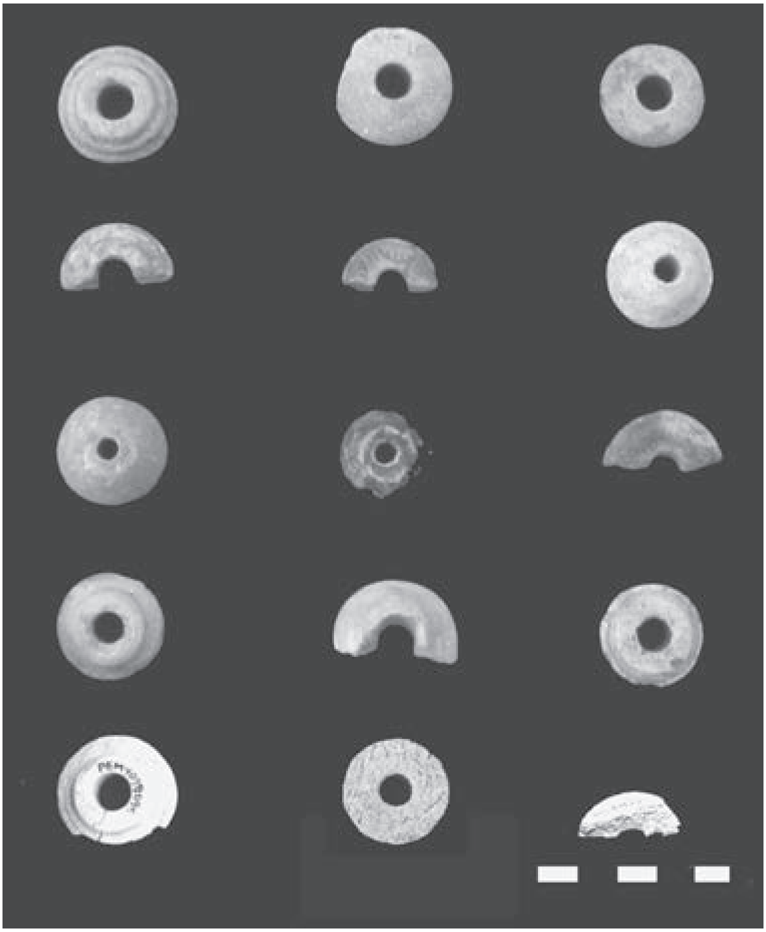

Figure 6.7. *Spindle whorls from Mayapán. At the bottom right are two human bone spindle whorls recovered from House Q-40a and Hall Q-54.*

at Mayapán, as the sample includes eight fully excavated houses in four neighborhoods. One clay spindle whorl was present among these houses, from a family grave at House Q-39. An unusual example includes a spindle whorl–sized, perforated, flat human bone disk recovered from dwelling Q-40a (figure 6.7). A fragment of a similar human bone whorl was found by Peraza Lope's INAH project at a nearby hall, Q-54 (figure 6.7). The Q-40a example measures 2.6 centimeters in external diameter, and its hole diameter is .78 centimeters, similar to dimensions reported by Yuko Shiratori (2008) for pottery whorls.

Notably, House Q-40a is an artisan locality that is attached to elite group Q-41; it is not difficult to imagine the symbolic importance of thread woven with a human bone whorl.

Cotton is grown in small quantities in Yucatán today in the kitchen gardens of Telchaquillo. Ideal growing conditions for cotton are not uniform in the northwest part of the peninsula compared to everywhere else in the Maya lowlands. Soil depth and moisture requirements (Reents-Budet 2006:115) are particularly substandard around Mayapán. But production of cotton thread may have been less important at the ancient city than weaving and embroidery. Significant quantities of thread may have been exchanged into the site. Similarly, while some cacao can be grown in moisture sinks in the Yucatecan landscape (Kepecs and Boucher 1996), Mayapán was deeply vested in obtaining these beans in quantity from distant locales. As the city's elites received cotton mantles as tribute, we know that at least some cotton products arrived at the city from other towns. The earlier Classic-era site of Dzibilchaltun also may have emphasized other industries and opted to import thread, as perforated sherds and molded pottery whorls are uncommon at that settlement (Taschek 1994:214, 219). The labor-intensive nature of cotton production makes it a logical industry for the spatial segregation of labor for a state with the power to make this happen (Berdan 1988). Dorie Reents-Budet (2006:116) describes the arduous tasks of tilling, hoeing, weeding, culling, eliminating pests, and watering cotton plants. She points out that once bolls are harvested, they must be hand processed and cleaned, their seeds removed, and the fibers combed and fluffed before being spun into thread. Given that tribute in mantas numbered in the tens of thousands in the Contact Period (Reents-Budet 2006:116), we can surmise that the needs were great during Mayapán's era. We suspect that Mayapán textile makers concentrated on later production stages that accorded cloth with greater value.

The environs of Mayapán are among the driest of the Maya region (Folan 1983:figure 3), and plants like maguey and henequen thrive locally. It is probable that fiber industries from these plants were also important for the site. Abundant bone tools are present in many contexts that resemble those associated with rope, mat, and basket production at other Mesoamerican sites, as we discuss in detail in the next section. Whorl weight may be more important than whorl diameter for distinguishing maguey from cotton whorls, but this distinction is complicated by the fact that some maguey fibers could be fine and of high quality (Carpenter, Feinman, and Nicholas 2012). The Mayapán whorls measured by Shiratori (2008:table 16.1) exhibit a close range of measurements, with an average whorl diameter of 2.8 centimeters (range 2.4–3.2

centimeters, standard deviation .2 centimeter) and an average hole diameter of .9 centimeter (range .7–1.0 centimeter, standard deviation .1 centimeter). These fall within the ranges of almost all of the whorls reported for El Palmillo, Oaxaca, where cotton and maguey thread was spun, but they are in the upper range of sizes for that site (Carpenter, Feinman, and Nicholas 2012:figure 3).

Bone Tools

The ubiquity of bone tools found at Mayapán suggests that their production was an important industry and a logical outgrowth of the abundance of game and fish. Deer bone tools are especially important (Pollock and Ray 1957:653). Animal bones were sometimes fashioned into tools needed for the manufacture of other crafts such as weaving and sewing. Animal products were also made into fine craft items such as animal crania headdresses, musical instruments, or ornaments. The bone tool industry at Mayapán may reflect, among other activities, later stages of cloth production. Thread may have been woven into mantles or plain mantles converted and embellished through embroidery and the use of dyes. Sharpened, polished bone implements and deer metapodial bone awl-like tools are particularly common in the site's assemblage (figure 6.8). A total of 372 bone tools have been analyzed from the PEMY (N = 116) and INAH (N = 256) projects in the site center. Ongoing faunal analysis from the 2008–2009 seasons will likely reveal more examples. Initial studies by Juliana Novic (2008) and Jonathan White et al. (2012) have been augmented by additional lab analysis by Marilyn A. Masson and Elizabeth H. Paris, and this work provides a general morphological and functional classification. The combined results of these studies are presented in tables 6.4 and 6.5.

Worked bone was used for a variety of functions. Table 6.4 lists 233 objects that were probably tools used to make other products. A total of 139 ornaments, instruments, and other decorative items are listed in table 6.5. Split deer metapodials (commonly referred to as awls) represent just over one-third of the entire collection of 372 objects (N = 127, 34 percent). The awls exhibit variation in the symmetry and workmanship of the pointed end and broken fragments were sometimes resharpened (figure 6.8). Eighteen other pointed bone artifacts (including eleven antler tines) and twenty thin perforator-like objects (including seven fish spines) were present in the sample. Perforators and needles (figure 6.8) are identified by their small circumference, and sea bass dorsal spines were sometimes perforated for threading (17 of 28 needles were fish spines). Sharpened fish spines may have been used for bloodletting or tattooing, if Tozzer's analogy to practices in Panama is correct (Pollock

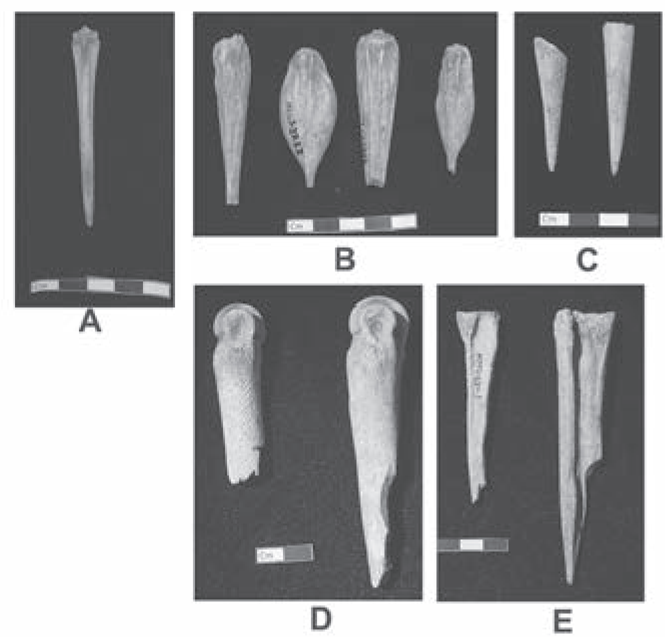

Figure 6.8. *Bone tools are common at Mayapán and reflect the importance of late-stage textile-working activities such as weaving, embroidering, and embellishing. Such tools include modified fish spines (A, B) and metapodial awls (C, D, E).*

and Ray 1957:652; Tozzer 1941:notes 396, 525). The working end of some awls was flattened with a spatulate appearance that appears designed for a specific task (twelve of 127), and eight other spatula-like (non-metapodial) tools were found along with flattened mammalian long bones that closely resemble weaving picks (table 6.4). Other items included one bone scoop, one scraper, and twenty unfinished, worked bone splinters (table 6.4). We have previously described drilled bone disks that resemble spindle whorls (figure 6.7).

The probable use of needles and bone spindle whorls is relatively clear, in contrast to deer metapodial (and other tapered long bone) tools that had a range of potential applications. For example, pointed bone objects were used for nose perforation in the context of nose plug insertion. Deities in the Borgia Codex are also equipped with pointed femurs used as ritual weaponry, sometimes linked to eye-gouging or other violent or sacrificial acts, and they are also

Table 6.4 Animal bone tool contexts and classifications, N = 233 (INAH-PEMY 1996–2009). Asterisks mark fully excavated contexts for which analysis is ongoing.

Deer metapodial bone tools (tapered, pointed)					
Q-151 (hall)	Tapered	1	Q-96 (platform)	Tapered	1
Q-152 (temple)	Tapered	1	Q-97 (hall)	Tapered	6
Q-152c (hall)	Spatulate	1	Q-99 (hall)	Spatulate	1
Q-162 (temple)	Tapered	1	F-13 (house)	Blunted	1
Q-162 (temple)	Blunted	1	H-11* (house)	Tapered	4
Q-162 (temple)	Spatulate	1	H-15z/e* (grave)	Tapered	2
Q-163 (hall)	Tapered	1	I-55a* (house)	Tapered	6
Q-163 (hall)	Spatulate	1	J-130 (house)	Tapered	1
Q-176a* (house)	Tapered	4	INAH Lote 1254	Tapered	1
Q-303 (workshop)	Tapered	1	INAH Lote 4000	Spatulate	1
Q-39* (house)	Tapered	2	INAH Lote 6392	Tapered	1
Q-54 (hall)	Tapered	18	INAH n/a	Tapered	2
Q-54 (hall)	Blunted	1	Milpa 11 surface	Spatulate	1
Q-54 (hall)	Spatulate	1	P-114 (house)	Tapered	2
Q-56 (house	Tapered	3	P-117 (house)	Tapered	1
Q-57 (unknown)	Tapered	4	P-117 (house)	Spatulate	1
Q-58 (temple)	Tapered	5	P-150 (house)	Tapered	1
Q-61/Q-58	Tapered	1	R-106 (palace)	Tapered	1
Q-64 (hall)	Tapered	3	R-108 (palace)	Spatulate	1
Q-66 (oratory)	Tapered	1	R-137 (house)	Tapered	1
Q-67 (house)	Tapered	1	R-151b (house)	Tapered	1
Q-69 (shrine)	Tapered	1	R-155 (house)	Tapered	1
Q-70 (hall)	Blunted	1	Y-43 (house)	Tapered	1
Q-72 (hall)	Tapered	1	Y-43 (house)	Spatulate	1
Q-74a (shrine)	Tapered	2	Y-44 (house)	Tapered	1
Q-79a (shrine)	Tapered	5	Y-45* (house)	Tapered	1
Q-82 (temple)	Spatulate	1	Z-120 (house)	Tapered	1
Q-87 (hall)	Tapered	1	Z-43 (outbuilding)	Tapered	1
Q-88a (hall)	Tapered	1	Z-47 (house)	Blunted	1
Q-92 (house)	Tapered	11	–	–	
Q-94 (shrine)	Tapered	1	–	–	
Q-95 (temple)	Tapered	3	–	–	
Q-95 (temple)	Curved splinter	1	–	–	
Subtotal metapodial tools					127

Table 6.4—*continued*

Flattened mammal long bone weaving pick-like implement		
I-55a* (house)	–	1
Q-152c (hall)	–	1
Q-54 (hall)	–	3
Q-80 (temple)	–	1
S-132a (house)	–	1
Subtotal weaving pick		7

Bone spindle whorl		
Q-54 (hall)	Human	1
Q-40a* (house)	Human	1
Q-56 (house)	Large mammal	1
Subtotal bone whorl		3

Bone perforator		
Q-162 (temple)	–	3
Q-54 (hall)	–	2
Q-67 (house)	–	1
Q-64 (hall)	Fish	1
Q-81 (hall)	Fish	1
Q-92 (house)	Fish	1
Q-79 (shrine)	Fish	1
Q-97 (hall	Fish	1
Q-53 (house)	Fish	1
Q-74a (shrine)	Fish	1
Q-64 (hall)	–	1
Q-72 (hall)	–	1
Q-92 (house)	–	2
Q-95 (temple)	–	1
R-183b (house)	–	1
R-137 (house)	–	1
Subtotal perforator		20
Other pointed bone tools		
H-11* (house)	–	1
P-114 (house)	–	1
Q-152 (temple)	Triangular	1
Q-162 (temple)	Triangular	1
Y-44 (house)	Triangular	1
Q-163 (hall)	–	1

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Needle		
I-55a (house)	Bone splinter	1
K-69b (house)	Bone splinter	1
P-71a (house)	Bone splinter	1
P-28b (house)	Bone splinter	1
INAH n/a	Bone splinter	3
H-20 (house)	Fish bone	1
Q-152 (temple)	Fish bone	3
Q-72 (hall)	Fish bone	2
Q-95 (temple)	Fish bone	1
Q-54 (hall)	Fish bone	4
Q-303 (workshop)	Fish bone	1
P-117 (house)	Fish bone	1
K-69b (house)	Fish bone	1
I-55a (house)	Fish bone	1
Q-64 (hall)	Fish bone	2
Q-79 (shrine)	–	1
Q-92 (house)		1
Q-97 (hall)		1
R-151b (house)	–	1
Subtotal needles		28
Mammal bone splinters—partly worked		
L-28* (house)	–	1
INAH Lote 163	–	1
M-60a (house)	–	1

continued on next page

Table 6.4—*continued*

Other pointed bone tools (continued)			*Mammal bone splinters (continued)*		
Q-67 (house)	–	1	Q-54 (hall)	–	1
Q-64 (hall)	Antler tine	1	P-114 (house)	–	1
Q-92 (house)	Antler tine	5	P-28b (house)	–	1
Q-54 (hall)	Antler tine	1	P-71a (house)	–	2
Q-55 (oratory)	Antler tine	1	INAH n/a	–	1
Q-95 (temple)	Antler tine	1	Q-152 (temple)	–	2
Q-97 (hall)	Antler tine	2	Q-176* (house)	–	1
Subtotal other pointed tools		18	Q-41 (palace)		1
Scoop, scraper, spatula			Q-41 (palace)		1
Q-83 (oratory)	Scoop	1	Q-56	–	1
Y-45* (house)	Scraper	1	Q-92 (house)	–	1
Q-152 (temple)	Spatulate	1	R-137 (house)	–	1
Q-162 (temple)	Spatulate	1	R-155 (house)	–	1
Q-54 (hall)	Spatulate	1	R-204 (house)	–	1
R-155 (house)	Spatulate	2	S-132a (house)	–	1
Y-43 (house)	Spatulate	1	Subtotal unfinished splinters		20
Q-64 (hall)	Spatulate	2			
Subtotal scoops, etc.		10			

part of sacred bundles (e.g., Díaz, Rodgers, and Byland 1993:6, 26, 62, plate 16). The Borgia bones appear as femurs (of human or deer size), with red-painted proximal epiphyses intact. Similarly, in the Madrid Codex (pages 40c–41c), pointed bones were used as perforators and bloodletters (Von Nagy 1997:53). Use wear and residue analysis are needed to positively ascertain the functions of awls and other pointed bones, but it is reasonable to suggest that a significant proportion were dedicated to textile industries. High quantities of quite similar bone tools are reported from the site of El Palmillo, Oaxaca, where they are associated with a cotton and maguey fiber industry (Feinman and Nicholas 2011:42, figure 12; Carpenter, Feinman, and Nicholas 2012:table 6, figure 8). The function of some modified bones is unclear, such as 13 modified pneumatic marine fish spines. These bulbous fish spines (N = 32) were regularly shaped into pointed objects that may have had a utilitarian purpose; a few of these were long and tapering, but most were ovoid in shape (table 6.5, figure 6.8b).

Table 6.5 Animal bone ornaments, flutes, rasps, and other crafted objects (N = 139).

Bone tube, possibly a flute		
Q-58 (temple)	–	1
Q-72 (hall)	–	1
Q-80 (temple)	–	1
Y-111 (house)	–	1
Lot 5129	–	1
R-155 (house)	–	1
Subtotal bone flute		6
Drilled tooth pendant		
Q-66 (oratory)	Human	1
H-11* (house)	Dog	1
Q-54 (hall)	Dog	1
Q-54 (hall)	Peccary	1
Q-83 (oratory)	Dog	1
Q-79A (shrine)	Mammal	1
INAH 3475	Mammal	1
Q-69 (shrine)	Peccary	1
Q-70 (hall)	Peccary	1
Q-82 (temple)	Peccary	1
P-28b (house)	Peccary	1
Q-39* (house)	Shark	1
Q-95 (temple)	Crocodile	1
Subtotal drilled tooth		13
Animal tooth filed and polished		
H-11* (house)	Dog	1
INAH 4000	Mammal	1
Q-92 (house)	Dog	1
Subtotal worked tooth		3
Misc. shaped bone object—human		
Q-81 (hall)	–	1
Q-64 (hall)	Spatulate	1
Q-92 (house)	Notched	1

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Bone tube, partly worked		
Y-45* (house)	Large animal	1
Y-111 (house)	Large animal	1
P-28b (house)	Turkey	1
Q-54 (hall)	–	1
Q-92 (house)	–	2
Subtotal unfinished tube		6
Rasp		
Q-54 (hall)	Deer	1
Q-72 (hall)	Large mammal	1
Q-54 (hall)	Human	2
Q-55 (oratory)	Human	1
Q-68 (house)	Human	1
Q-92 (house)	Human	1
H-11* (house)	Human	1
Q-55 (oratory)	Large mammal	1
Q-58 (temple)	Large mammal	1
Q-92 (house)	Turkey	1
Subtotal rasp		11
Bone bead		
Q-303 (workshop)	Fish	1
Q-79 (shrine)	Fish	1
INAH 5130	Fish	1
INAH 165(10)	Fish	1
Q-64 (hall)	–	1
Q-92 (house)	–	1
Q-95 (temple)	–	1
Q-74a (shrine) (house)		1
P-115b (house)	Shark/ray	2
P-71a (house)	Shark/ray	2
Q-54 (hall)	–	1
Q-58 (temple)	Shark/ray	1

continued on next page

Table 6.5—*continued*

Misc. shaped bone object—human		
Q-95 (temple)	Perforated	1
Q-58 (temple)	Pointed, shaped	2
Q-74a	Pointed	1
Subtotal misc. shaped bone object—human		7

Bone bead		
P-114 (house)	Shark/ray	2
Q-41 (house)	Shark/ray	2
R-155 (house)	Shark/ray	1
Q-97 (hall)	Shark	1
Q-39* (house)	Shark	1
Q-69 (shrine)	Turtle	1
Q-162 (temple)	Turkey (tube bead)	1
Q-58 (temple)	Turkey (tube bead)	1
P-28b (house)	Turkey (tube bead)	1
Q-303 (workshop)	Turkey (tube bead)	1
F-13 (house)	Turkey (tube bead)	1
Subtotal bead		27

Misc. shaped bone object—animal		
Q-162 (temple)	Fragment	1
Q-54 (hall)	Fragment	1
Q-58 (temple)	Fragment	1
R-106 (palace)	Fragment	1
R-142c (oratory)	Fragment	2
Q-58 (temple)	Fragment	1
F-13 (house)	Rectangular	1
Y-45 (house)	Rectangular	1
R-155 (house)	Rectangular	1
P-28b (house)	Rectangular	1
Itzmal Ch'en	Rectangular	1
Q-54 (hall)	Rectangular	1
Subtotal shaped animal		13
Highly burned and polished bone		
L-28 (house)		1
I-55a* (house)		1

continued on next page

Spines		
Q-152 (temple)	Pneumatic	3
Q-54 (hall)	Pneumatic	7
Q-80 (temple)	Pneumatic	1
R-171c (house)	Pneumatic	2
Y-43 (house)	Pneumatic	1
INAH 5175	Pneumatic	1
INAH 6352	Pneumatic	1
INAH 163	Pneumatic	1
P-117 (house)	Pneumatic	1
INAH	Pneumatic	1
Q-57 (unidentified alignment)	Pneumatic	2
Q-64 (hall)	Pneumatic	2
Q-92 (house)	Pneumatic	4
Q-95 (temple)	Pneumatic	2
Q-97 (hall)	Pneumatic	2
R-183b (house)	Pneumatic	1

continued on next page

Table 6.5—*continued*

Highly burned and polished bone			*Spines*		
H-15* (mass grave/hall)		1	Q-152 (temple)	Stingray	1
Q-95 (temple)		2	Q-162 (temple)	Singray	1
Q-74a (shrine) (house)		1	Q-82 (temple)	Stingray	1
Subtotal burned/polished		6	Q-54 (hall)	Stingray	1
Perforated, notched, grooved			P-117b (house)	Stingray	1
Q-54 (hall)	–	3	INAH	Stingray	1
Q-95 (temple)	–	1	Subtotal spine		38
Q-81 (hall)	–	1	*Earspool*		
INAH	–	1	Q-95 (temple)	Human	1
Q-92 (house)		1	Q-80 (temple)	Shark	1
Subtotal engraved		7	Subtotal earspool		2

Figure 6.9 illustrates some of the more exceptional craft items made from animal bone. A total of 139 bone craft objects or fragments are represented in the sample (table 6.5). Thirteen drilled teeth were identified, including those of dog, peccary, shark, crocodile, and one human (table 6.5, figure 6.9a). Six bone tubes with perforated holes were probably flutes, and six additional tubes may represent unfinished flutes (table 6.5, figure 6.9b). A puma or jaguar femur was nicely cut and may have been intended to be part of a staff (figure 6.9c). The sample included twenty-seven bone beads of fish, shark, ray, turtle, or turkey (table 6.5, figure 6.9d). Two bone earspools were present, one of human bone and the other made from a shark vertebra (figure 6.9d). Eleven notched shafts made of human, large mammal, and turkey long bone represented rasps (figure 6.9e). Six stingray spines were identified. Other worked fragments of ornamental bone that were polished, shaped, perforated, or engraved are listed in table 6.5.

The spatial distribution of bone objects indicates the widespread nature of activities involving their use. In general, bone artifacts are recovered across much of the site in low frequencies, with some exceptions that might link structures to specialized activities (tables 6.4, 6.5). Ornamental or musical objects were more common at the site center, as indicated by the number of structures from grid Square Q listed in table 6.5. Only seven of thirty-five test pit or surface collection contexts in the settlement zone had four or more bone tools; five were located in downtown Mayapán next to the site center (P-114, P-28b, R-155, Q-41, Q-303) and two were in other locations (Y-43, P-71a).

All but group Q-41 were commoner dwellings. Faunal analysis (still in progress) from fully excavated dwellings has identified four bone tools from Y-45a and Q-39, five from Q-176; and Houses H-11 and I-55a are distinguished by slightly higher quantities. Ten pointed bone objects were found from House I-55a. Two needles were among the I-55a assemblage, along with two tapered metapodials and one flattened long bone weaving pick-like item; these suggest that textile production was important at this locality. One piece of burned and polished bone was also at I-55a. Metapodial or other tapered bone tools were also particularly abundant in full excavation samples of House H-11 (N = 5) and House Q-176 (N = 4). In contrast, no awls were recovered in the assemblage from fully excavated House L-28, which contained only one bone splinter and one piece of polished bone. House X-43 (fully excavated) had no bone artifacts. The quantity and type of metapodial tools at I-55a and, to a lesser extent, H-11 and Q-176 implies greater involvement in textile production than at houses like L-28 and X-43; these items were not a regular part of every household toolkit. Although Q-176 is slightly larger and more elaborate, the other houses are comparable in terms of size and degree of elaboration. Additional houses identified from test pit samples that may have been involved in textile working, as suggested by two or more metapodial or other weaving tools, include Y-43 (N = 2), P-114 (N = 3), and R-155 (N = 3).

A different type of concentration is present in the patio of house group P-28, in the downtown crafts district west of the site center (as indicated by a 1 × 2 meter test pit sample). At P-28, six bone objects included two beads or pendants, one needle, one inlay fragment, one turkey bone tube, and one polished bone splinter (tables 6.4, 6.5). This assemblage is more likely to reflect a combination of activities that involved making musicial instruments, sewing (and/or bloodletting), and making or acquiring bone ornaments. Other contexts also had a mixture of items that represent ornaments, instruments, or crafting tools. For example, a midden associated with House R-155, next to a cluster of palaces east of the site center, revealed seven bone objects (1 × 2 meter test pit sample), including one bead, one possible flute, two spatulate tools, one metapodial tool, one unfinished splinter and one rectangular inlay piece. Like that of P-28, this assemblage suggests involvement in a variety of crafting activities.

Monumental zone samples were hand sorted and not routinely screened, but this method was generally consistent due to continuity in a local, highly skilled labor force. While some sampling errors may plague the data, differential frequencies at structures in the site center imply specific activities involving bone objects at several locations. A total of 256 bone artifacts in

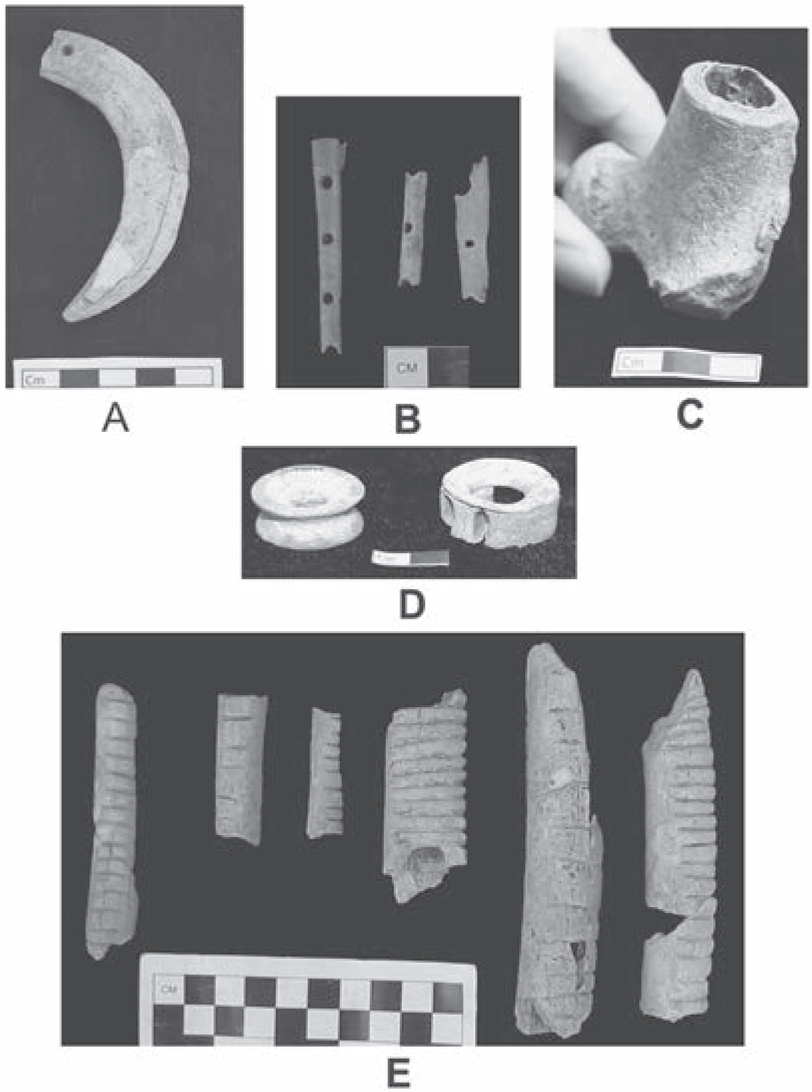

Figure 6.9. *Bone ornaments and instruments from Mayapán, including a perforated peccary tooth (A), bird bone flutes (B), a carved puma or jaguar femur (C), a shark vertebra earspool and a shark vertebra bead (D), and human long bone rasps (E).*

the sample came from the monumental center—of these, 236 are from thirty-three secure contexts (tables 6.4, 6.5). Nineteen of these contexts had one to three objects, five had four to six items, and nine contexts had eleven or more artifacts. Generally, the distribution of bone objects by monumental building type is close to the proportion each building type represents in the sample, but three types of buildings had more bone artifacts than might be expected. Halls, monumental zone houses, and temples formed 36 percent, 18 percent, and 21 percent of the sample of structures yet had 42 percent, 21 percent, and 25 percent, respectively, of the monumental center assemblage of bone objects. Oratories and shrines represented 9 percent and 12 percent of the structure samples, and these building types had 3 percent and 8 percent, respectively, of the bone artifacts. A tendency for greater use of bone items at halls, monumental zone houses, and temples is thus inferred, and this variation is accounted for by examining the frequencies at individual structures. Seventy percent of the 236 bones from known monumental contexts are from nine structures with eleven to fifty-three artifacts. Hall Q-54 had the largest sample, with fifty-two modified bones (tables 6.3, 6.4). The next largest assemblage is found at House Q-92, with thirty-three bones, followed by Temple Q-95 (N = 16), Halls Q-64 (N = 14) and Q-97 (N = 13), and Temples Q-58 (N = 13), Q-152 (N = 12), and Q-162 (N = 11).

The Hall Q-54 assemblage includes twenty deer metapodial tools, three rasps, three probable weaving picks, two animal tooth pendants, one shark vertebra bead, four other pointed objects, four fish bone needles, seven altered pneumatic spines, one bone tube, and seven other artifacts. The metapodial tools, weaving picks, and needles suggest some production activities at this locality, although ceremonial use is a possible alternative. Analogous assemblages of artifacts are present at two other halls. Hall Q-64 had three metapodial tools, two spatulates, two needles, two perforators, one antler tine, two pneumatic spines, and a bead, a spatula, and a shaped bone fragment. Hall Q-97 had six metapodial tools, one needle, one perforator, two antler tines, two pneumatic spines, and a shark vertebra bead. Material from monumental zone House Q-92 had 11 metapodial tools, four pneumatic spines, three bone perforators, one splinter, one needle, five antler tines, a polished dog tooth, one fish vertebra bead, two bone tubes, two rasps, and two pieces of shaped bone. Copper bell production also occurred at this house, which is identified as a luxury crafting locality (Paris 2008).

Bone items at temples overlapped with those found at halls. Temples Q-58, Q-95, Q-152, and Q-162 had the greatest number of bone artifacts. All had metapodial tools, although sacrificial Temples Q-58 and Q-95 had greater quantities (N = 5, N = 4). While only one metapodial tool was found at the other two temples, each also had a spatulate tool and another pointed bone object. Q-162 had three perforators, and both Q-152 and Q-162 had a stingray spine. Q-58 was distinguished from the other two by the presence of a flute and a rasp. Temple Q-158, unlike the other two, had three bone needles, three pneumatic fish spines, and two bone splinters. Beads were present at Q-58 and Q-162, and a crocodile tooth pendant and human bone earspool were found at Q-95. Temple Q-95 had the greatest diversity, with nine different categories of objects, including (beyond those already mentioned) a needle, perforator, other pointed bone, shaped pieces (N = 4), and pneumatic spines (N = 2) while the other temples had from five to seven types of artifacts (tables 6.4, 6.5). The large drilled crocodile tooth pendant from Q-95 is the only example found at Mayapán. The sacrificial rites at this burial shaft temple may explain the presence of trophy objects, including the human bone earspool and perforator. A crocodile is featured in the fisherman mural atop this building, and the pendant may have reflected a reference to the Tlatecuhtli deity (chapter 2).

Small Shrines Q-79, Q-79a, Q-74a, and Q-69 had eight metapodial tools among them as well as two fish spine perforators and one needle, three bone beads, two animal tooth pendants, and two pieces of shaped bone. As these vicinities were associated with public buildings of the site center, overlap in the objects recovered from their general facilities is not surprising But Shrine 74a, more isolated and within the site's Main Plaza, had two metapodial tools.

Like the other monumental buildings with higher quantities of bone objects, the temples and shrines have a mixture of items that represent personal possessions, musical instruments, and ritual use. Ceremonious usage of these items is easily envisioned. Metapodial tools could also have been used for ritual mutilation; awls or weaving picks may have been worn in headdresses of deity impersonators (e.g., Vail and Stone 2002); fish spines may have been useful in bloodletting; and finished objects such as beads or rasps could have been discarded in the context of many possible behaviors. Rasps made of human bone were probably deeply symbolic, representing relics of revered ancestors or, perhaps, sacrificed war captives. But the overlap of hall and domestic assemblages within the monumental center may suggest some use of the public buildings for production. Production of certain items may have itself been of great symbolic importance and geared toward special occasions (e.g., McAnany 2010:115–21). Some ritual occasions may have also called for offerings that included goods essential to daily life (chapter 2, figure 2.13).

Who used the public plazas and the buildings that framed them, especially the relatively open colonnaded halls? It is difficult to say whether tools were discarded casually or formally at these locations or whether they belonged to the noble patrons of the edifices or visitors who frequented the Main Plaza. At Xochicalco, artifact distributions also suggested overlap in the use of public precinct buildings and domestic contexts, leading the investigators to suggest that retainers living in the precinct sometimes undertook ordinary activities in support of patrons or events sponsored at the site center (Cyphers and Hirth 2000:130–31). At Mayapán, similar behavior seems likely. Parallels are observed for many artifact categories beyond bone tools. Small houses such as Q-92 were next to public buildings and probably housed retainers. Other houses excavated in Mayapán's monumental precinct, such as Q-56, had fewer bone tools (three metapodial tools, one bone spindle whorl, and one splinter) that indicate lesser engagement in textile production. Some halls—for example, Q-72—had fewer bone tools (N = 6), and while activities may have overlapped with other central edifices, they were not as important.

Marine Shell

Shell ornament production at Mayapán is widespread and diverse, and the city was fully reliant on trade networks with coastal sites to obtain raw marine shell materials for this industry. A total of 2,632 shell items have been identified from the INAH and PEMY projects, including 2,601 marine shells, of which 2,304 were identified and 296 consisted of unidentified fragments (table 6.6). An additional 32 specimens include fossil shells, coral, or inland aquatic *Pomacea* snail fragments. The marine shell sample is closely split between gastropods (55.3 percent) and bivalves (44.7 percent). A variety of products were made, including ornaments, cups, and occasional tools (chisels or celts). One of the more remarkable shell objects found previously at Mayapán is a shell "collar" type of object carved with hieroglyphs and numerical coefficients that Tatiana Proskouriakoff (1953:283) identified as part of the Tzolkin day count.

Ornaments are of particular interest due to the use of beads (particularly red ones) as currency (Tozzer 1941:95, 231n418). Two main bead forms are present in our sample: discoidal and cylindrical. Other than red and white shell beads, what other ornaments may have been used as units of exchange? We argue that suspended olive/*Prunum* and *Spondylus* ornaments also fit reasonable criteria for currency items (figure 6.10), as Colonial Spanish references to "beads" may have included a variety of suspended, drilled shells beyond the

Table 6.6 List of identified shell from INAH (1996–2004) and PEMY (2001–2009) projects. Percent given is that of 2,304 identified shells. Total sample included 2,632 shells, with 296 unidentified shell fragments and 32 fossils, coral, or non-marine shells.

Taxonomic name	*Number*	*Percent of 2,304*	*Common name, attributes of interest*
Strombus sp. and conch	873	37.90	Conch
Dinocardium	338	14.70	Giant cockle
Dosinia sp.	154	6.70	Small bivalve
Oliva sp.	149	6.50	Olive
Bivalve	90	3.90	Bivalve
Mercenaria campechiensis	69	3.00	Quahog
Phacoides sp.	68	3.00	Small bivalve
Prunum sp.	56	2.40	Common Marginella, small gastropod, olive size
Natica sp.	52	2.30	Moon shell, small gastropod
Spondylus sp.	39	1.70	Thorny oyster
Chione sp.	38	1.60	Small bivalve
Gastropod (marine)	25	1.10	Gastropod
Anadara	24	1.00	A genus of ark clam
Arca zebra	23	1.00	Turkey wing clam
Busycon	20	0.90	Lightning whelk
Cardiidae	20	0.90	Cockles
Trachycardium sp.	20	0.90	Yellow cockle
Mytilidae	20	0.90	Mussels
Pleuroploca gigantea	17	0.70	Horse conch
Ostreidae	16	0.70	Oyster
Pectinidae	16	0.70	Scallop
Pinna carnea	16	0.70	Amber pen shell, reddish and textured like *Spondylus* but thin, fan shaped, translucent
Ficus communis	15	0.70	Paper fig shell, similar to pear whelk
Polinices lacteus	15	0.70	Also a moon shell and similar to *Natica*

continued on next page

Table 6.6—*continued*

Taxonomic name	*Number*	*Percent of 2,304*	*Common name, attributes of interest*
Anomia	10	0.40	Jingle shell/saddle oyster, very thin, uneven margins, bumpy, can be translucent when flaked
Barbatia tenera	10	0.40	Delicate ark shell
Conus sp.	10	0.40	Cone snail, gastropod, variants used in traditional African currency and kula ring exchange, brown and white coloring
Anomalocardia	7	0.30	Caribbean pointed Venus family Veneridae
Cassis	6	0.30	Helmet shell
Gouldia cerina	6	0.30	Waxy gould clam Veneridae, brown and white markings
Diodora cayenensis	5	0.20	Keyhole limpet, conical, ribbed purplish/white markings, rings
Nerita sp.	5	0.20	Checkered nerite, ribbed, black/white checkered pattern, ribbed
Haliotis sp.	4	0.20	Abalone, pearly ear shells, Venus's ear iridescent interior, pearly
Fasciolaria tulipa	4	0.20	Tulip shell
Isognomon alatus	4	0.20	Flat tree oyster
Terebra	4	0.20	Auger shell, long tapering spire
Crassostrea virginica	4	0.20	Atlantic oyster
Chama sp.	3	0.10	Leafy jewelbox oyster, looks like *Spondylus*, preserves redness
Asaphis deflorata	3	0.10	Gaudy asaphis, clam
Cyphoma sp.	3	0.10	Flamingo tongue shell, small, olive-sized but with ring-like lateral ridge
Cypraea sp. (cowry)	3	0.10	Cowry
Littorina sp.	3	0.10	Periwinkle
Melongena corona	3	0.10	Crown conch
Carditamera floridana	2	0.10	Cardita
Euvola ziczac	2	0.10	Scallop

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TABLE 6.6—*continued*

Taxonomic name	*Number*	*Percent of 2,304*	*Common name, attributes of interest*
Ischadium recurvum	2	0.10	Mussels
Lucinidae	2	0.10	Clam
Marginella sp.	2	0.10	Olive-like
Plicatula gibbosa	2	0.10	Kitten paw, related to oyster, pronounced ridges and reddish color, triangular in shape, like *Spondylus* but no spines
Pteria sp.	2	0.10	Pearly oyster, produces pearls and pearly interior
Tellina radiata	2	0.10	Sunrise tellin, smooth shell, nice color when fres
Turbinella angulata	2	0.10	West Indian chank, large conch
Veneridae	2	0.10	Venus clams
Aequipecten muscosus	1	0.04	Scallop
Architectonica nobilis	1	0.04	Atlantic sundial, pronounced spiral, pattern of square markings around spiral
Brachydontes	1	0.04	Scorched mussell
Busycotypus canaliculatus	1	0.04	Channeled whelk
Callista	1	0.04	Clam
Crepidula fornicate	1	0.04	Common Atlantic slipper snail
Cypraea or *Cymatium*	1	0.04	Cowrie or hairy trumpet, very different unless worked, both have brown markings, hard, smooth
Oliva or *Strombus*	1	0.04	Either olive or conch
Pholas	1	0.04	Campeche angel wing
Phyllonotus pomum	1	0.04	Apple murex
Pseudochama radians	1	0.04	Atlantic jewelbox, like *Chama*
Pterioida	1	0.04	Clam
Trivia candidula	1	0.04	small ribbed gastropods, olive sized, ribbed, called "cowries" in Britain, not closely related, superficial resemblance, little white trivia
Urosalpinx cinerea	1	0.04	Atlantic oyster drill, predatory, knobby rugged

discoidal and cylindrical forms. Like these latter beads, olive shell ornaments were often perforated in systematic ways and suspended as belts, tunic elements, or collars in Maya art (figure 6.10). An example that is contemporary with Mayapán is the olive shell collar worn by Kukulcan/Quetzalcoatl illustrated in the Dresden Codex (Taube 1992:figure 93). Individually suspended pendants may also have represented currency units—most notably, drilled bivalve shell forms that have longstanding use histories at Maya archaeological sites (e.g., Buttles 1992:93). The Atlantic thorny oyster (*Spondylus americanus*) shell is often shown in Classic Period art, and it was also a valuable offering in sites dating as early as the Formative Period, along with a related Pacific species (e.g., Freidel, Reese-Taylor, and Mora-Marin 2002; Moholy-Nagy 2003, 2008). *Spondylus* and other bivalves were made into pendants (figure 6.10) that were probably used as pectorals or shell chastity objects (Tozzer 1941:106). One subadult burial of about twelve years of age was identified at Mayapán commoner House L-28. This individual was probably female, as a *Spondylus* pendant was placed in the pelvic region (Peraza Lope et al. 2008:576).

Red beads made of *Spondylus* shell found archaeologically represent the red bead monies in use at the time of Spanish contact (Freidel, Reese-Taylor, and Mora-Marin 2002). But most shell beads at Mayapán are white. Similarities in the form and size of white shell beads and red *Spondylus* beads suggest to us the parallel use of white shell beads as monetary units. As discussed previously, the Relacion of Valladolid explicitly distinguishes different lengths and probable values of coral-colored beads from other beads (presumably white ones). The contextual association of white shell beads with other known currency units also implies that they functioned similarly. For example, white and red shell discoidal beads are stacked with green jade cylindrical beads in the painted, bejeweled headdress of a Chen Mul effigy censer portraying the god Itzamna (figure 6.2e). This association of these beads of three different colors supports the case that they functioned similarly as ornaments in the city's exchange system. Another example is evident in the bracelets or anklets found with a child burial at House Q-39 (figure 5.33). These adornments consisted of strings of alternating white discoidal beads and copper bells (bells were also monies). Other suspended shell objects in the grave included a white marine bivalve shell pendant (not *Spondylus*) and numerous *Spondylus* discoidal and cylindrical beads (figure 5.33). The overlap in the use of certain beads and pendants as decorative ornaments and monetary units at Mayapán matches cross-cultural expectations for premodern currencies. Freidel, Kathryn Reese-Taylor, and David Mora-Marin (2002) argue effectively that adornment is a

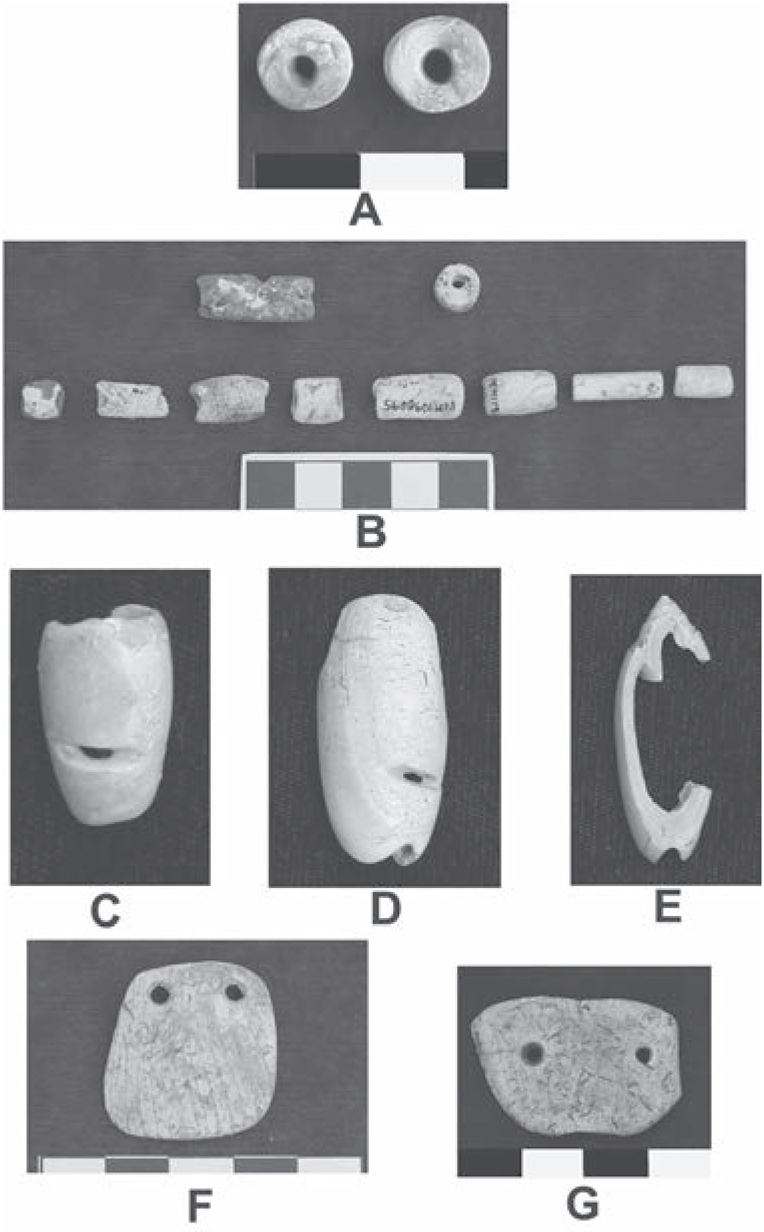

Figure 6.10. *Suspended shell objects likely to be currencies at Mayapán, including discoidal red (Spondylus) and white beads (A), cylindrical beads (B), modified Oliva and Prunum shells (C, D, E), and bivalve pendants (usually Spondylus), as shown here (F, G).*

critical component of assigning value to shell monies in the commercial realm. These authors point out that the display of these items by high-status persons establishes their value, desirability, and sanctification. Evidence abounds among ethnographic case studies for the practice of wearing monies as part of personal attire (Quiggin 1949:258).

Pieces of shell are regularly found in test pits across Mayapán. As for other craft industries, surplus shell-working contexts must be distinguished from other locations with minor quantities of debris. Shell workshops are indicated by statistical outliers with quantities equal to or beyond one standard deviation above the mean. A second important distinction is the type of shell remains that are present. Preforms and shell-working debris indicate production contexts while contexts with primarily finished ornaments are more likely to represent consumer assemblages. Examining the distribution of finished objects also contributes toward wealth assessments of elite and commoner houselots at the city. In the following paragraphs, we also suggest that distinguishing between currency and non-currency shell-object production represents a third important consideration.

There are two specific objectives to our analysis of shell. The first compares scales and types of production according to context. The second examines the products made at the city and compares them to potential shell-currency items and ornaments at other Maya sites. We identify varying scales of involvement of houselots in ornament making at Mayapán, from occasional pursuits to manufacture for exchange. Workshops that focused specifically on shell beads have not been identified, perhaps because a low rate of manufacturing failures is associated with this industry. Houselots that were engaged in surplus production used a broad range of marine shell taxa that are represented by shell flakes, cores (marine shells from which sections have been removed), ornament fragments, and partially worked pieces.

Most marine shells were brought whole to the site for the purpose of craft production. Shell species were not uniformly available along the west and north coasts of the Yucatán Peninsula (E. Andrews 1969:41–45), and this fact attests further to Mayapán's reliance on a matrix of exchange relationships to supply its craft industries and sources of currency. Mayapán was closest to the north coast, about 55 kilometers as the crow flies. While *Prunum* shell (worked similarly to olive shell) was available at some north coast beaches, *Oliva* shells are only available on the east and west coasts (E. Andrews 1969:41, table 1; Andrews et al. 1974:table 2). Due to preservation problems, shellfish would not have been a viable component of the Mayapán diet.

Frequencies of Marine Shells and Finished Shell Objects

A total of 2,632 shells were analyzed from the INAH and PEMY projects (tables 6.6, 6.7), which included 2,304 pieces of identified marine shell, 296 unidentified fragments, and 32 miscellaneous items (coral, fossil coral, fossil shell, a crab claw, and inland aquatic or terrestrial snails). These materials were identified in the field lab by Elizabeth L. France (2008), Gina Lasalla (2009), and White (White et al. 2012). *Strombus* species (conch) dominated the assemblage, forming 37.9 percent of the sample, followed by *Dinocardium* (giant cockle, 14.7 percent), *Dosinia* clams (6.7 percent), and various *Oliva* species (6.5 percent). Some identified bivalves were also relatively abundant, including *Mercenaria* (quahog, 3.0 percent) and *Phacoides* (3.0 percent) as were bivalve fragments not identified to species (3.9 percent). Other taxa forming 1 percent or more of the sample include *Prunum* (Common Marginella, 2.4 percent), *Natica* (moon shell, 2.3 percent), *Spondylus* (thorny oyster, 1.7 percent), *Chione* (a small bivalve, 1.6 percent), gastropods not identified to species (1.1 percent), *Anadara* (ark clam, 1.0 percent), and *Arca zebra* (turkey wing clam, 1.0 percent). A total of sixty-seven taxonomic identifications are listed on table 6.6, most of which formed less than 1 percent of the sample. The large amount of *Strombus* shells may reflect their large size, which would have created more debris. But their importance is also evident in the city's shell-working industries. Thirty-eight classifications of bivalves account for 44.5 percent of the total shell sample. Twenty-nine categories of gastropods form 55.5 percent of the shells, which includes *Strombus* (37.9 percent) and all other gastropods (17.6 percent).

Shells were clearly used for different purposes, and the abundance of worked or finished gastropod artifacts provides a clearer picture of their crafting trajectory. With some important exceptions, bivalve trajectories are more difficult to ascertain, as many examples merely reflect flaked debris. Table 6.6 lists some important characteristics of identified shells, many of which had specific coloring that may have contributed to their value. Table 6.7 groups identified shells based on form, size, and coloring. A group of larger, more robust gastropods, dominated by *Strombus*, also includes whelks and similar species and forms 42.6 percent of the sample. These shells were used to make the greatest range of objects, permitted in part by their large size. As noted elsewhere in the Americas, conch and whelk tools can be utilitarian, including cups, picks, chisels, and adzes (Eaton 1974; Luer et al. 1986; Masson 1988), although such objects are uncommon at Mayapán (figure 6.11). Conch shells were often used to make small discoidal or cylindrical beads, plaques, or pendants. In this respect they were used for some of the same products as bivalves. Pendants

Table 6.7 Identified shell taxa INAH-PEMY projects, organized into general taxonomic/morphological categories. (Percent shown is that of identified marine shell specimens, N = 2,304.)

Robust gastropod group	*Percent of 2,304*	*Bivalve group (except for Spondylus-like)*	*Percent of 2,304*
Strombus sp. and conch	37.90	*Dinocardium*	14.70
Gastropod (marine)	1.10	*Dosinia* sp.	6.70
Busycon	0.90	Bivalve	3.90
Pleuroploca gigantea	0.70	*Mercenaria campechiensis*	3.00
Ficus communis	0.70	*Phacoides* sp.	3.00
Conus sp.	0.40	*Chione* sp.	1.60
Cassis	0.30	*Anadara*	1.00
Fasciolaria tulipa	0.20	*Arca zebra*	1.00
Terebra	0.20	*Trachycardium* sp.	0.90
Melongena corona	0.10	*Cardiidae*	0.90
Turbinella angulata	0.10	Pectinidae	0.70
Busycotypus canaliculatus	0.04	*Barbatia tenera*	0.40
Phyllonotus pomum	0.04	*Anomalocardia*	0.30
Urosalpinx cinerea	0.04	*Gouldia cerina**	0.30
Total	42.60	*Diodora cayenensis**	0.20
Olive and similar types		*Isognomon alatus*	0.20
Oliva sp.	6.50	*Asaphis deflorata*	0.10
Prunum sp.	2.40	*Crassostrea virginica*	0.20
Cyphoma sp.	0.10	*Carditamera floridana*	0.10
Cypraea sp. (cowry)	0.10	*Euvola ziczac*	0.10
Marginella sp.	0.10	Lucinidae	0.10
Cypraea or *Cymatium*	0.04	*Tellina radiata**	0.10
Trivia candidula	0.04	Veneridae	0.10
Total	9.30	*Architectonica nobilis*	0.04
Other small, delicate gastropods		*Brachydontes*	0.04
Natica sp.	2.30	*Callista*	0.04
Polinices lacteus	0.70	*Crassostrea*	0.04
Nerita sp.	0.20	*Pholas*	0.04
Littorina sp.	0.10	*Pterioida*	0.04

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Table 6.7—*continued*

Other small, delicate gastropods	*Percent of 2,304*	*Bivalve group (except for Spondylus-like)*	*Percent of 2,304*
Architectonica nobilis	0.04	Mytilidae**	0.90
Total	3.30	Ostreidae**	0.70
Spondylus group		*Anomia***	0.40
Spondylus sp.	1.70	*Haliotis* sp.**	0.20
Pinna carnea	0.70	*Ischadium recurvum***	0.10
Chama sp.	0.10	*Pterioida***	0.04
Plicatula gibbosa	0.10	Total bivalve	42.00
Pseudochama radians	0.04	*Other*	
Total	2.60	*Crepidula fornicate*	0.04
		Oliva or *Strombus*	0.04

* special coloring when fresh
** pearly interior characteristics

and beads were made from bivalves such as *Plicatula gibbosa* and *Spondylus*, as well as species similar to *Spondylus*, including *Pinna carnea*, *Chama*, and *Pseudochama radians*. Some of the shells in this *Spondylus* group share the red color of the thorny oyster, including *Chama* and *Pinna carnea*. The *Spondylus* group forms 2.6 percent of the sample (table 6.7). As the spines of *Spondylus* were usually removed in pendants found at the city, the resemblances between these species increased with processing. The Olive group forms 9.3 percent of the sample and includes small elongate gastropods used for suspended ornaments (table 6.6). They exhibit an overlapping range of modifications: spires are often removed and horizontal notches or round perforation holes are present. These shells include *Oliva*, *Prunum*, *Cyphoma*, *Cypraea* (cowry), *Cymatium*, *Marginella*, and *Trivia candidula* (known as "cowries" in Britain but not closely related). An additional group of small, more delicate gastropods (table 6.7) tend to be about the same size as Olive group shells, but they have a more rounded and less elongate shape. These gastropods include *Natica*, *Polinices lacteus*, *Nerita*, *Littorina*, and *Architectonica nobilis*, and they form 3.3 percent of the sample. Bivalves other than the *Spondylus* group represent 42 percent of the identified shells (table 6.7); within this group, 2.3 percent are oyster or mussel shells with pearly qualities that may have been important for crafting. Some bivalves are also notable for their markings or color—for example, *Tellina radiata* (Sunrise Tellin), *Chama* (retains red coloring), *Nerita*

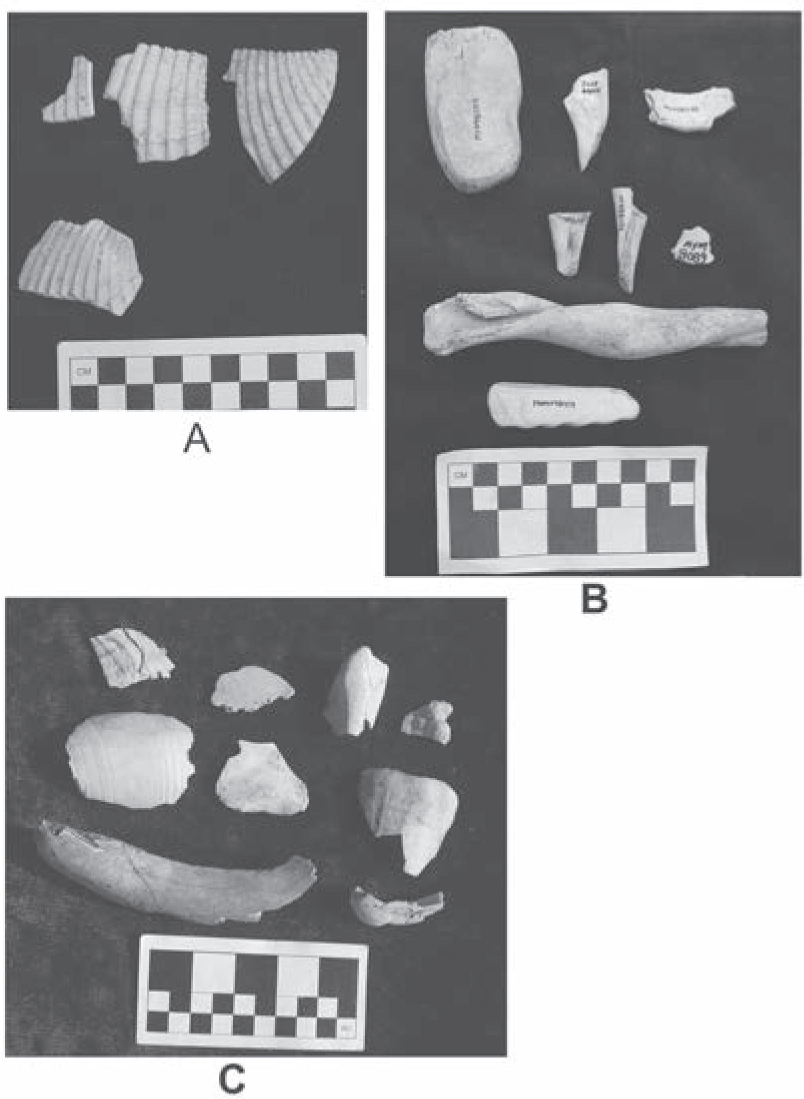

Figure 6.11. *Bivalve (Dinocardium) debris (A) and Strombus (B, C) debris from Mayapán shell workshops. These types of shells were used to make a range of ornaments and objects that are infrequent and non-systematic and were not likely to have served as currencies, unlike Spondylus and olive/Prunum suspended ornaments shown in figure 6.10 (although white discoidal beads of Strombus were probably also currencies).*

Table 6.8 Finished shell objects—INAH/PEMY contexts, N = 326.

General category	*Taxa/artifact type*	*Number*	*Percent of 326*
Bivalve pearly	Abalone worked	2	0.6
Bivalve pearly	*Anomia* ornament	2	0.6
Bivalve	*Barbatia* pendant	1	0.3
Bivalve	Bivalve pendant	3	0.9
Gastropod	*Busycon* ornament fragment	2	0.6
Bivalve	*Chione* pendant	5	1.5
Gastropod	*Conus* ornament	3	0.9
Olive group	*Cypraea* pendant	1	0.3
Bivalve	*Dinocardium* pendant/rectangular	2	0.6
Bivalve	*Dinocardium* worked	1	0.3
Bivalve	*Dosinia* worked	1	0.3
Bivalve	*Mercenaria* pendant	1	0.3
Bivalve pearly	Mytilidae bead	1	0.3
Bivalve pearly	Mytilidae pendant	1	0.3
Olive group	*Oliva* various	96	29.4
Bivalve	Pectinidae disc bead	1	0.3
Bivalve	Pectinidae pendant	1	0.3
Bivalve	*Phacoides* pendant	1	0.3
Other small gastropod	*Polinices* pendant	2	0.6
Olive group	*Prunum* various	22	6.7
Spondylus group	*Spondylus* bead	3	0.9
Spondylus group	*Spondylus* pendant	23	7.1
Spondylus group	*Spondylus* worked	1	0.3
Gastropod	*Strombus* bead	28	8.6
Gastropod	*Strombus* columnella	6	1.8
Gastropod	*Strombus* dentiform	1	0.3
Gastropod	*Strombus* pendant, not all drilled	43	13.2
Gastropod	*Strombus* bracelet	5	1.5
Gastropod	*Strombus* spoon/spatulate	4	1.2
Gastropod	*Strombus* lip tool	2	0.6

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Table 6.8—*continued*

General category	*Taxa/artifact type*	*Number*	*Percent of 326*
Gastropod	*Strombus* cup	1	0.3
Gastropod	*Strombus* worked fragment	36	11.0
Unidentified	Unidentified bead	12	3.7
Unidentified	Unidentified pendant, not all drilled	4	1.2
Unidentified	Unidentified worked	3	0.9
Fossil	Fossil shell, 2 worked bivalve, 2 longitudinally cut Marginella, 1 flattened and filed olive	5	1.5
			100.0
Pendant total			30.1
Bead total			14.7
Olive and *Prunum* ornament total			36.2

(black and white checkered pattern), *Diodara* (purplish white markings), and *Gouldia cerina* (brown and white markings).

It is interesting that some of the rarer shells found at Mayapán were important in other ancient societies for ornament making or as currencies. Close to home, *Chama* was used to make red shell beads in the Caribbean (Keegan and Carlson 2008/2009), and at the site of Ejutla, Oaxaca (Feinman and Nicholas 1993:108). The spiral of the *Conus* shell was important for currency in Africa and Oceania (Quiggin 1949:figures 7, 73) and was also used for the famed kula ring bracelets. Cowries were widely used across the Old World as a unit of exchange (Einzig 1949:147–51; Quiggin 1949:25–39).

A total of 326 finished artifacts were present in our sample of 2,632 shell objects (table 6.8). This tally is provisional, as it was sometimes difficult to determine from small fragments of worked debris (smoothed, polished, incomplete specimens) whether or not they were from completed ornaments or broken manufacturing failures. Numerous *Oliva* or *Prunum* shells exhibit a removal of the spire, lip, and/or columnella (figure 6.10) and represent a finished ornament type that dates back to the Late Preclassic in the Maya area (e.g., Garber 1989:figure 23; Aizpurúa and McAnany 1999:122–23). Figure 6.12 illustrates examples of polished or partially worked *Oliva* and *Prunum* shells and a whole *Cypraea*. Such specimens were often completely smoothed and polished, and this may have been an early step in ornament making. Although

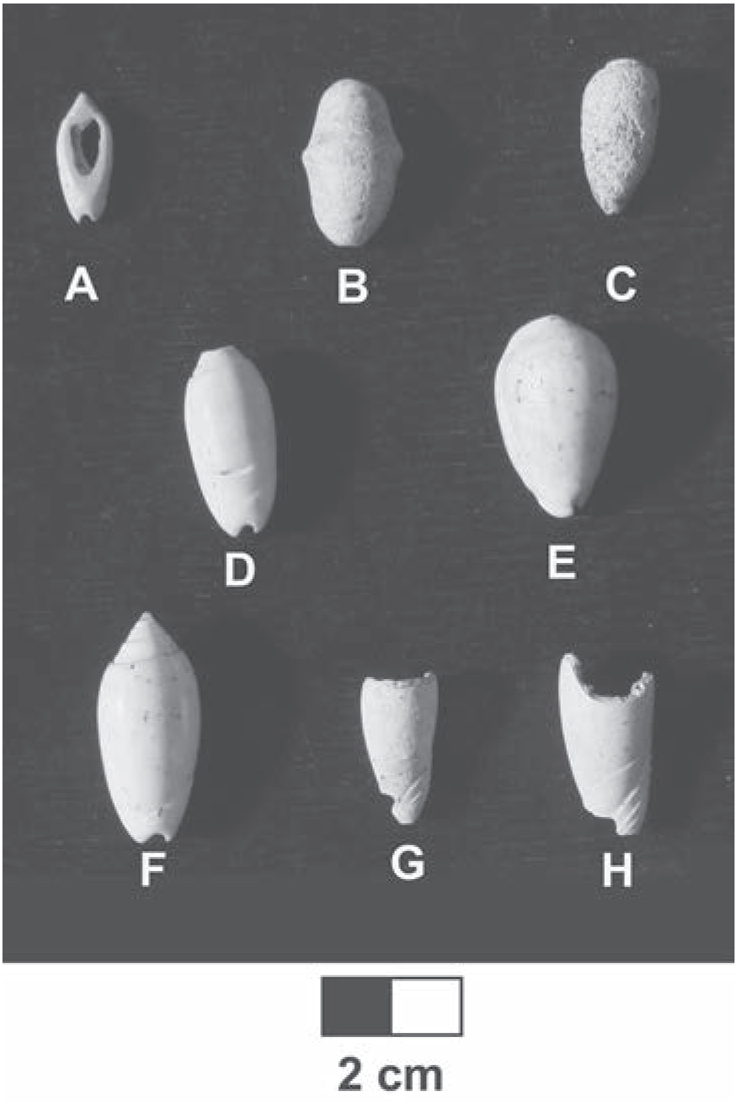

Figure 6.12. *Partly worked olive/Prunum small marine gastropod group shells from Workshop I-55, including a split example (A), an unworked Cyphoma (B), a fossil shell perhaps unrelated to the shell-working industry (C), an incompletely notched shell (D), polished Cypraea and Prunum (E, F), and unsmoothed spire-lopped shells (G, H).*

polished shells are included in the finished-object inventory, they may represent preforms. Finished shells consist of 77.3 percent marine gastropods, 15.4 percent marine bivalves, 1.5 percent fossil shells, and 5.8 percent unidentified shells (table 6.8).

The most numerous completed ornament types were *Oliva* shell ornaments (29.4 percent). It is worth noting that *Prunum* shell ornaments—closely related to *Oliva* shells in shape, modification, and use—formed an additional 6.7 percent; the total of *Oliva* and *Prunum* combined forms over one-third of the finished-object sample (36.2 percent). The remainder of the sample is largely comprised of pendants or related, shaped geometric pieces (30.1 percent)—some not drilled—and beads (14.7 percent) (figure 6.13). Pendants, beads, and olive/*Prunum* objects together form 81 percent of the finished objects. The remaining 19 percent includes small quantities of fossil tools, *Strombus* objects, and unidentified fragments. Fossil shells (figure 6.12c) were probably used as abraders or for other crafting tasks; two were merely smoothed, two were longitudinally split, and one was flattened.

Most of the pendants are made of conch shell (23.2 percent), including worked fragments and undrilled pieces (table 6.8). *Strombus* was also popular for bead making, as beads of conch formed 8.6 percent of the finished-object sample, and beads unidentified to species (3.7 percent) are also likely to be of conch shell. *Spondylus* pendants (and worked fragments) formed 7.4 percent of the completed-object sample. All other artifact types except for *Oliva*/*Prunum* shells form less than 1.9 percent of the sample. Additional patterns are apparent when considering the five general type groups listed in table 6.7. Pendants and non-drilled geometric ornaments made of bivalves (other than *Spondylus*) formed 6.4 percent of the sample (Abalone, *Anomia*, Barbatia, miscellaneous bivalves, *Chione*, *Dinocardium*, *Dosinia*, *Mercenaria*, Mytilidae, Pectinidae, and *Phacoides*). Beads of this group of bivalves form 5.2 percent of the sample. More utilitarian *Strombus* columnella and lip objects, including spatulas, spoons, and a cup, form 4 percent of the finished tools (table 6.8). *Oliva* and *Oliva*-like ornaments and pendants make up 36 percent of the finished-object sample, and beads made of all types of shell represent nearly 15 percent of the sample (table 6.8). Given the importance of shell "beads" as units of monetary exchange, the ubiquity of *Oliva* group ornaments and pendants (made from various shells) suggests to us that these items had a place in the currency system. They are more abundant than cylindrical or discoidal beads.

The production side of shell industries at Mayapán can be assessed by the characteristics of the sample of shell-working debris. The INAH and PEMY project samples included fragments with modification (cut marks, smoothing,

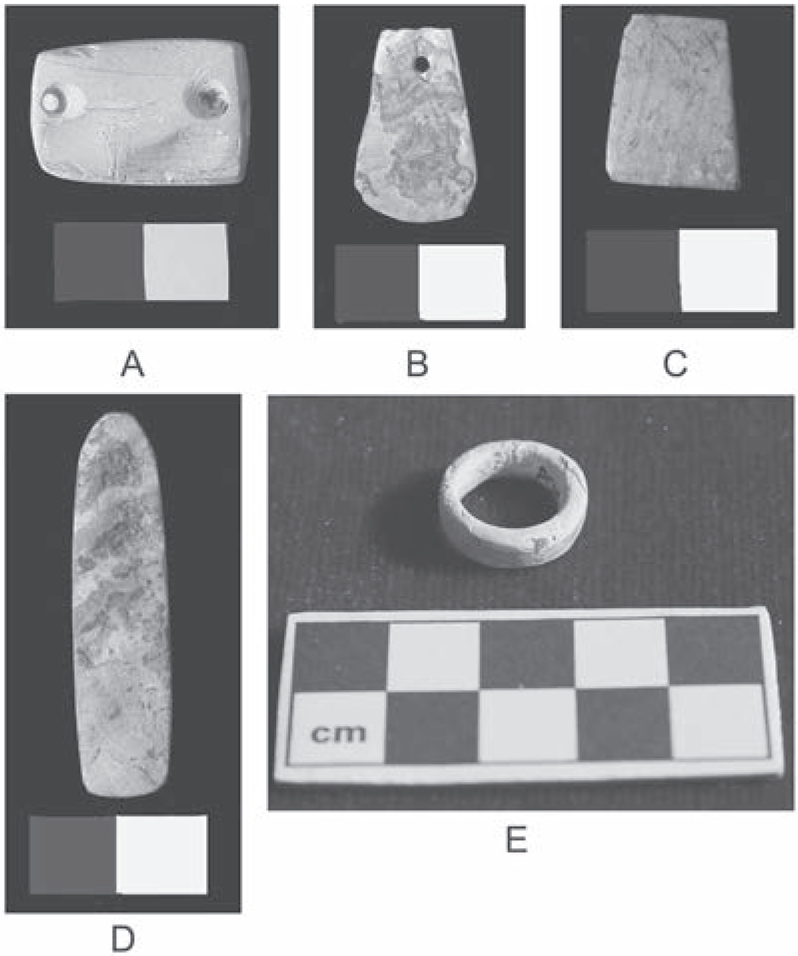

Figure 6.13. *Marine shell ornaments from Mayapán that are not thought to have been currency items, including an incompletely drilled Strombus rectangular pendant (A), an ax-shaped pendant (B), a wedge-shaped plaque (C), an elongate plaque (D), and a shell ring (E). All are from the I-55 workshop except for the ring (from a burial in Q-39).*

polish, partly drilled pendants or beads and other preforms), and debris that lacked signs of modification other than natural or cultural percussion breakage. A total of 99 debris pieces were visibly altered (table 6.9), and 2,207 pieces of debris lacked evidence for impacts beyond breakage.

Table 6.9 INAH/PEMY preform shell debris exhibiting significant modification (all contexts, N = 99).

Taxa/Modification	*Number*	*Percent of 99*
Anadara ornament preform	1	1.0
Anomia discoidal bead preform, not drilled	1	1.0
Anomia ornament preform	2	2.0
Bivalve cut fragment	1	1.0
Bivalve pendant preform half drill hole	1	1.0
Busycon ornament nearly finished	1	1.0
Busycon pendant preform drilled	1	1.0
Busycon worked fragment unfinished	1	1.0
Dinocardium cut	1	1.0
Dinocardium ornament preform	2	2.0
Dinocardium smoothed	2	2.0
Dinocardium smoothed drilled	1	1.0
Dosinia polished preform	1	1.0
Dosinia smoothed	1	1.0
Mercenaria campechiensis cut	1	1.0
Mercenaria cut smoothed	1	1.0
Mercenaria unfinished ornament, not drilled	1	1.0
Oliva fragment	22	22.2
Oliva preform partial groove	2	2.0
Oliva preform smoothed	1	1.0
Oliva tinkler preform partial groove	2	2.0
Ostreidae, cut, rectangular, unfinished	1	1.0
Ostreidae ornament preform	2	2.0
Pectinidae ornament preform	4	4.0
Prunum no spire preform partly drilled	1	1.0
Prunum preform	3	3.0
Spondylus rectangular, not drilled, colored orange	1	1.0
Strombus, shell cup fragment, unfinished	1	1.0
Strombus claw shape fragment	1	1.0
Strombus cut fragment	2	2.0

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Table 6.9—*continued*

Taxa/Modification	*Number*	*Percent of 99*
Strombus disc fragment not drilled	1	1.0
Strombus bead preform, discoidal, not drilled, colored blue	1	1.0
Strombus ornament fragment	2	2.0
Strombus ornament preform	1	1.0
Strombus pendant preform partly drilled	6	6.1
Strombus rectangular, notched	1	1.0
Strombus rectangular not drilled	1	1.0
Strombus rectangular preform	3	3.0
Strombus rectangular preform partly drilled	1	1.0
Strombus rough cut paint pot	1	1.0
Strombus smoothed	5	5.1
Strombus spatulate ornament fragment	1	1.0
Strombus square rough	1	1.0
Strombus columnella ornament preform	1	1.0
Strombus columnella object polished unfinished	1	1.0
Strombus columnella pointed object unfinished	1	1.0
Strombus worked fragment unfinished	1	1.0
Trachycardium smoothed	1	1.0
Unidentified grooved fragment	1	1.0
Unidentified triangular pendant preform	1	1.0
Unidentified rough square partly drilled	1	1.0
Unidentified rounded edge	1	1.0
Unidentified smoothed	2	2.0
Total	99	100

Modified debris was limited to fourteen different identified taxonomic categories, inlcuding Anadara, *Anomia*, bivalves not identified to genus, *Busycon*, *Dinocardium*, *Dosinia*, *Mercenaria*, *Oliva*, Ostreidae, Pectinidae, *Prunum*, *Spondylus*, *Strombus*, and *Trachycardium*. Nearly two-thirds of the modified shell debris is represented by *Strombus* (33.3 percent) and *Oliva* or *Prunum* shells (31.3 percent); less abundant taxa of note include *Dinocardium* (6.1 percent), Ostreidae (5.1 percent), *Anomia* (3 percent), and *Mercenaria* (3.0 percent). All other identified taxa formed 2 percent or less of the sample (table 6.9). Beyond

Table 6.10 Summary of ornament types by taxa in sample of modified shell debris (itemized in detail in table 6.9). (INAH/PEMY projects)

Olive and related Olive group shells	31.3%
Bivalve pendant preform	19.2%
Strombus/Busycon pendant unfinished	13.1%
Spondylus rectangular object unfinished	1.0%
Strombus rectangular object unfinished	7.1%
Unidentified taxa pendant/ornamament	3.0%
Bivalve ornament fragment	5.1%
Gastropod ornament fragment	9.1%
Bead unfinished	2.0%
Strombus miscellaneous fragment	6.1%
Unidentified taxa worked fragment	3.0%

the *Oliva/Prunum* ornaments, the majority of the sample was comprised of unfinished pendants or ornaments (57.6 percent). Bead preforms comprised only 2 percent of the modified debris and 6.1 percent is represented by miscellaneous *Strombus* objects (an unfinished cup, a spatulate, columnella objects, and various worked fragments). Clearly, *Oliva/Prunum* ornaments and pendants made of various other shells dominate this assemblage of altered debris, as together they form 88.9 percent of the sample (table 6.9). This pattern does not necessarily mean that these objects were produced in abundance at the city, as the overall number of modified (rather than finished) items is small, with only 99 specimens listed in table 6.9. It is difficult to know whether modified fragments represent manufacturing failures or pieces of broken finished objects.

Bivalves were popular for pendant manufacture, although a variety of shells were used for this purpose (tables 6.9, 6.10). Unfinished pendants made of bivalves formed 19.2 percent of the modified debris and one *Spondylus* example is present. Thirteen percent of the partially worked pendants were made of *Strombus* or *Busycon* (figure 6.13a, d); others were not identified species (3 percent). Rectangular or square ornaments are listed separately in table 6.10 (figure 6.13a), and these were relatively common in the sample of unfinished *Strombus* objects (7.1 percent); one *Spondylus* example was also present.

Shell Debris

Unmodified shell debris represents percussion flakes (figure 6.11), unworked fragments, or slightly (incompletely) worked fragments; taxa frequencies are

Table 6.11 Debris (percussion flakes, unworked fragments, or slightly worked fragments), all seasons, N = 2,207 (PEMY project).

Taxa	*Number*	*Percent of 2,207*	*Taxa*	*Number*	*Percent of 2,207*
Strombus	721	32.70	*Crassostrea virginica*	4	0.20
Dinocardium	329	14.90	*Fasciolaria tulipa*	4	0.20
Unidentified	218	9.90	*Isognomon alatus*	4	0.20
Dosinia sp.	156	7.10	*Terebra*	4	0.20
Bivalve	73	3.30	*Asaphis deflorata*	3	0.10
Phacoides sp.	67	3.00	*Chama* sp.	3	0.10
Mercenaria campechiensis	65	2.90	*Cyphoma gibbosum*	3	0.10
Natica sp.	58	2.60	*Littorina* sp.	3	0.10
Fossil shell	41	1.90	*Melongena corona*	3	0.10
Chione sp.	32	1.40	Abalone	2	0.10
Prunum sp.	25	1.10	*Carditamera floridana*	2	0.10
Anadara	23	1.00	*Cypraea zebra* (cowry)	2	0.10
Arca zebra	23	1.00	*Euvola ziczac*	2	0.10
Oliva sp.	23	1.00	*Ischadium recurvum*	2	0.10
Cardiidae	21	1.00	Lucinidae	2	0.10
Mytilidae	19	0.90	*Lucinoma filosus*	2	0.10
Trachycardium sp.	18	0.80	*Marginella*	2	0.10
Gastropod (marine)	17	0.80	Ostreidae or Mytilidae	2	0.10
Pleuroploca gigantea	17	0.80	*Plicatula gibbosa*	2	0.10
Busycon	15	0.70	*Pteria colymbus*	2	0.10
Ficus communis	15	0.70	*Turbinella angulata*	2	0.10
Ostreidae	15	0.70	Veneridae	2	0.10
Pinna carnea	15	0.70	*Aequipecten muscosus*	1	0.05
Arcoidea	14	0.60	*Architectonica nobilis*	1	0.05
Polinices lacteus	13	0.60	*Brachydontes*	1	0.05
Spondylus	12	0.50	*Busycotypus canaliculatus*	1	0.05
Coral	11	0.50	*Calista*	1	0.05
Pomacea	11	0.50	Crab claw	1	0.05
Barbatia tenera	9	0.40	*Crepidala fornicata*	1	0.05

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Table 6.11—*continued*

Taxa	*Number*	*Percent of 2,207*	*Taxa*	*Number*	*Percent of 2,207*
Pectinidae	9	0.40	*Cypraea* or *Cymatium*	1	0.05
Spondylus or Ostreidae	8	0.40	Fossil coral	1	0.05
Anomalocardia	7	0.30	Pteroidea	1	0.05
Cassis sp.	7	0.30	*Pholas*	1	0.05
Conus sp.	6	0.30	*Phyllonotus ponum*	1	0.05
Gouldia sp.	6	0.30	*Pseudochama radians*	1	0.05
Anomia	5	0.20	*Tellina radiata*	1	0.05
Diodora cayenensis	5	0.20	*Trivia candidula*	1	0.05
Nerita sp.	5	0.20	*Urosalpinx cinerea*	1	0.05

listed in table 6.11. *Strombus* fragments were most common (32.7 percent), followed by several kinds of bivalves: *Dinocardium* (14.9 percent), *Dosinia* (7.1 percent), *Phacoides* (3 percent), *Mercenaria* (2.9 percent), and bivalves unidentified to species (3.3 percent). *Natica* formed 2.6 percent of the unmodified debris sample, and all other taxa formed 1.4 percent or less. The majority of shell debris from the site appears to reflect industries using many taxonomic categories of shell for which finished tools are not present. This discrepancy may be due to the fact that finished products were modified to an extent that prohibited taxa identification or, alternatively, tools or ornaments of these taxa were not made according to ubiquitous, standardized trajectories.

Ratios of Debris to Finished Objects

Evaluating the site's shell industry is aided by comparing the proportions of debris to finished tool frequencies per taxa. Table 6.12 provides the ratios of all shell-working debris (modified or unmodified) to finished products for nineteen taxa for which finished products were identified. Very low ratios for some taxa suggest that some key finished products were exchanged into Mayapán and not solely supplied from local production. Large ratios indicate an inverse pattern for other taxa where local industries generated abundant debris relative to the quantity of finished products. We suggest that taxa with lower ratios are the best candidates for imported shell currency items, as these objects would have been obtained in the city's regional commercial activities. Only six taxa fit this expectation, with low ratios between .1 and .3 pieces of

TABLE 6.12 Ratio of all debris (with or without modification) to finished ornaments—only species listed are those with finished tools present in sample (PEMY project).

Taxa	*Percent of taxa*	*Percent of all debris combined*	*Percent of finished ornament*	*Debris/finished tool ratio*
Oliva sp.	6.5	2.2	29.4	0.1
Spondylus sp.	1.7	0.9	8.3	0.1
Haliotis sp.	0.2	0.1	0.6	0.1
Prunum sp.	2.4	1.3	6.7	0.2
Conus sp.	0.4	0.3	0.9	0.3
Cypraea sp. (cowry)	0.1	0.1	0.3	0.3
Anomia	0.4	0.3	0.6	0.6
Strombus sp. and conch	37.9	32.7	38.7	0.8
Chione sp.	1.6	1.4	1.5	0.9
Polinices lacteus	0.7	0.6	0.6	0.9
Pectinidae	0.7	0.6	0.6	0.9
Barbatia tenera	0.4	0.4	0.3	1.3
Busycon	0.9	0.8	0.6	1.3
Mytilidae	0.9	0.8	0.6	1.3
Bivalve	3.9	3.3	0.9	3.6
Phacoides sp.	3.0	2.9	0.3	9.5
Mercenaria campechiensis	3.0	2.9	0.3	9.6
Dosinia sp.	6.7	6.9	0.3	22.3
Dinocardium	14.7	14.5	0.6	23.7

debris per finished item. These include *Oliva* and *Prunum* (ratios of .1 and .2, respectively), *Spondylus* (.1), Abalone (.1), *Conus* (.3), and *Cypraea* (.3). Of these taxa, *Oliva/Prunum* and *Spondylus* are numerically far more significant in the sample than the others, which implies their currency status.

In contrast, seven shell taxa exhibit nearly a 1:1 ratio of debris to finished products, which indicates the importance of specific local manufacturing trajectories. These taxa include *Strombus*, *Chione*, *Polinices*, *Barbatia*, Pectinidae, *Busycon*, and Mytilidae. Of this list, only *Strombus* is present in major proportions in the debris and finished-item samples. Large, versatile *Strombus* shells were made into a variety of useful objects and currency beads or pendants. For this reason, *Strombus* ratios are not specifically indicative of bead manufacture.

Two taxa had ratios of debris to finished items of nearly 10:1, including *Phacoides* and *Mercenaria* (9.5 and 9.6, respectively). Two other taxa had higher ratios of over 20:1, including *Dosinia* and *Dinocardium* (22.3 and 23.7, respectively). These comparisons imply a hierarchy of shell values and different trajectories of production and consumption for shell working at Mayapán (table 6.12).

There is not an even correspondence in the proportions of species represented and the types of finished or worked shell items in the assemblage. For example, olive shells comprise 6.5 percent of the taxa identified but 29.4 percent of the completed objects (or object fragments) in the sample (and 27.3 percent of the modified production debris). As mentioned earlier, modified olive and *Prunum* fragments are the primary category for which finished products and incomplete fragments may be difficult to discern; but their importance in both categories is indicated by their ubiquity. Similarly, *Spondylus* forms 1.7 percent of the species list yet 7.1 percent of the completed-shell artifact list. In contrast, there are far more other (non-*Spondylus*) bivalves in the sample of debris than in the ornament or tool categories.

Oliva/Prunum and *Spondylus* shells in particular have long-term significance in the Maya area, as they were important valuables as early as the Formative Period (Buttles 1992; Masson and Freidel 2013). Their status at Mayapán as potential currency items is thus not surprising. Despite a widespread shell-working industry within the city, finished, valuable ornaments of these shell groups were also probably obtained through exchange on a regular basis.

Shell Production Workshops

The best information on surplus shell production contexts at Mayapán are from the set of horizontally excavated structures (PEMY project), which provide the largest samples. Table 6.3 lists seventeen surplus shell production contexts detected by various collection methods; in four contexts, shell was the only surplus craft industry, and the others represent multi-crafting localities. These contexts were identified arbitrarily as those with shell quantities occurring at or above one standard deviation from the mean (table 6.13). Quantification per square meter was straightforward for systematic (28.26 square meters) surface collections. The number of shells per area of excavation is our best metric for test pits and horizontal excavations. Table 6.13 also quantifies shell according to excavation unit volume. Comparisons of shells per square meter and per cubic meter at fully excavated houses highlight the same three workshop contexts—I-55a, Q-39, and Q-176 (table 6.13). Shells per cubic meter were less useful for excavation samples due to the diluting effect of sterile levels near bedrock or in fill. Most debris at houselot workshops was

Table 6.13 Quantities of shell at shell workshops identified by the PEMY project. Values indicate the number of shells per square meter of surface collections, and number/square meter and number/cubic meter for test pits and fully excavated structures*.

Structure	*Surface collections number/ square meter*	*Test pits number/ square meter*	*Test pits number/cubic meter*	*Horizontal excavations number/ square meter*	*Horizontal excavations number/cubic meter*
P-114 house	1.00	14.6	34.4	–	–
Q-183 house	0.50	–	–	–	–
Z-120/ and Z-119/ AA-75 adjacent houses	0.80	–	(17.7)	–	–
Z-43 house	0.50	10.0	25.1	–	–
R-110b*	0.40	7.0	(8.0)	–	–
R-177*	0.40	–	–	–	–
Q-46a*	0.40	–	–	–	–
Z-39 elite house	–	15.5	52.0	–	–
Q-303 workshop	–	15.0	(18.1)	–	–
S-10bc house	–	11.0	37.9	–	–
S-12b house	–	11.0	(21.6)	–	–
P-28 house	–	10.5	(16.0)	–	–
Z-47b house	–	8.0	(14.2)	–	–
I-55a house	–	(6.0)	(11.5)	1.30	5.4
Q-39 house	–	–	–	1.20	4.1
Q-176 house	1.00	19.3	45.6	0.90	3.6
H-11 house	–	–	–	0.50	1.9
H-15 hall	–	–	–	0.10	0.3
H-15 grave	–	–	–	0.90	1.3

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Table 6.13—*continued*

Structure	*Surface collections number/ square meter*	*Test pits number/ square meter*	*Test pits number/cubic meter*	*Horizontal excavations number/ square meter*	*Horizontal excavations number/cubic meter*
H-17 temple	–	–	–	0.10	0.2
I-57 workshop	–	2.0	8.8	0.30	1.1
L-28 house	–	–	–	0.30	1.8
Q-40a house	–	–	–	0.30	1.3
X-43 house	–	–	–	0.03	0.4
Y-45 elite house	–	–	–	0.10	0.3
Mean	0.17	3.9	12.8	0.50	1.8
Standard deviation	0.28	3.5	12.0	0.50	1.7
Mean + standard deviation	0.46	7.4	24.8	1.00	3.5

• All horizontally excavated structures are shown, but only I-55a, Q-39, Q-176 are workshops. The list includes those with quantities equal to or greater than the mean value plus 1 standard deviation, with close exceptions, other probable workshops are marked by an asterisk, equal to twice the mean value and almost > / = 1 standard deviation above the mean). Values in parenthesis do not meet outlier criteria for the column in which they occur, for reasons explored in the text.

within around 40 centimeters of midden above bedrock. Similarly, artifacts concentrated within the top 40 centimeters of horizontally excavated structures; these investigations for the most part terminated at floors and wall bases or on bedrock patios that were close to the surface. Some structures are identified as outliers according to only one set of data, while others are identified as workshops by surface collections, excavation area, and/or volume (table 6.13). Reasons for these different results vary by structure. For example, the shell-working area at House I-55a was in front of the building, in the patio area, and the test pit data come from a midden behind the house where shell had not been discarded. The test pit data identified debris from surplus obsidian blade making while the full excavations revealed shell working in front of the house. Although test pits in middens may not fully represent activities at houses, these data represent a good starting point for examining production patterns

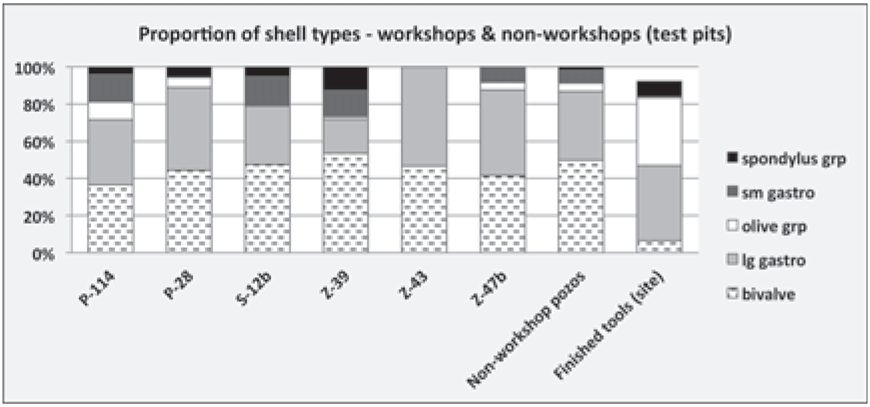

Figure 6.14. *Types of selected shell material in workshops compared to non-workshops and the finished tool assemblage for the entire site (test pit data).*

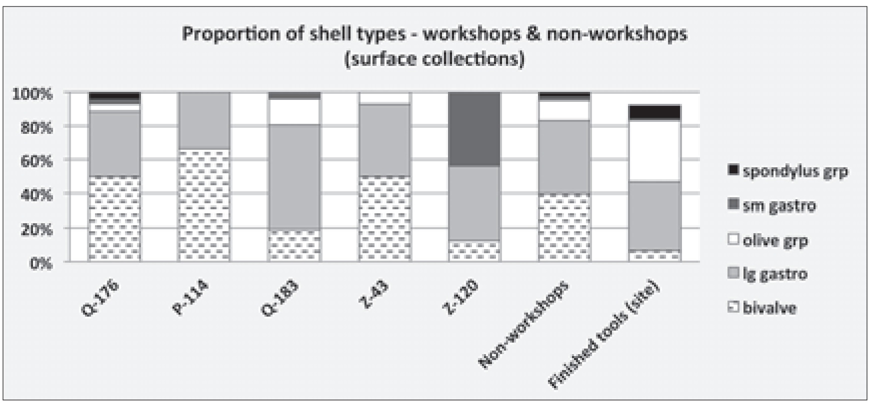

Figure 6.15. *Types of selected shell material in workshops compared to non-workshops and the finished tool assemblage for the entire site (surface collection data).*

across many contexts at the city, as indicated by cases in table 6.13 where more than one type of sampling unit pointed to a surplus crafting industry. The seventeen domestic contexts where surplus shell ornament production was identified include Houses Q-176, P-114, Q-183, Q-46a, Q-303, Q-39, P-28, Z-120, Z-119/AA-75, Z-43, R-110b, R-177, S-10, S-12, Z-47, Z-39, and I-55a. Five of these localities were identified by surface collection densities, six additional houselots were identified from test pit densities, and two were determined from horizontal excavations (table 6.13).

Table 6.14 Proportions of finished tools of major shell groups at workshops, non-workshops, and the composite site assemblage. Non-workshops are marked with an asterisk. Percentage given is that of total taxonomically identified shells. Note that P-114, Z-43, and Q-176 were sampled by multiple sample units (PEMY project).

Sample type	*Context*	*Bivalve misc. (percent)*	*Large gastro-pod (percent)*	*Olive group (percent)*	*Small gastro-pod (percent)*	*Spondylus group (percent)*	*Total identi-fied shell tool*
Test pit	P-114	36.0	35.0	9.0	15.0	4.0	74
Test pit	P-28	44.0	44.0	6.0	–	6.0	18
Test pit	S-12b	47.0	32.0	–	16.0	5.0	19
Test pit	Z-39	54.0	18.0	1.0	14.0	13.0	71
Test pit	Z-43	47.0	53.0	–	–	–	15
Test pit	Z-47b	42.0	46.0	4.0	8.0	–	24
Test pit	Q-303	–	100.0	–	–	–	8
Test pit	S-10bc	25.0	63.0	–	13.0	–	8
Test pit	All workshops	43.0	36.0	4.0	11.0	6.0	237
Test pit	Non-workshops	49.9	36.9	4.4	7.1	1.8	339
Surface collection	Q-176	50	39.0	5.0	2.0	5.0	44
Surface collection	P-114	67	33.0	–	–	–	15
Surface collection	Q-183	19	62.0	15.0	4.0	–	26
Surface collection	Z-43	50	43.0	7.0	–	–	14
Surface collection	Z-120	13	44.0	–	44.0	–	16
	All workshops	40	44.0	6.0	8.0	2.0	114

Surface collection	Non-workshops	40	43.0	12.0	2.0	3.0	168
Horizontal excavation	I-55a	51.0	36.0	12.0	–	1.0	251
Horizontal Excavation	Q-39	60.0	31.0	9.0	–	1.0	134
Horizontal excavation	Q-176	47.0	39.0	12.0	1.0	1.0	114
Horizontal excavation	H-11*	44.0	44.0	9.0	–	3.0	66
Horizontal excavation	Y-45*	33.0	56.0	6.0	4.0	–	48
Horizontal excavation	H-17*	26.0	46.0	26.0	–	2.0	54
Horizontal excavation	L-28*	33.0	63.0	2.0	–	2.0	49
Horizontal excavation	H-15*	29.0	62.0	6.0	3.0	–	34
Horizontal excavation	H-15 grave*	42.0	53.0	6.0	–	–	36
Horizontal excavation	Q-40a*	55.0	38.0	7.0	–	–	29
Horizontal excavation	I-57*	53.0	41.0	6.0	–	–	17
Horizontal excavation	X-43*	33.0	67.0	–	–	–	6
Horizontal excavation	All workshops	53.0	35.0	11.0	0.0	1.0	499
Horizontal excavation	Non-workshops	37.0	51.0	9.0	1.0	1.0	339
Grand total	Finished tools (entire site)	6.7	40.2	36.5	0.6	8.3	326

Contexts R-110b, R-177, and Q-46a are not included, as their shell quantities were not quite 1 standard deviation above the mean value.

Table 6.15 Results of chi-square tests between workshop and non-workshop contexts for the proportions of five major shell taxa groups; chi-square test value for 4 degrees of freedom is 9.487, p = .05 (PEMY).

Sample type	*Comparisons*	*Chi-square result*	*Significance*
Test pit	Workshops and non-workshops	11.39000	Reject the null hypothesis of no difference
Surface collection	Workshops and non-workshops	8.73000	Fail to reject the null hypothesis of no difference
Horizontal excavation	Workshops and non-workshops	49.52000	Reject the null hypothesis of no difference
Horizontal excavation	Non-workshops (excluding H-17) and H-17	19.69910	Reject the null hypothesis of no difference
Horizontal excavation	Workshops and H-17	18.47457	Reject the null hypothesis of no difference
Horizontal excavation	Workshops and non-workshops (excluding H-17)	27.39013	Reject the null hypothesis of no difference

Comparisons of the distribution of the five major taxa groups of shell (as defined in table 6.7) show few striking differences in the proportions and ranges of shell taxa present at workshop versus non-workshop locales (table 6.14, figures 6.14, 6.15). The importance of bivalve shell working is indicated by percentages ranging from 40 to 53 for all workshops and by 37–40 percent bivalves in non-workshops sampled by various collection units (table 6.14). Large gastropod shell fragments similarly formed 35–44 percent of all workshop samples and 37–51 percent of all non-workshops. Chi-square statistical tests were employed to determine whether differences existed between surplus workshop contexts and the other (non-workshop) sampling units (table 6.15). These results failed to indicate that workshop and non-workshop samples were significantly different from one another, with the exception of surface collection data (table 6.15). Sample sizes may have affected surface collection results. These data suggest a close relationship between shells made in surplus production contexts and consumer contexts.

Fully excavated contexts provide the most robust data on differences between samples. Olive group shells are more abundant in the Temple H-17

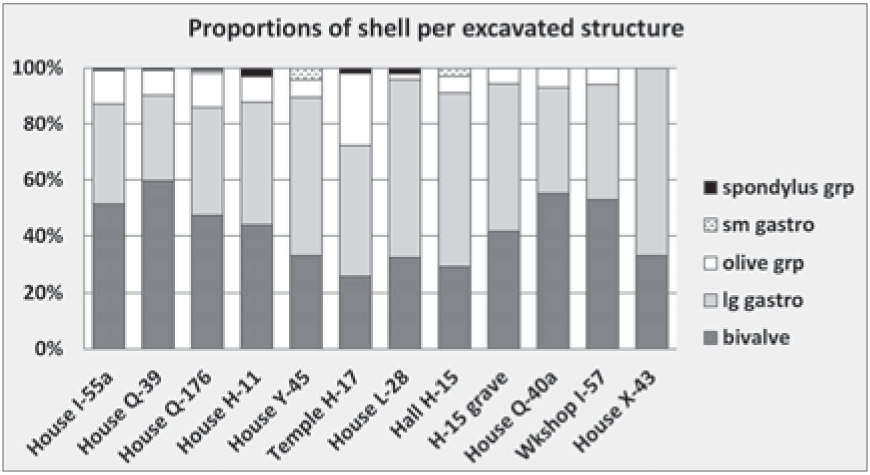

Figure 6.16. *Comparisons of shell proportions in five taxa groups among horizontally excavated structures—Workshop houses I-55a, Q-39, and Q-176 are shown at the left of the graph. Other contexts did not engage in significant surplus production. Much overlap exists between workshop shells and other contexts; the temple stands out for higher proportions of olive shell.*

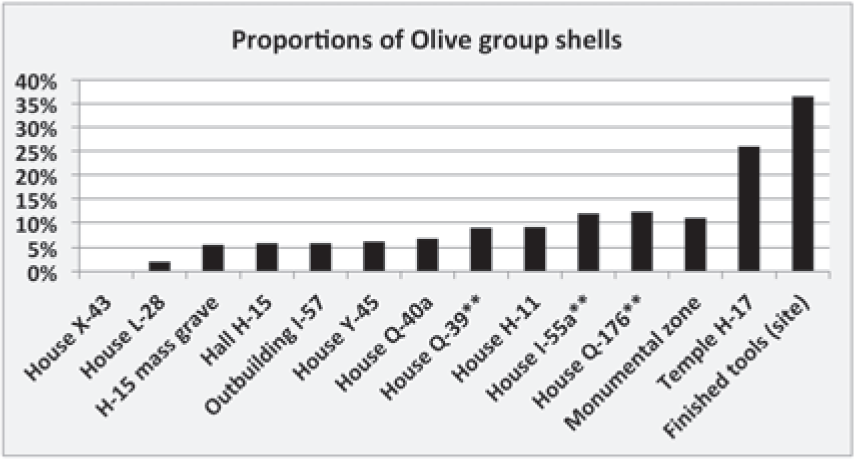

Figure 6.17. *Proportions of Olive group shells (within five major shell taxa groups) of each fully excavated structure compared to those of the monumental center and the finished shell assemblage for the entire site. Shell workshops are indicated by asterisks. Temple H-17 and the finished-tool sample have much higher proportions than other contexts, including the monumental zone.*

assemblage (26 percent) compared to other contexts in which these taxa form 0–12 percent of the sample (table 6.14, figures 6.16, 6.17). Additional chi-square tests were performed to compare non-workshop contexts without H-17 to H-17, workshops to H-17, and workshops to non-workshops without H-17, respectively—all results indicated that the null hypothesis should be rejected and that the frequencies of the H-17 assemblage are significantly different from the others (table 6.15, figures 6.16, 6.17), even though the same range of taxa groups is generally observed among the samples. Despite the chi-square results, table 6.14 indicates slightly greater quantities of Olive group shells or *Spondylus* group shells at certain workshops, such as I-55a, Q-176, and Z-39, but not in quantities as great as at the H-17 temple. Similarly, workshop I-55a is associated with unfinished *Oliva/Prunum* group debris (figure 6.12) and more idiosyncratic ornaments (Figure 6.13).

Although the INAH monumental zone sample was not collected with the use of screens, it provides valuable supplemental information regarding the proportions of the five major taxa groups under consideration (table 6.16). For samples with twenty identified shells or more, the proportions of Olive group shells (ranging from 2 percent to 14 percent) are more similar to Workshops I-55a and Q-176 than to the high quantities at Temple H-17. The numerically robust sample from Temple Q-58, the most analogous context to H-17, had only 7 percent olive shells. The high proportions of Olive group shells from Temple H-17 are thus anomalous, even when compared to monumental center buildings. As observed for the PEMY settlement zone samples, bivalve and large gastropod shells form the majority of material from the site center.

Further differences are noted between surplus production workshops and most other contexts tested in terms of the proportion of finished tools for the site (figure 6.17). Specifically, Olive group shells occur in much lower proportions (12 percent or less) in our workshop and non-workshop contexts than they do in the finished composite tool sample (36.5 percent, table 6.14). The Temple H-17 assemblage (with 26 percent Olive group shells) is more like the overall finished-tool sample than the domestic contexts (figure 6.17). This observation lends support to the idea that more Olive group shells were entering Mayapán as currency items than were produced at the city's houselots. Overall, the distribution of Olive group shells across contexts of different social status or function at Mayapán is relatively equitable. This pattern is clearly illustrated in figure 6.17 (also table 6.16), where most proportions range from 6 to 12 percent, including ordinary commoner houses not engaged in shell surplus production, such as Q-40a and H-11 (7 percent and 9 percent, respectively) and outlying elite House Y-45 (6 percent). Except for Temple

Table 6.16 Monumental zone structures—frequencies of five major taxa groups (INAH project).

Structure	*Bivalve (percent)*	*Large gas-tropod (percent)*	*Olive group (per-cent)*	*Small gas-tropod (percent)*	*Spondylus group (percent)*	*Other shell (percent)*	*Total identi-fied shell taxa*
Monumental zone House Q-56	36	55	–	9	–	–	11
House Q-57	34	45	2	–	18	–	44
Monumental zone House Q-63	–	50	50	–	–	–	2
Monumental zone House Q-67	33	52	11	–	4	–	27
Monumental zone House Q-68	25	50	19	–	6	–	16
Monumental zone House Q-92	41	38	13	3	4	1.0	130
Monumental zone House Q-93	48	38	9	2	4	–	82
Hall Q-54	27	54	14	4	1	–	78
Hall Q-97	37	41	12	–	10	–	41
Oratory Q-55	38	62	–	–	–	–	21
Oratory Q-66	20	60	10	–	10	–	10
Shrine Q-61	25	25	50	–	–	–	16
Shrine Q-98	–	67	33	–	–	–	3
Temple Q-58	29	56	7	1	6	–	109
All monu-mental zone structures	35	47	11	5	2	0.2	590

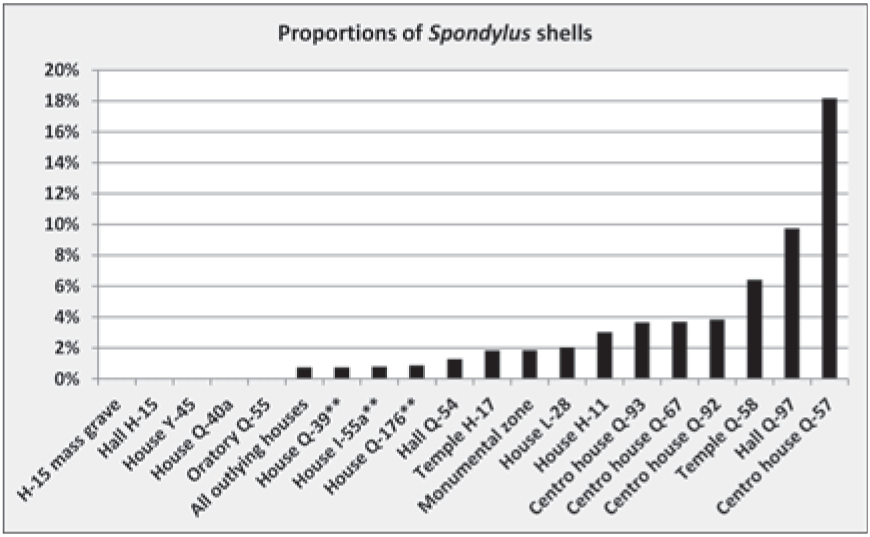

Figure 6.18. *Proportion of Spondylus group shells in horizontally excavated contexts from the monumental zone and settlement zones (contexts with shell samples of 20 or more specimens).*

H-17, the distribution of Olive group shells is not hierarchical and does not accord with expectations of a prestige-goods model.

Similarly, the *Spondylus* group represents 8.3 percent of the entire site finished-tool sample, yet forms only 1 percent of all of the outlying horizontally excavated structures and 2 percent of the monumental zone contexts (figure 6.18). Only two of twenty horizontally excavated contexts within and outside of the site center have proportions of *Spondylus* group shells above 6 percent: Hall Q-97 and commoner custodial House Q-57 (site center). Four other contexts have proportions of 3–4 percent that are above the 2 percent monumental zone average—these include Itzmal Ch'en's custodial House H-11 and other custodial houses in the site center (Q-93, Q-67, and Q-92). In contrast, Hall H-15 had no *Spondylus* group shells and Hall Q-54 and Temple H-17 had average *Spondylus* proportions of 1–2 percent that are like those of the humble outlying dwelling of L-28 (2 percent). As with Olive group shells, individual structure anomalies exist, but proportions are relatively equitable across contexts representing different social statuses and functions. There is no consistent evidence for top-down distribution of *Spondylus* group shells. As argued for Olive group shells, *Spondylus* group shells were probably valued as monetary units of exchange at Mayapán.

Smaller test pit samples are of more limited use in comparing shell frequencies, as two household shell workshops (Q-39, I-55a) were not detected until full excavation. Nonetheless, it is noteworthy that of the sixty-two non-workshop test pits in which shell was recovered, Olive or *Spondylus* shells were present at 29 percent of the contexts, 24.2 percent had at least one Olive shell, and 6.5 percent had at least one *Spondylus* shell. These contexts represent ten different vicinities (milpa fields) of the settlement zone and eighteen different houselot contexts, only two of which are elite. Minimally, these test pit results reflect widespread access to potential shell currencies—nearly one in three contexts yielded specimens despite the small sample per houselot.

Troubling in our study of shell items at Mayapán is the relative scarcity of beads—as conventionally defined—in houselot or production contexts. Although Olive and *Spondylus* group ornaments are good candidates for shell media of exchange, surely discoidal or cylindrical beads were also used, as these best fit Landa's description. A total of thirty-six beads are present in our sample of all excavated units; most of those identified to genus were made of conch shells (N-24), two were made of *Spondylus*, and one was made of oyster shell. The beads are not concentrated in elite or public buildings; only two came from elite House Y-45, three came from monumental zone custodial House Q-92, outlying commoner Houses H-11, P-150, and Q-40a each had one, commoner Houses P-117 and Q-176 each had three, and Hall H-15 had four. Six were recovered from workshop House I-55a, one from workshop House Z-43, and eleven from workshop House Q-39, but the latter were concentrated as grave goods in a single burial feature. This distribution does not indicate a tendency for bead manufacture within workshop contexts, with the possible exception of I-55a. Beads were highly curated and not frequently lost. All of the beads were completed, and partly manufactured examples were not found. Ten were of a cylindrical shape, eleven were discoidal, two were rectangular, and one was trapezoidal.

Although Carnegie excavators rarely cleared entire structures horizontally, they tested a number of architectural features, particularly graves and caches that provide supplementary information. Lot lists compiled from the Carnegie Institution of Washington's *Current Report* series (Masson 2009) reveal that this work recovered at least 151 finished shell ornaments, of which 63 were from nineteen commoner domestic contexts and 88 were from six elite residences and fourteen monumental building groups. Abundant shell beads (N = 22) were recovered from a burial in an epicentral custodial house (Q-62), which resembles our findings at the family tomb of House Q-39 (figure 5.33). The interchangeability of shell beads with other kinds of suspended shell ornaments as grave offerings implies their mutual status as shell currency units.

Although beads were present at House Q-62, two other commoner burials (Q-37a and K-57) had shell pendants and/or Olive shell ornaments. In only six cases investigated by the Carnegie were shell beads solely recovered without being accompanied by other kinds of shell ornaments (three commoner and three monumental contexts). This observation emphasizes the close symbolic and functional association of beads with bivalve pendants and tinklers. Rarer objects such as shell rings clearly served only as adornments (figure 5.33). Jade beads were also placed into caches with shell beads or ornaments in domestic settings investigated by the Carnegie (J-71b, A-1, and Q-244d) and at the site center. In general, shell ornaments and beads were regularly recovered by this earlier project at commoner dwellings.

Why might shell beads be relatively scarce in non-mortuary domestic contexts at Mayapán? Their relative scarcity may reflect their value, as might be expected for a monetary unit, along with the necessary characteristics of durability and portability. Commoners regularly possessed beads in low numbers. The lack of evidence for significant quantities of shell bead production at Mayapán may also reflect the fact that beads were obtained in significant numbers from external sources through commercial exchanges and that city artisans did not primarily supply them. In this respect, patterns for shell beads, a known currency, match those that we have previously described for Olive and *Spondylus* group suspended ornaments, or their close imitations. Toward the end of this chapter, we discuss consumption patterns of potential shell currencies in greater detail.

Metallurgy

One other currency item, copper bells, was made at Mayapán. Two contexts for bell production have been well documented in Peraza Lope's INAH-sponsored investigations (Paris 2008), and two additional multi-crafting houses (Q-40a and Q-39) have recently been added to the list by the recovery of bell-casting ceramics (Paris and Cruz Alvarado 2012; Cruz Alvarado et al. 2012:figure 15.13). The INAH project investigated an outlying secondary elite house (R-183b) and a custodial caretaker house (Q-92) behind Temple Q-95 in the monumental center and recovered small crucible vessels that were filled with copper alloy material and bell clusters (Paris 2008:figures 5–7). Paris (2008:54) argues that production at these houses was for local consumption and that activities focused on reworking imported metal objects into numerous small bells. Most of Mayapán's 381 studied metal artifacts are bells (85 percent), according to Paris (2008:table 2). The production debris found at

R-183 and Q-92 was of a limited scale and metal production was not common at the city. No crucibles were present at Q-40a or Q-39; both were adjacent to elite group Q-41.

Six bell shapes have been defined for Mayapán, with variable suspension styles (Paris 2008:table 5). Bells found across the site at non-production locales exhibit a wide size range with a relatively even distribution (Paris 2008:figure 17). It has not been possible to discern standardized intervals of size and potential value despite Tozzer's suggestion regarding bell monies (1941:n418). Their scarcity, and the probability that the majority of Mayapán's bells were opportunistically exchanged from beyond the Maya region, would have made it difficult to impose production standards. Nonetheless, they were clearly one of the most valuable objects in circulation. Bells were uncommon at Mayapán, and like shell beads, they are concentrated in a few wealthy mortuary contexts and also distributed relatively evenly in general excavation contexts of elite and commoner dwellings. We discuss consumption patterns in more detail later in this chapter. We infer that if bells were used as currency items, this occurred infrequently compared to shell, cacao beans, and cotton mantles.

Obsidian Production and Consumption

Obsidian was a common household tool at Mayapán. Its availability reflects the importance of distant trade for inventories used in daily life. Most residents of the city would have obtained their obsidian from workshops within Mayapán or market stalls maintained by craftspersons who removed blades from imported blade cores. Two sets of questions guide the examination of obsidian frequencies with respect to production and consumption patterns in this chapter. First, where were obsidian blades made, who made them, and what can be said about the scale of production? Second, to what degree were blades widely accessible? Former studies of obsidian distributions in Postclassic northern Belize (Masson 2000) and elsewhere (P. Rice 1987) suggest that by this period, obsidian was a valued item, although it was not prohibitively expensive and could be obtained without restriction in the marketplace.

Obsidian Workshops

We calculated the mean and standard deviation of the number of obsidian blades per square meter of surface collection or the area and volume of test pits and horizontal excavations (table 6.3). Contexts with frequencies at least one standard deviation above the mean are identified as potential surplus production contexts. Cores are sometimes present in these high-density contexts that

Table 6.17 Surface collection obsidian interval frequencies. Asterisks mark intervals that are density outliers (mean plus 1 standard deviation) and represent probable workshops (PEMY project).

Number of obsidian pieces within 28.26 square meter-collection unit	*Number of structures per interval*	*Percent of structures per interval*	*Percent of commoner contexts per interval*
	36	35.3	97
0.5–4	29	29.3	97
5–13	23	23.2	83
15–21*	5	5.1	100
23–26*	3	3.0	66
30–48*	3	3.0	100
Total	99		

* Mean pieces per 3 meter dog leash collection unit (28.26 square meter): 5.38, standard deviation is 8.64, values above 14.02 per collection represent the mean value plus 1 standard deviation. Workshops/densities: Q-196 (48 pieces), Q-176 (40 pieces), Q-46a (30 pieces, R-174 (26 pieces), Z-39 (25 pieces), Q-188 (23 pieces), P-114 (21 pieces), Q-303 (20 pieces), P-115b (19 pieces), R-173b (18 pieces), P-24 (15 pieces).

support their status as probable houselot workshop deposits. As with all types of manufacturing traditions at Mayapán, a continuum may have existed in the scale of obsidian production, and it is important to recognize that test pits or surface collections may not have sampled the areas of densest debris. For example, at fully excavated House I-55a, two 1 × 2 meter test pits probed a rich midden behind the house from which obsidian densities were almost (but not quite) one standard deviation beyond the mean. Full excavation of the house sampled areas to the front and side of the building and revealed exceptionally high obsidian frequencies.

A total of nineteen individual houselots were associated with surplus obsidian workshop activity, as indicated by the surface collection, test pit, and/or horizontal excavation densities (table 6.3, figure 6.4). These contexts have frequencies at or beyond one standard deviation above the mean, with the exception of R-137, which was the only other case in the test pit sample that qualified as an outlier/workshop when two anomalously high contexts were removed and the mean and standard deviation recalculated. Some of the same contexts were flagged by higher densities through multiple sampling methods (tables 6.17, 6.18, 6.19). Future research at Mayapán will surely encounter additional blade-making workshops.

TABLE 6.18 Test pit obsidian interval frequencies. Intervals with one asterisk represent outliers for the entire test pit sample (mean value plus 1 standard deviation). Two asterisks indicate an interval that is close to this arbitrary cutoff.

Interval:Number of obsidian pieces per square meter of excavation unit	*Number of contexts per interval*	*Percent of contexts per interval*	*Percent of commoner houses per interval*
0	7	11.7	100
1–3.5	16	25.0	100
4–8	11	20.0	100
9–15	12	20.0	83
17–23	3	5.0	66
27–30**	4	6.7	75
31–37*	3	5.0	100
42–47*	2	3.3	100
91–95*	2	3.3	100
Total	60		

Mean: 13.1, standard deviation: 31.9, mean + standard deviation = 31.9 (includes all cases).Mean: 10.4, standard deviation: 11.6, mean + standard deviation = 21.9 (excludes two cases in highest interval).

Workshops (densities): Q-303 (95), Q-176 (91), P-28 (47), P-114 (42), Z-120 (37), R-155 (31), S-10 (31). Other high density contexts (not above standard deviation) include R-110 (30), J-130 (28), Z-39 (27), R-137 (27).

Interval: Number of obsidian pieces per cubic meter	*Number of contexts per interval*	*Percent of contexts per interval*	*Percent of commoner houses per interval*
0	7	11.7	100
1–3	4	6.7	100
4–6	6	10.0	100
10–20	13	21.7	100
23–34	14	23.3	78.5
40–54	4	6.7	100
61–68**	4	6.7	100
69–72*	2	3.3	100
90–109*	4	6.7	75
157–172*	2	3.3	100

Mean: 32.2, standard deviation: 37.6, mean + standard deviation = 69.7 (includes all cases)
Mean: 27.6, standard deviation: 28.7, mean + standard deviation = 56.3 (excludes two highest cases)
Workshops (densities): Q-303 (172), J-130 (157), P-114 (109), Q-176 (107), S-10 (105), Z-39 (91), P-28 (72), R-110 (69)

Table 6.19 Obsidian densities for horizontally excavated contexts in the settlement zone (calculated from Masson, Escamilla Ojeda, and Peraza Lope 2008; Escamilla Ojeda 2009, 2012). Surplus production locations are listed at the bottom (I-55a and Q-176).

Structure	*Number of cores*	*Number of obsidian pieces*	*Area (square meter)*	*Obsidian pieces per square meter*	*Area (cubic meter)*	*Obsidian pieces per cubic meter*
House X-43	0	14	252.00	0.1	18.59	0.8
Temple H-17	4	408	601.60	0.7	328.20	1.2
Elite house Y-45	1	277	376.00	0.7	176.10	1.6
House L-28	0	55	212.00	0.3	30.40	1.8
Hall H-15	0	351	475.34	0.7	126.40	2.8
Workshop I-57	0	125	74.25	1.7	18.91	6.6
H-15 grave	0	316	40.25	7.9	28.66	11.0
House H-11	7	542	133.30	4.1	35.88	15.1
House Q-39	7	656	120.00	5.5	34.23	19.2
House Q-40a	11	682	88.50	7.7	21.74	31.4
House Q-176*	11	1,141	140.00	8.2	33.07	34.5
House I-55a*	8	2,351	196.00	12.0	47.35	49.7

Mean density per square meter was 4.12, standard deviation 4.03. Mean density per cubic meter was 14.6, standard deviation 16.0. Significant obsidian working activity was also present at Q-40a and Q-39, as illustrated by cores and higher densities, although they are not 1 standard deviation above the mean value.

Surface collection densities are calculated from the total number of blades within standardized 28.26-square-meter (3 meter dog leash) collection units. Of ninety-nine surface collections, 35.3 percent of the samples had no obsidian and 29.3 percent had less than one blade within each collection unit (table 6.17). Values of less than one blade were calculated when more than one collection was taken from a single context, as the total number of blades from all collections per context was divided by the total collection area. Higher quantities are present in the remaining contexts, as 23.2 percent of the collections had 5 to 13 blades within a single dog leash sample, 8.1 percent had 15 to 26 blades within a surface collection, and three cases had 30 to 48 pieces (table 6.17). The mean number of obsidian pieces per sample unit was 5.38 (standard deviation 8.64), thus, there are eleven contexts with over 15 pieces per unit that represent outliers in quantities of one standard deviation beyond the mean. These include collections taken at Structures Q-196, Q-176, Q-46a, R-174, Z-39 (the only elite house), Q-188, P-114, Q-303, P-115, R-173, and P-24; these contexts are listed in order of descending density. From this list, Houses Q-303, Q-176, P-114, and Z-39 were also identified as surplus obsidian-working localities by other sampling methods. Excavation data provide a more robust look at obsidian densities.

Test pit densities are calculated by excavation area and volume (table 6.18). These calculations almost always identified the same contexts as significant outliers in terms of obsidian frequencies. For cases where a context represented an outlier according to only one of these measures, and if it was close to one standard deviation beyond the mean in the other measure, it was included in the workshop list. Eleven percent of the test pits had no obsidian. Low densities ranging from 1 to 15 pieces per square meter or from 1 to 34 pieces per cubic meter were found in most of the test pit samples, according to the number of contexts within intervals of square meter (65 percent) or cubic meter (61 percent) densities (table 6.18). Seven workshops were identified by quantities of obsidian in excess of 31 pieces per square meter, and eight workshops were flagged by densities in excess of 69 pieces per cubic meter (table 6.18). These contexts include those that are equal to or greater than one standard deviation above the mean of the entire test pit sample. Densities per square meter identify the following houses as workshops: Q-303, Q-176, P-28, P-114, Z-120, R-155, and S-10. According to densities per cubic meter, outliers include the following contexts: Q-303, J-130, P-114, Q-176, S-10, Z-39, P-28, and R-110. Four contexts were outliers by both measures (Q-303, Q-176, P-114 and S-10). As this sample includes two cases with far more obsidian than the remainder (91 and 95 pieces at Q-303 and Q-176, respectively), means and standard deviations without these two cases are also presented in table 6.18. The interval of 27–30 pieces that is indicated by two asterisks on table 6.18 adds four cases to the workshop list. Of these four, three qualify as workshops according to densities per cubic meter on the same table; House R-137 is the only case that does not, but it is included in our workshop tally. It is interesting that House I-55a, an outlier in the fully excavated sample, falls below the qualifying intervals in table 6.18, with only 25 pieces per square meter and 45.5 pieces per cubic meter in the test pit samples.

Support for the correlation between obsidian densities and production activities is found in the co-occurrence of obsidian blade cores in five of the nine test pits thought to represent workshops. Three contexts, Z-120, Z-39 and R-155, had one obsidian core, and Q-303 had two. House J-130 also had two obsidian cores and had very high densities (157 pieces per cubic meter).

Obsidian assemblages were analyzed for twelve fully excavated localities in the settlement zone (table 6.19; Escamilla Ojeda 2009, 2012). Obsidian densities for these contexts are lower than for test pits, as full excavations include clean-swept interior architectural spaces. Two contexts, I-55a and Q-176, are identified as surplus obsidian-working localities, according to the number of pieces per square meter and per cubic meter (table 6.19). With densities per cubic meter of 49 and 34 pieces, respectively, they exceed the mean (14.6) plus one standard deviation (16.0). House Q-40a has values that are close to this measure and obsidian working may have been among its varied other crafting pursuits (table 6.3), but we have not technically counted it as a workshop for this study. Similarly, obsidian is abundant at Q-39, which ranks fourth in density per cubic meter. The recovery of 8 to 11 blade core fragments at I-55a, Q-176, and Q-40a provides additional evidence of blade making, although two other houses had 7 core fragments each, including Q-39 (table 6.19). The surplus production of obsidian at Q-176 was initially indicated by surface collection and test pit sampling (tables 6.17, 6.18). It is noteworthy that Houses Q-40a and Q-39 are both multi-crafting houses that are adjacent to elite group Q-41, and their partial engagement in some obsidian working below the levels of Q-176 and I-55a is not surprising. House Q-176 is also a multi-crafting house in Milpa 1, next to the site center. House I-55a is close to the Itzmal Ch'en group, which it faces.

The type and location of these contexts reveals important information about the social context of craft production. All but one of the nineteen high-frequency surface collections, nine test pits, and two horizontally exposed obsidian workshop locales represent commoner residences, with the exception of Z-39, a secondary elite house next to the southern edge of the monumental center and the southern terminus (Z-50) of the site's principal sacbe. This context was identified as an obsidian production locality from both surface collection and test pit samples. The most striking observation about the location of these residential workshops is their tendency to be located near the monumental center (table 6.3, figure 6.4). Nine of the nineteen obsidian workshop localities are within Milpa 1, to the immediate west of the site center. Milpa 1 has the highest density of surplus crafting houselots, and we suggest that it represents a crafts barrio (figures 6.4, 6.19). Including nine houselots that made surplus obsidian, there are thirteen total crafting houselots in Milpa 1, and as only four of these thirteen made a single surplus item, multi-crafting was common in this neighborhood. Of the nine obsidian workshops in Milpa 1, three exclusively made obsidian blades, and the remainder made other crafts as well (table 6.3). Some of the highest obsidian densities come from Milpa 1 crafting houselots such as Q-303, Q-176, P-28, and P-114 (table 6.18). The proximity of the Milpa 1 houselots to the site center is likely to be

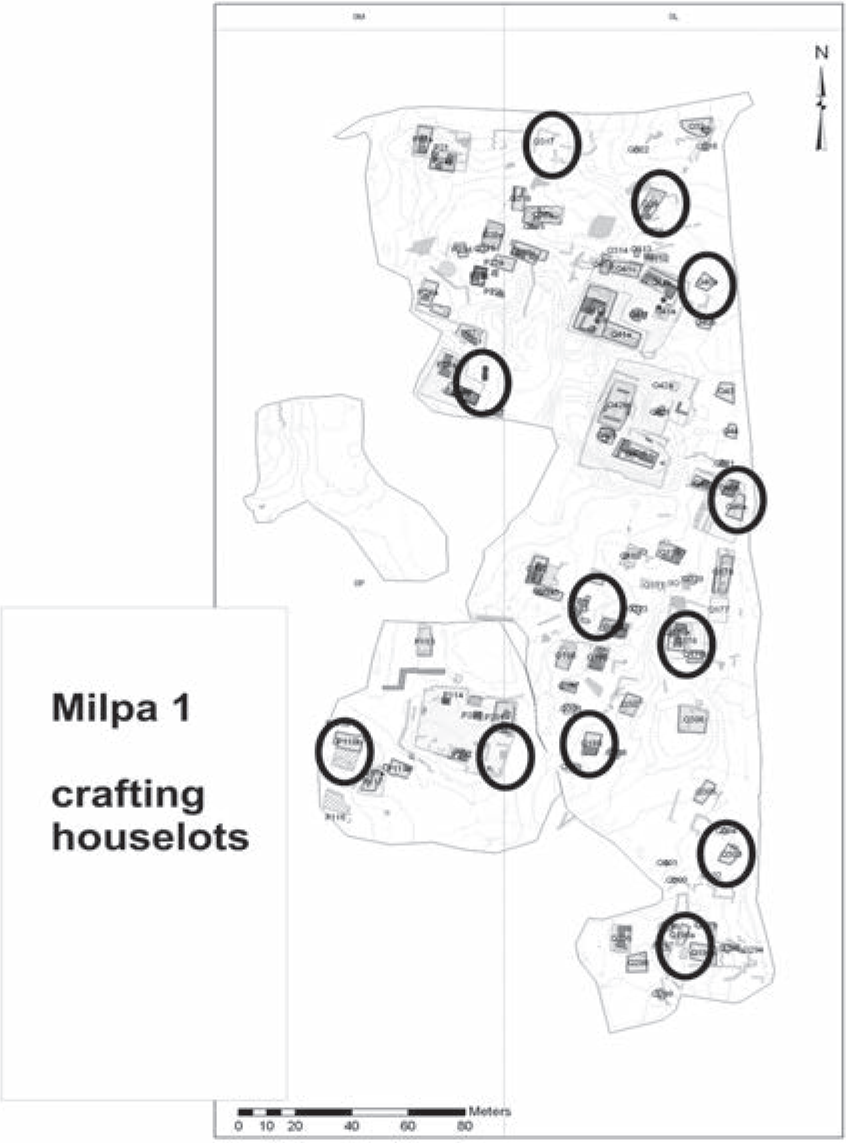

Figure 6.19. *Milpa 1, located immediately to the west of Mayapán's monumental center, has a concentration of surplus craft production houses and represents the only crafts barrio identified at the city.*

significant, and although all of these obsidian workshops are within independent houselot walls, manufacture for elite clients may partially explain the concentration of activity in this part of the city. But Milpa 1 is also located in downtown Mayapán, at the nexus of a number of roads leading to the site center from the city gates (chapter 4). This location may also have offered ample opportunities for vending or participation in central or neighborhood marketplaces at Mayapán.

Surplus obsidian-working contexts outside of Milpa 1 also tend to be located near nodal architecture in the settlement zone (figure 6.4). Two such contexts are in Milpa 32 (R-173b and R-174) and two are in Milpa 11 (R-155 and R-110). These locations, like Milpa 1, represent downtown settlement zones. Milpa 32 also has a large elite residential group in its midst (Q-244) and Milpa 11 (R-155 and R-110) is near a row of the three largest palaces at Mayapán (R-86, R-96, and R-103). House I-55a, in Milpa 16, faces the Itzmal Ch'en group, the largest focal node outside of the site center. A less clear spatial association is noted for Workshops S-10 and J-130, which are within 250 meters of a colonnaded hall (J-111). One workshop context is not located near any elite residences or public architecture, House Z-120 in Milpa 4 (figure 6.4), in the southeastern residential zone of the city.

Our data suggest that the highest levels of obsidian production are associated with craftsmen living near elites and who possibly worked in their service. Exceptions may be represented by I-55a; although it is 50 meters to the southeast of Itzmal Ch'en, elites did not reside in this area. House Z-120 also represents an exception, which illustrates that commoners may have sometimes produced obsidian at home without close supervision. House Z-120 is also a chert and shell workshop. Nineteen surplus obsidian production localities have been identified using basic statistical criteria.

Obsidian Consumption

Obsidian frequencies for surface collections and test pits described above reveal that 35 percent of the ninety-nine surface collection contexts had no obsidian, but the majority of these contexts had no lithic tools at all (tables 6.17, 6.18, 6.20). Surface collections were taken in all parts of the city, even where dense midden concentrations were not visible at the surface in sparsely inhabited areas. For this reason, some collections have low densities of all materials. The majority of both surface collections and test pit samples suggest that obsidian was used regularly for daily activities of commoners. The right-hand column of tables 6.17 and 6.18 indicates the proportion of commoner contexts represented by the obsidian frequency intervals. Affluent craft specialists tended to possess more obsidian,

Table 6.20 PEMY surface collection obsidian-chert/chalcedony tool ratio intervals.

Interval: Ratio of obsidian pieces to other lithic tools	*Number of contexts*	*Percent of total contexts per interval of 96*	*Percent of commoner contexts (non-workshops)*	*Percent of elite contexts per interval*	*Number of contexts (workshops) per interval*	*Percent of contexts (workshops) per interval*	*Percent of commoner contexts (non-workshops and workshops)*
No lithic tools	21	21.9	100	0	0	0	100
No obsidian	12	12.5	92	8	0	0	92
Only obsidian (1–30 pieces)	24	25.0	79	8	3	12.5	92
.3–.7	4	4.2	100	0	0	0	100
1	6	6.3	100	0	0	0	100
1.5–2.9	7	7.3	71	14	1	14.3	86
3.0–6.5	11	11.5	73	9	2	18.2	91
8–11	7	7.3	43	14	3	42.9	86
12–15	4	4.2	50	0	2	50.0	100
Total	96		79	6	11		96
Below: Ratios of obsidian to all other chipped stone tools, recalculated to include used chert and chalcedony flakes.							
No lithic tools	33	34.4	97	3	0	0.0	97
Only obsidian	12	12.5	92	8	0	0.0	92
.1–.8	19	19.8	84	11	1	5.3	89
1–2.6	17	17.7	59	12	5	29.4	88
3.0–6.5	8	8.3	63	0	3	37.5	100
7–11	6	6.3	67	0	1	33.3	100
30	1	1.0	0	0	1	100.0	100
Total	96		79	6	11		96

even when they did not manufacture obsidian blades, compared to non-crafting houselots. As table 6.18 reveals, the interval of 9–15 pieces per square meter includes seven ordinary (non-crafting) houselots, three surplus craft-producing (commoner, non-obsidian) houselots, and two elite houses. Houselot samples in the higher interval of 17–25 pieces per square meter include one ordinary, two craft-production (non-obsidian) commoner houselots, and one elite context. These data suggest that commoners were able to obtain obsidian with ease. It was not prohibitively expensive and elites did not control its distribution.

The relative importance of obsidian in consumer contexts is also reflected by the ratio of obsidian to other kinds of lithic artifacts. Obsidian blades at Mayapán were used for a range of light to heavy cutting tasks (Masson, Escamilla Ojeda, et al. 2008; Escamilla Ojeda 2009), and some functions probably overlapped with sharp chert or chalcedony tools. Here we assess three different ratios that attest to the relative importance of obsidian. The ratio of obsidian to chert/chalcedony tools (formal and retouched tools) represents our first measure. Chert and chalcedony unifacial and bifacial tools are not as ubiquitous as blades or other types of artifacts, so additional ratios are also employed. We also calculate the obsidian to all chert/chalcedony artifact ratios (formal and retouched tools and all used flakes, cores, and flaking debris). We are especially partial to a third ratio, which considers the quantity of obsidian to all modified chert/chalcedony artifacts, including unifaces, bifaces, and used flakes but excluding unused production debris. This is the most valuable ratio, as it considers all lithics used for work activities at Mayapán's houselots. But few comparable case studies exist, as the number of used flakes has been rarely assessed in the Maya area. At Mayapán, these tools were identified by examining every chert/chalcedony flake with an 8x magnification geological loupe for evidence of retouch or edge damage attributable to utilization. Artifact-sherd ratios are employed in other studies (e.g., M. Smith 2003d), as sherds potentially represent a type of constant for occupational duration or intensity. But the quantity of sherds can also be related to other functional factors. As pottery production areas such as Q-176 have greater sherd densities that dwarf the quantities of stone tools, we do not employ sherd ratios.

Both obsidian and chert tools were recovered in thirty-nine of ninety-six surface collections that were clearly associated with a structure (table 6.20). Of the total sample, 36.5 percent had ratios of one or more obsidian blades per chert/chalcedony stone tool. When used chert flakes are included in the ratio, at least 32 percent of the surface collections had one or more obsidian blades per stone tool (table 6.20). Commoner contexts represented the majority of the sample, and they form 50–73 percent of the cases with 3 to 15 obsidian blades per stone tool (higher ratio intervals, table 6.20). Elites and obsidian workshop localities also used blades in equal or greater numbers to chert or chalcedony tools, as might be expected.

Table 6.21 PEMY test pit sample obsidian to chert/chalcedony tool ratio intervals.

Interval: Ratio of obsidian to other lithic tools	*Number of contexts*	*Percent of total contexts per interval of 96*	*Percent of commoner contexts (non-workshops) per interval*	*Percent of elite contexts per interval*	*Number of contexts (workshops) per interval*	*Percent of contexts (workshops) per interval*	*Percent of commoner contexts (non-workshops and workshops)*
No tools	4	6.8	100	0	0	0.0	100
No obsidian	3	5.1	100	0	0	0.0	100
Only obsidian	22	37.3	91	5	1	4.5	95
0.8	1	1.7	100	0	0	0.0	100
1.3–3.7	6	10.2	83	0	1	16.7	100
5.5–11.7	9	15.3	89	0	1	11.1	100
14–31	7	11.9	71	14	1	14.3	86
36–77	5	8.5	20	20	3	60.0	80
110, 285	2	3.4	0	0	2	100.0	100
Total	59		47	3	9 (plus 1 elite workshop)		59
Note: only one elite house workshop is represented, within a ratio of 54 pieces of obsidian per other stone tools. Below: ratios of obsidian to all other chipped stone tools, recalculated to include used flakes.							
No obsidian	7	11.9	100	0	0	0.0	100
Only obsidian	2	3.4	100	0	0	0.0	100
.02	1	1.7	100	0	0	0.0	100
.1–.9	31	52.5	84	6	3	9.7	94
1–3.8	16	27.1	56	6	6	37.5	94
4.8–8	2	3.4	100	0	0	0.0	100
Total	59		47	12	9		

Table 6.22 PEMY obsidian to chert/chalcedony uniface and biface ratios, horizontally excavated structures.

Structure	*Context type*	*Obsidian/lithic tool ratio*	*Obsidian/lithic tool ratio, including used flakes*
X-43	Commoner house by city wall, short and incomplete domestic history	0.7	0.1
I-57	Chert/chalcedony workshop outbuilding, near commoner houses	1.2	0.2
Q-39	House, multi-craft workshop, next to elite Palace Q-41 and downtown monumental center	1.9	1.4
Y-45	Elite house in southeast settlement zone	2.5	.4
H-17	Temple, Itzmal Ch'en group	4.4	3.6
L-28	Commoner house by city wall	5.0	0.4
Q-176	Commoner house, obsidian and multi-craft workshop, downtown near monumental center	6.9	6.0
H-11	Commoner house, custodial to Itzmal Ch'en group	7.2	2.5
H-15 hall	Colonnaded hall, Itzmal Ch'en group	7.5	2.4
H-15 grave	Mass grave by Hall H-15	7.9	2.3
Q-40a	Commoner house, multi-craft workshop, next to elite Palace Q-41 and downtown monumental center	8.4	8.3
I-55a	Commoner house, obsidian and multi-craft workshop, near Itzmal Ch'en	20.8	10.2

Test pit data affirm these findings that obsidian tools were equally or more important than chert tools at Mayapán houselots, including those of ordinary residents who were not surplus crafters. These data indicate that 37.3 percent of the test pit contexts had from 1 to 31 obsidian blades per chert/chalcedony tool. These ratios were reflected in a sample consisting of 71–89 percent non-crafting commoner houselots (table 6.21). Obsidian blades were, as expected, more ubiquitous relative to stone tools at workshop localities, with ratios of 36 to 285 blades per chert tool. When used chert flakes are added to the calculations, results are similar: 30.5 percent of the contexts had 1 to 8 blades per chert tool, and these intervals are made up of 56–100 percent ordinary (non-crafting) commoner houselots (table 6.21).

Ratios of obsidian to chert/chalcedony tools for horizontally excavated structure intervals are provided in table 6.22, and these generally confirm the findings of surface collection and test pit samples. Only one of twelve contexts has a ratio below 1.2 obsidian fragments per other stone tool, indicating common access to obsidian across social and functional contexts. Ratios of non-workshop houses vary from 0.7 to 7.2. Except for the high ratio at obsidian workshop I-55a (20.8 pieces of obsidian per chert tool), ratios of obsidian to chert tools do not distinguish obsidian workshops well from other localities (table 6.22). This fact is not surprising, as it simply reflects that multi-crafting localities like Q-176 used a high number of chert tools for diverse activities. It is interesting, however, to note that obsidian to chert tool ratios tend to be higher at obsidian workshops when used flakes are included in the chert tool ratio (table 6.22).

Setting obsidian workshops aside, comparisons of non-workshop commoner houses, elite residences, and public buildings are informative. Commoner Houses L-28 and H-11 have more obsidian (ratios of 5.0 and 7.2, respectively) than elite House Y-45 (2.5) or Temple H-17 (4.4). The ratio of House H-11 is essentially the same as that of contexts from Hall H-15. While House H-11 is located next to the Itzmal Ch'en group (H-15 and H-17), this is not the case for L-28, a house located in an unassuming neighborhood near the north part of the city wall. A low ratio at I-57 (1.2) indicates the singular focus of chert/chalcedony toolmaking at this workshop and a lack of other domestic activities at this locality. The very low ratio at commoner House X-43 concurs with other assessments that this house was occupied only briefly, and a full range of domestic activities did not occur there.

Obsidian to chert tool ratios that include used chert flakes reveal that elite House Y-45a and commoner House L-28 have a very low ratio (0.4), and this ratio is exceeded significantly by all other contexts (2.3–10.2) except for chert Workshop I-57 and commoner House X-43 (table 6.22). By this measure, obsidian-working contexts have the three highest ratios (10.2, 8.3, 6.0), and public buildings Temple H-17 and Hall H-15 have more relative obsidian than five other houses tested, probably because utlitized flakes are less ubiquitous at ceremonial structures.

Table 6.23 Composite comparisons for PEMY project chipped tool assemblage.

	Obsidian (number)	*Lithic tools (number)*	*Used flakes (number)*	*Flakes (not used) (number)*
Fully excavated contexts	6,918	1,200	1,974	38,187
Test pits	2,110	104	4,354	34,474
Surface collections	811	164	558	8,320
Total	9,839	1,468	6,886	80,981
	Obsidian (percent)	*Lithic tools (percent)*	*Used flakes (percent)*	*Total chipped stone tools (excluding non-used flakes)*
Fully excavated contexts	68	12	20	10,092
Test pits	32	2	66	6,568
Surface collections	53	11	36	1,533
Total	obsidian	lithic tools	utilized flakes	

Composite site ratios:
Ratio obsidian/lithic tools: 6.7
Ratio obsidian/lithic tools + used flakes: 1.2
Ratio obsidian/lithic tools + used flakes + unused flakes: 0.1

The total obsidian to lithic tool ratio for Mayapán is 6.8 pieces of obsidian per uniface or biface, and when used flakes are added to the other non-obsidian chipped stone tools, there are 1.2 obsidian pieces for all lithic tools, including the most expedient categories (table 6.23). When these ratios are expressed as percentages (table 6.23, figure 6.20), obsidian forms 68 percent of the entire chipped stone tool assemblage of excavated contexts (retouched unifaces and bifaces form 12 percent, used flakes form 20 percent). Obsidian also forms 32 percent of the chipped stone tools from test pits and 53 percent of the surface collection tools (figures 6.21, 6.22). Overall, these composite values attest to the importance of this material in daily life at the city, especially considering the fact that 95 percent our test pit and 93 percent of our surface collection are commoner dwellings.

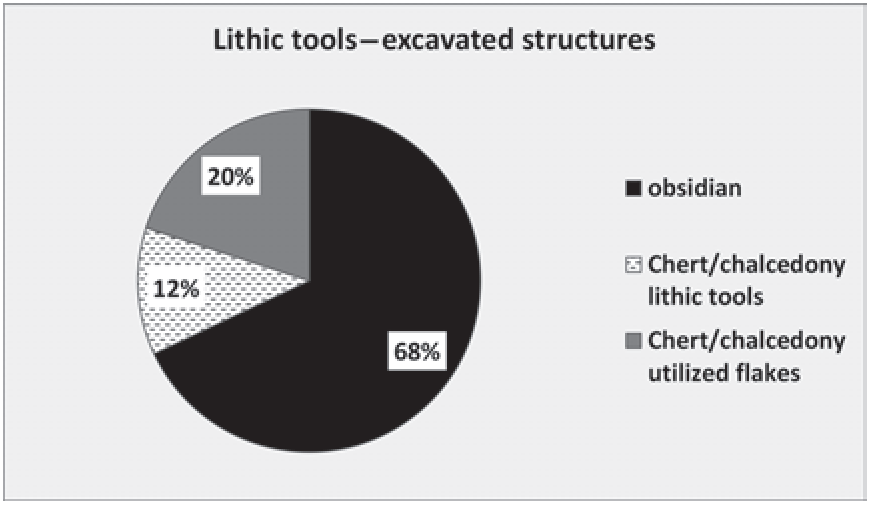

Figure 6.20. *Proportion of obsidian to chert/chalcedony chipped stone tools and used flakes (fully excavated contexts).*

Obsidian Artifacts

Almost all obsidian artifacts from Mayapán are blade fragments. Except for the low numbers of prismatic blade cores mentioned previously, the sample includes occasional flakes, chips, small side-notched projectile points, and, rarely, thumbnail-sized scrapers (Proskouriakoff 1953:283). As outlined in detailed studies by Bárbara Escamilla Ojeda (2009, 2012), core fragments were highly expended, ranging from 1.2 to 3.5 centimeters in length and from 1.6 to 2.1 centimeters in width. Average obsidian blade length was 4.1 centimeters (ranging from 1.6 to 7.6 centimeters), and average width was 1 centimeter (ranging from .2 to 3.31 centimeters). These blade widths are not much smaller than those of Laguna de On, Belize, for which the mean width was 1.2 (Masson 2000). Laguna de On is around 400 kilometers from the highland Guatemala volcanic sources; Mayapán was nearly twice as far. Their relatively comparable mean blade sizes suggest general parity in the small size of blade cores that were traded up the coast of Yucatán and into inland sites. Perhaps blades of this size were most greatly desired. Light, medium, and heavy wear on the edges of blades was commonly observed. Visual sourcing by Escamilla Ojeda (2009, 2012) suggests that most (80.8 percent) of the obsidian traded to Mayapán was from Ixtepeque, and other sources present include El Chayal (15.6 percent) and San Martín Jilotepeque (3.4 percent). The dominance of

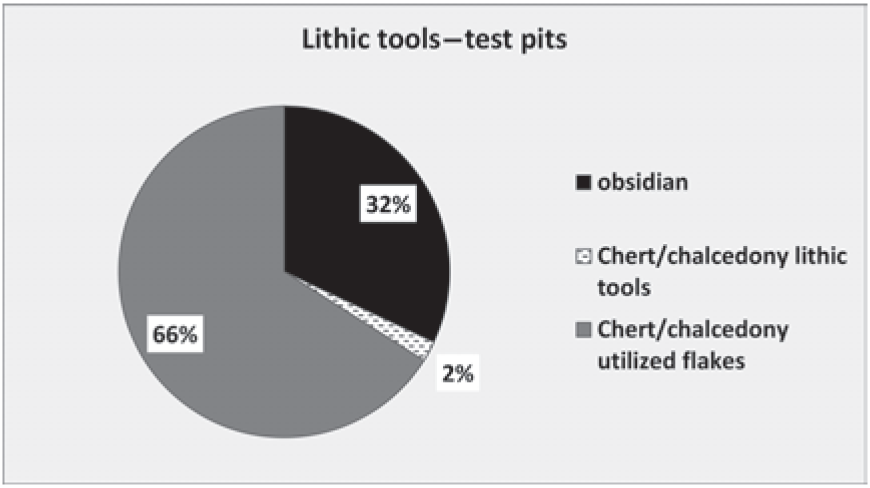

Figure 6.21. *Proportion of obsidian to chert/chalcedony chipped stone tools and utilized flakes (test pits).*

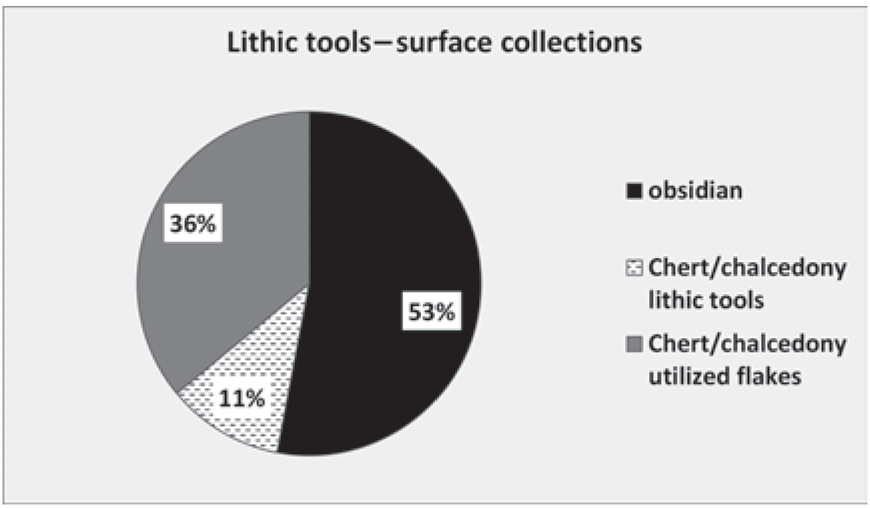

Figure 6.22. *Proportion of obsidian to chert/chalcedony chipped stone tools and utilized flakes (surface collection contexts).*

the Ixtepeque source in the Late Postclassic Period has been established for sites contemporary to Mayapán in the Maya area (Masson and Chaya 2000; Braswell 2010).

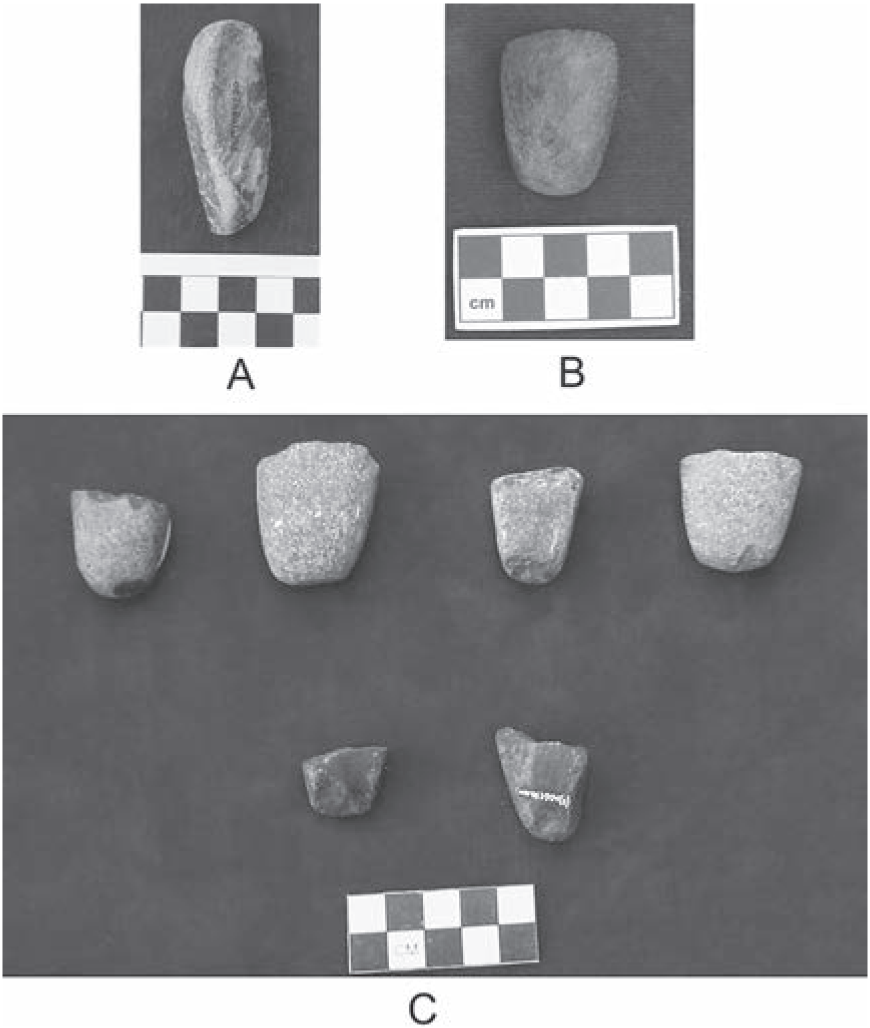

Figure 6.23. *Greenstone axes from Mayapán houselots. The majority are from commoner dwellings, and the chisel (A) is from an offering on top of Hall H-15.*

Woodworking Industries: Greenstone Celts

Although wooden objects do not preserve at Mayapán, this industry was probably important. Small greenstone celts and chisels were likely used for woodworking (figure 6.23). Carved wooden effigies of important deities are referred to regularly in documentary sources. For example, twenty wooden masks were present at one Colonial Period ceremony in Yaxcaba (Scholes and Roys 1938:614); buckets were also made of wood during the Contact Period (Tozzer 1941:198). In Cenote Dzab-Na of Tecoh, not far from Mayapán, a wooden statue was also found (Strömsvik 1956).

Greenstone celts and chisels at Mayapán exhibit variation in color from shades of nearly black to dark green. These stones probably originated from the Maya highlands of Chiapas or Guatemala, where small river cobbles of similar composition and coloring are abundant. Test pit and surface collection data reveal that greenstone celts were commonly found at commoner and elite houselots near the epicenter but were also regularly recovered in mid-city and more peripheral locations within the city wall (table 6.24). Fully excavated contexts revealed that similar quantities of axes were found in smaller surface collection or test pit samples (i.e., no context had more than two greenstone axes). They are found at houses engaged in surplus craft work and at houses where such activities were not undertaken. Although an ax was not recovered at fully excavated House L-28, one was found on the surface of a nearby similar house (L-23). Split axes, which perhaps entered this state as a result of use-related breakage, were commonly reused as chisels. Of the eighteen axes and chisels that could be measured, the mean length was 4.0 (standard deviation of 0.9) when an unusual example that is 11.5 centimeters long is eliminated from the calculation.

Four greenstone ax fragments or pieces of raw material were also found in the interior floors of Hall H-15 and Temple H-17, and two of these were concentrated in offerings of smashed incense burners (figures 3.11, 3.12, 6.23a). The use of greenstone fragments as offerings attests to this material's symbolic value. Commoners regularly possessed greenstone objects, but they are not distributed as regularly as obsidian. One of the finest greenstone axes, represented by a small polished medial fragment, was found at Hall H-15. Offering pieces at Itzmal Ch'en consisted of one piece of raw material and one fragmented tool (chapter 3); these may have symbolized original whole objects of symbolic or historical value (Weiner 1992; Lesure 1999). Some of the finest examples are from the monumental center, including the large ax of 11.5 centimeters in length. Variation in ax size, workmanship, quality and the color of the greenstone material attests to a gradation of value among these objects (figure 6.23). The greenstone ax is an artifact class with a long-standing history in the Maya area (Freidel and Reilly 2010). Other greenstone objects were scarce at Mayapán, including the PEMY settlement zone samples. Beads were found in similar quantities at commoner crafting houselot Q-176 (N = 3) compared to Hall H-15 (N = 3) and Temple H-17 (N = 2) but are largely absent from other houselot contexts.

Table 6.24 Greenstone objects recovered by PEMY project horizontal excavations, surface collections, and test pits.

Unit type	*Structure*	*Greenstone ax*	*Greenstone polisher*	*Greenstone raw material*	*Greenstone jade, onyx, or micaceous ornament/bead*
Horizontal	H-11 house	1	–	–	–
Horizontal	H-15 hall	2	1	–	3
Horizontal	H-17 temple	1	–	1	2
Horizontal	I-55a craft specialist	1	–	–	–
Horizontal	Q-39 craft specialist	2	–	–	1
Surface	Q-176 craft specialist	2	–	–	3
Surface	Q-40 craft specialist	2	–	–	–
Surface	Y-45 elite house	1	–	–	–
Surface	L-28 house	–	–	–	–
Surface	X-43 house	–	–	–	–
Surface	L-23 house	1	–	–	–
Surface	M-59a house	1	–	–	–
Surface	Q-179 house	1	–	–	–
Surface	Q-181 house	1	–	–	–
Surface	Q-185 house	1	–	–	–
Surface	Q-195 house	1	–	–	–
Surface (2)	Q-42 elite house	2	–	–	–
Surface	R-175b house	1	–	–	–
Surface	Y-106 house	1	–	–	–
Test pit	Z-120 craft specialist	1	–	–	–
Test pit	S-8c craft specialist	1	–	–	–
Test pit (2)	P-114 craft specialist	2	–	–	–

Table 6.25 Mayapán tool typology.

Type	*Characteristics*	*Use*
Pointed bifaces	Elongated, thin bifaces with one pointed end, clear shoulders, and rounded or tapered proximal sides	Knives, lanceolates
Diamond-shaped bifaces	Small bifaces with diamond shape, shoulders tend to be at center of artifact	Perforators or projectiles
Wedge-shaped bifaces	Also known as triangular bifaces	Axes
Oval bifaces (small)		Axes
Hammerstones	Spherical or sub-spherical, sometimes made from cores	Battering
Small hammerstones or polishing stones	Wedge-shaped and planoconvex in cross section	Crafts
Thick bifaces—celtiform	Resemble northern Belize general utility biface type, blunt, battered end	Heavy pounding and smoothing tasks
Stage 1 and 2 bifaces	Larger, thicker bifaces that appear unfinished, perhaps preforms of types listed above	Cores, expedient heavy tasks, preforms
Narrow bifaces type 1	Parallel sided (or nearly so), thick, proximal and distal ends are similarly shaped	Perforators, drills, or fragments of bifacial projectile points
Narrow bifaces type 2	Narrow bifaces like type 1 but with thick oval base	Perforators or drills
Narrow bifaces type 3	Narrow bifaces that are thinner in cross-section than types 1 or 2	Probable bifacial projectile points
Side-notched points	Most are primarily unifacial with bifacial edge trimming, some are fully bifacial; rounded, squared, and concave bases	Projectile points
Eccentrics	Zoomorphic, crescent, S-shaped—rare	Symbolic
Rare tool forms (from monumental center)		
Long bifacial knives	Proximal fragments of 12 cm and 15 cm in length, appear to be made of Colha chert; resemble Proskouriakoff's (1962:356, figure 27) "large, leaf shaped blades"	Ceremonial knives

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Table 6.25—*continued*

Type	*Characteristics*	*Use*
Large thick biface	Well made and appears to be made of Colha chert	Miscellaneous
Thin stemmed biface		Knife
Thick stemmed biface	Resembles Proskouriakoff's (1962:357, figure 7) "stemmed points"	Lanceolate
Thin oval biface	Fully oval and symmetrical	Celtiform
Expedient unifaces and bifaces		
Retouched flakes	Much variation in form and modification	A variety of cutting tasks
Gravers, spurs, denticulates	Some variation in form and modification	Crafting
Scrapers	Some variation in form and modification	Crafting

Chert and Chalcedony Tools

Frequencies of Mayapán Stone Tool Types

A total of 1,497 chert and chalcedony unifaces and bifaces were recovered from the PEMY investigations; 1,493 of these are inferred to be of Postclassic date. In 2008 we outlined a descriptive typology for the formal tools from the site that is summarized in table 6.25 (Masson, Escamilla Ojeda, and Peraza Lope 2008). Proskouriakoff (1962b:330) was not particularly impressed by the workmanship of chipped stone tools at the city in terms of style, standardization, or raw material; she went so far as to state that the variable tool morphology was "symptomatic" of deep social disorder and cultural poverty. But Mayapán, like earlier centers, has examples of finely crafted stone tools alongside a wide array of more simply made examples that have been modified through extended lives of recycling or resharpening.

As noted by Proskouriakoff (1962b:355), Mayapán's stone tools are smaller in size than earlier, southern lowland precedents. The size and scarcity of chert or chalcedony axes at Mayapán perplexed Carnegie project investigators, so much so that Joseph A. Hester, Jr. (1953) undertook experiments to see if land could be cleared using unmodified limestone hand axes. We attribute the use of small agricultural oval and wedge-shaped axes to differences in local land use and forest. Drier Yucatán areas may have been more easily cleared with burning and the use of smaller bifaces. Chert or chalcedony cobbles also appear to be small in this region, and this would have provided its own constraints on tool size.

Triangular hatchets (wedge-shaped bifaces) are common at Mayapán (Proskouriakoff 1953:282) and represent one of the formal bifacial tool categories (figure 6.24e). Similar hafted examples appear in the Dresden, Madrid, and Borgia codices (e.g., Dresden Codex:11 [Bill, Hernández, and Bricker 2000]; Madrid Codex:55b, 54b [Villacorta C. and Villacorta 1976]; Borgia Codex:52, plate 26 [Díaz, Rodgers, and Byland 1993]), where they are used as weapons, although they were also likely useful for a variety of agricultural and wood-working activities (e.g., Borgia Codex:59, plate 19; Díaz, Rodgers, and Byland 1993). These objects closely resemble the "triangular bifaces" made by Colha flintknappers in the Postclassic Period (Shafer and Hester 1983; Michaels 1987:153, figure 30). Pointed bifacial knives resemble those of contemporary central Mexico in form and also constitute a formal lithic tool type for the city. These knives are typically pointed on either end and have straight or slightly convex sides, with some variations in the definition of a shoulder in the basal half of the artifact. They are distinguished from lance or spear points (in the Borgia Codex), which have a clear, elongate triangular shape (e.g., Díaz, Rodgers, and Byland 1993:53, plate 25). Mayapán pointed bifaces are similar to the Postclassic lenticular bifaces at Colha in northern Belize (Shafer and Hester 1988; Michaels 1987:146, figure 27), although the Belize artifacts tend to be narrower, thinner, and have more standardized shoulders and straight, tapering edges, whereas the Mayapán versions are more variable in terms of edge convexity.

Table 6.25 lists recurring chipped stone tool types at Mayapán, and their overall frequencies are charted in figure 6.25. Those that exhibit significant standardization in morphology, size, and, presumably, function (figure 6.24) can be classified as formal tools, including the following: side-notched projectile points (most often unifacial with bifacial edge retouch), pointed bifaces (useful as knives and lanceolates), wedge-shaped (triangular) axes, small oval biface celts, and narrow bifaces (Types 1 and 2) that, when complete, may have been used as perforators or drills. Fragments of certain, thinner narrow bifaces, sometimes with stems (Type 3), can be difficult to distinguish in width, thickness, and length from elongated bifacial projectile points, which are relatively rare at the site (figure 6.24i, j, k). Spherical (or sub-spherical) chert or chalcedony hammerstones also occur with regularity. Informal, more expediently manufactured tools exhibit greater variation (figure 6.26) and include gravers made on the points or projections of retouched flakes, a variety of retouched flakes, composite flake tools, used cores, and thick or other nonstandardized

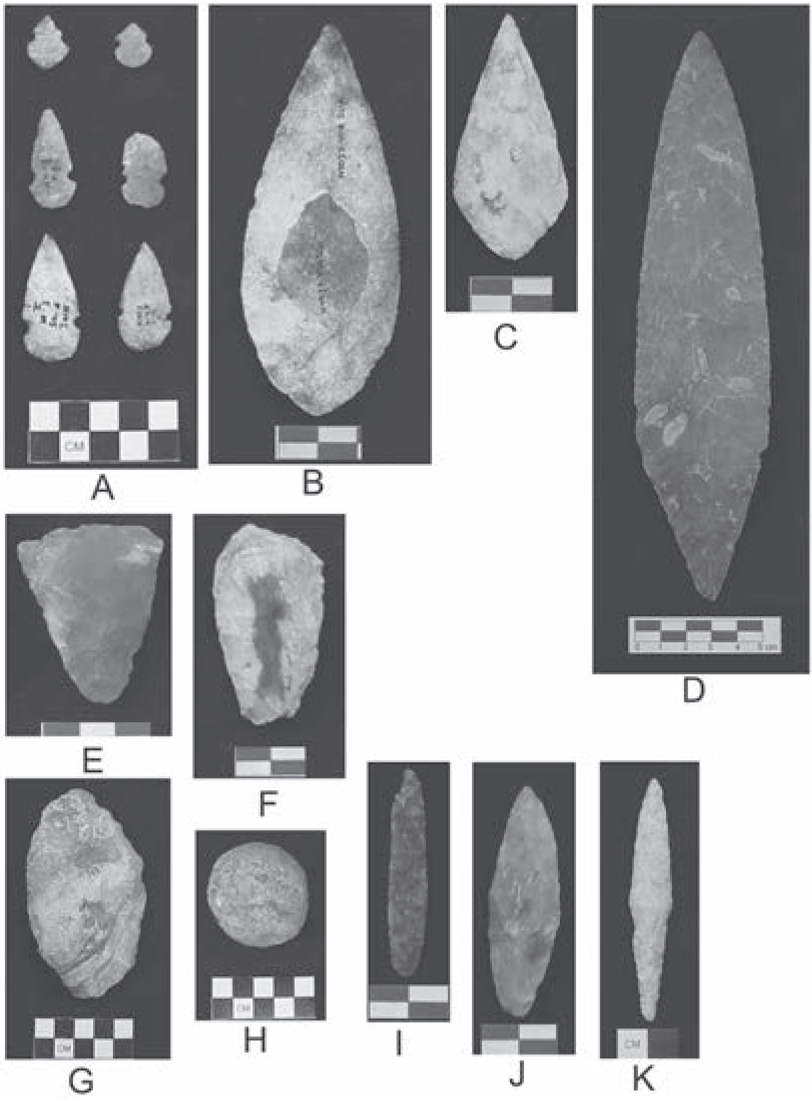

Figure 6.24. *Formal tool types at Mayapán, including side-notched projectile points, rounded base variety with varied degrees of resharpening shown (A), pointed bifacial knives with rounded or converging bases (B, C, D), wedge-shaped (triangular) axes (E), oval biface celts (F), thick (Stage 1 or 2) bifaces (G), spherical hammerstones (H), narrow bifaces with parallel sides (I), convex sides (J), or with metric/morphological characteristics of either projectile points or perforators/drills (K). The large, elongated pointed biface (D) is rare for its size at Mayapán, and examples B and C exhibit more typical size ranges.*

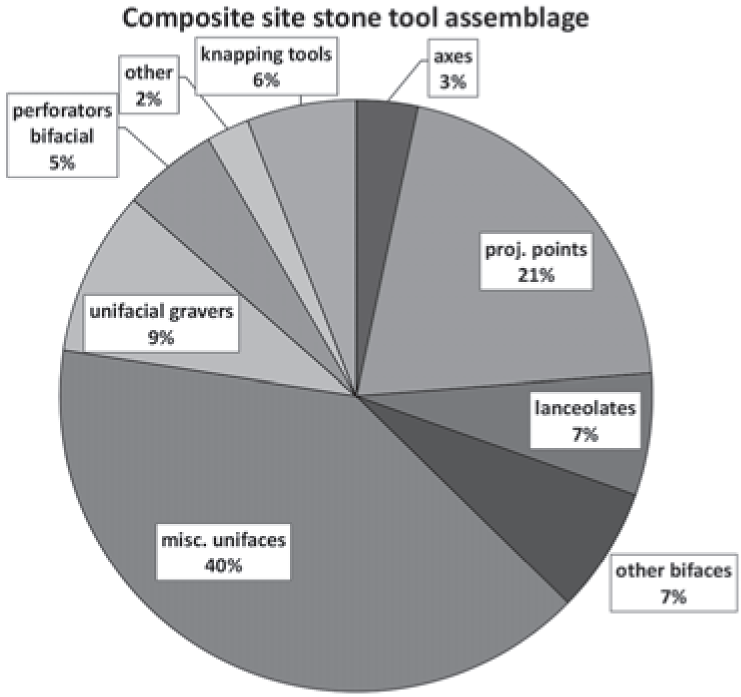

Figure 6.25. *Proportion of major stone tool types from all contexts at Mayapán (details in table 6.23).*

bifaces. The relative quantities of these general tool categories from the PEMY project are summarized in table 6.26, which indicates that the most frequent tool categories are various expedient unifacial tools (40.1 percent). Next most common were side-notched projectile points (20.4 percent), followed by unifacial gravers (9.0 percent), miscellaneous bifaces (6.9 percent), pointed bifacial knives (6.6 percent,), artifacts related to chipped stone production (6.0 percent), bifacial perforators (5.2 percent), axes (3.3 percent), and other items amounting to 2.3 percent of the sample, including eccentrics, greenstone axes, and polishing stones (table 6.26).

These frequencies provide the basis of four primary observations about lithic tool use and activities at the city. First, expedient technology was highly significant for crafting and ordinary tasks. Second, crafting activities represented

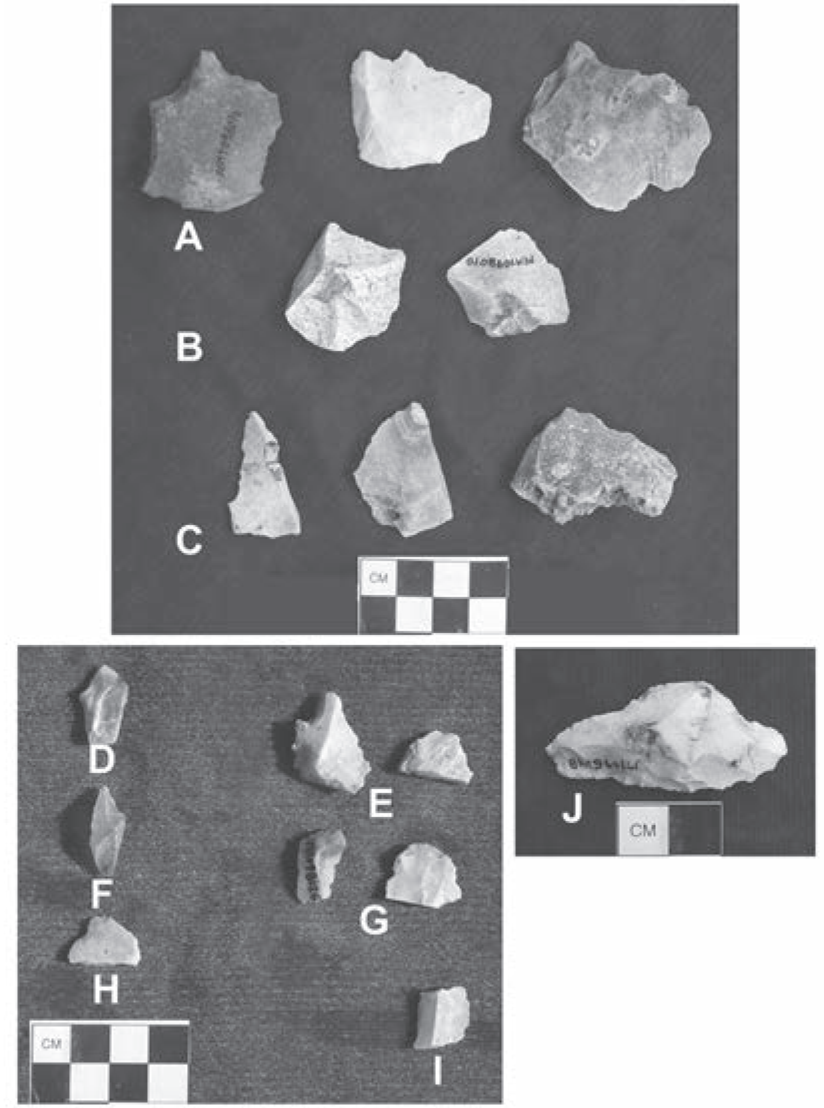

Figure 6.26. *Flake tools at Mayapán, including gravers (Row A, example D), miscellaneous retouched flakes (Rows B, C, examples G, H, I), a burin spall graver (F), retouched flakes with notches (E, left, H), a mini-scraper (E, right), and a composite flake tool (J). Examples A–I are from shell Workshop Q-39 and example J is from shell Workshop I-55.*

Table 6.26 Stone tool types from Mayapán (PEMY project, surface collection, test pit, and fully excavated contexts). Materials are chert/chalcedony unless otherwise indicated.

Projectile point	*Total*	*Percent*	*Subtotal (%)*
Projectile point (66 are obsidian)	304	20.4	
Subtotal points			20.4
Knife and lanceolate	*Total*	*Percent*	*Subtotal (%)*
Pointed biface	85	5.7	
Other knives/lanceolates	14	0.9	
Subtotal knife/lanceolate			6.6
Ax	*Total*	*Percent*	*Subtotal (%)*
Wedge-shaped biface	24	1.6	
Oval biface celt (25) and informal celtiform (1)	26	1.7	
Subtotal ax			3.3
Other biface	*Total*	*Percent*	*Subtotal (%)*
Biface formal fragment (pointed knife or ax)	12	0.8	
Biface informal	11	0.7	
Biface informal discoidal	3	0.2	
Biface informal planoconvex	19	1.3	
Biface informal thick	22	1.5	
Biface, informal GUB	3	0.2	
Biface fragment	33	2.2	
Subtotal other biface			6.9
Perforator/drill	*Total*	*Percent*	*Subtotal (%)*
Perforator/drill (narrow biface types 1 and 2)	36	2.4	
Narrow biface (informal)	1	0.1	
Perforator/drill/bifacial point	*Total*	*Percent*	*Subtotal (%)*
Perforator/drill/bifacial point (narrow biface type 3)	41	2.7	
Subtotal perforator/drill/graver			5.2
Unifacial tools	*Total*	*Percent*	*Subtotal (%)*
Graver (mainly unifacial tools)	135	9.0	
Subtotal unifacial graver			9.0
Uniface scrapers (26)/scraper and composite tools (2)	28	1.9	

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Table 6.26—*continued*

Unifacial tools	*Total*	*Percent*	*Subtotal (%)*
Unifaces/retouched flake	567	38.0	
Trimmed blade (formal)	4	0.3	
Subtotal misc. uniface			40.1
Misc. crafting/industry tools	*Total*	*Percent*	*Subtotal (%)*
Greenstone ax	26	1.7	
Limestone disk	2	0.1	
Polished pebble	7	0.5	
Subtotal misc. greenstone/limestone/pebble tools			2.3
Chipped stone production tools or by-products	*Total*	*Percent*	*Subtotal (%)*
Hammerstone (various shapes)	14	0.9	
Oval biface (Stage 2 preform or core)	2	0.1	
Pointed biface (preform)	3	0.2	
Projectile point preform (9 are obsidian)	28	1.9	
Core/core fragment, used	9	0.6	
Core, not used (not including obsidian)	28	1.9	
Burin core	5	0.3	
Subtotal misc. chipped stone production tools			6.0
Eccentric	*Total*	*Percent*	*Subtotal (%)*
Eccentric, mini	1	0.1	
Subtotal eccentric			0.1
Total Postclassic tools	1,493	100.0	100.0
Pre-Mayapán artifact	*Total*		
Pre-Mayapán projectile point (stemmed biface)	2		
Pre-Mayapán projectile point (stemmed triangular point)	1		
Constricted adze	1		
Total tools	1,497		

by gravers, perforators, and some proportion of the unifacial tools were a key component of urban life. Third, agricultural activities (forest clearing, hoeing) are poorly represented due to low frequencies of axes of any kind (wedge-shaped or oval, 3.3 percent, figure 6.25). Fourth, military activities were a dominant concern, as implied by the high proportion of projectile points (figure 6.25). Projectile points and pointed knives/lanceolates combined comprise over one-fourth of the assemblage (27.1 percent) of all formal and expedient flake tools. That these projectiles and knives were used in warfare is clear from the mass graves unearthed at Mayapán. A pointed knife was embedded in the rib cavity of a victim near Q-79 (Adams 1953:figure 1). An enlarged, personified pointed knive is aimed at a death god on the inner Kukulcan Temple (Q-162a) frieze (chapter 2, figure 2.12). A mass grave at group Itzmal Ch'en (H-15) is also littered with projectile point fragments.

Was Mayapán populated to a large extent by craftspeople and warriors or citizen militia? The stone tool frequencies imply that farming was minimal and reiterate the concerns of Carnegie investigators regarding how the city sustained itself (J. Hester 1953:289; Proskouriakoff 1956:340; A. Smith 1962:214). Four considerations may explain these findings, and they are not mutually exclusive. First, agrarian activities may have been directed at a largely cultivated landscape that required little tree felling. Burning is an effective clearing technique in the area today (J. Hester 1953). Second, agricultural activities involving stone tools may have been practiced in outfield locations, resulting in low household recovery. We doubt that this is the case, as Bradley W. Russell's (2008a) surveys outside the city wall also revealed few bifacial axes. Third, Mayapán may have traded for significant portions of its food. Fourth, corvée service or tribute obligations may have provided Mayapán with some of its agricultural staples. The agrarian landscape of the city would have been complex and varied, involving houselot gardens, cultivation of enclosed or open spaces in the city's neighborhoods, fruit orchards, and outfield plots for corn and other staples. It is probable that residents of all houselots engaged in some subset of these activities. At the minimum, part-time craftspersons would surely have had gardens in their houselots. But from the perspective of the stone tool assemblage, agrarian activities required far less use of heavy chopping tools than in the Classic Period. It is interesting that oval bifaces were also relatively scarce at Postclassic Laguna de On, Belize (14 percent of the assemblage) despite the fact that raw materials were readily available and oval biface celts were a primary product made for exchange in the earlier Classic Period at nearby Colha (Shafer and Hester 1983; Hester and Shafer 1984).

Mayapán farmers would have used the small oval biface celts or wedge-shaped axes that are found at the city's ancient houselots. It is notable that bifacial celts were also diminished in size at the Postclassic settlements of northern Belize, home to the larger Classic Period technology (Shafer and Hester 1983; Michaels 1987; Masson 1993; Galup 2007). There is great similarity in the length and thicknesses of oval biface celts and wedge-shaped axes at Mayapán, as revealed by our own measurements of these artifacts, and both shapes would have likely sufficed to do the job. The forest today at Mayapán differs from that of northern Belize (and much of Quintana Roo), even when conditions of secondary growth prevail in both environments. Vegetation around Mayapán is lower, drier, and scrubbier; the tool of choice for Belizean workers is the machete while farmers in the towns around Mayapán employ a *coa*, a short, hooked, sickle-like hafted tool.

Spatial Comparisons of Stone Tool Assemblages

The distribution of chipped stone tools per context helps to identify variation in the different kinds of activities at Mayapán dwellings. Among fully excavated structures, comparisons are made of the relative quantities of aggregated stone tool categories, including projectile points, axes, miscellaneous bifaces, perforators, gravers, artifacts related to flintknapping activities, and other tool groups listed in table 6.27. Relative percentages of tool types with each structure's assemblage are considered, along with the number of tool types per square meter and per cubic meter of excavation (tables 6.27, 6.28). The latter values are instructive, as they are independent of the presence or absence of other types of tools. With this measure we can compare the amount of axes between localities irrespective of whether or not a context also used a large number of gravers or other tools for specific activities. But densities are also affected by the degree of activity specialization or length of occupation.

Overall, the numbers of specific tool types per square meter or per cubic meter are low, due to the fact that full excavations include a significant amount of relatively clean interior space (tables 6.27, 6.28, figures 6.27–6.32). Axes at fully excavated dwellings were present in densities of 0.04 to 0.1 per cubic meter (table 6.28). Some differences of potential importance are observed in the other metrics provided. Axes, never common, are in greatest abundance at Houses H-11 and X-43. House H-11 also has among the three highest percentages of axes of its total tool assemblage (11.4 percent) along with two other outlying houses, X-43 (12.5 percent) and L-28 (9.1 percent), as indicated in table 6.27 and figure 6.27. Axes are present in lower proportions at Houses Y-45 (4.1 percent), I-55, Q-176, and Q-40 and Temple H-17 (the latter four range from 1.1 to 1.8 percent). Notably, they are absent at Hall H-15 and its associated mass grave and at two chert/chalcedony workshop contexts (I-57 and Q-39).

House Q-39 has the highest relative quantities of miscellaneous bifaces (excluding axes) per square meter and per cubic meter, but the differences

Table 6.27 Percentage of tool types for horizontally excavated structures (PEMY).

Type	*Temple H-17 (percent)*	*House I-55 (percent)*	*Workshop I-57 (percent)*	*House Q-176 (percent)*	*House Q-39 (percent)*	*House Q-40a (percent)*
Projectile point	6.3	7.1	12.5	6.3	3.4	3.3
Projectile point obsidian	1.1	0.9	–	4.6	2.3	6.7
Subtotal projectile point	7.4	8.0	12.5	10.9	5.7	10.0
Pointed biface	4.2	3.5	3.8	3.4	1.4	4.4
Biface stemmed lanceolate	–	1.8	–	–	–	–
Biface informal knife	–	0.9	1.0	–	–	1.1
Biface informal pointed	–	0.9	–	0.6	0.3	–
Subtotal knife/lanceolate	4.2	7.1	4.8	4.0	1.7	5.6
Wedge-shaped biface	1.1	0.9	–	1.1	–	1.1
Oval biface celt	–	0.9	–	0.6	–	–
Biface informal celtiform	–	–	–	–	–	–
Subtotal ax	1.1	1.8	0.0	1.7	0.0	1.1
Biface formal fragment	2.1	–	1.9	2.9	0.6	–
Biface informal	2.1	1.8	–	1.1	1.1	–
Biface informal discoidal	–	–	–	–	–	–
Biface informal planoconvex	1.1	1.8	–	0.6	0.9	–
Biface informal thick	–	–	1.0	–	–	1.1
Biface informal "gub"	–	0.9	–	0.6	–	1.1
Biface fragment	2.1	0.9	–	1.7	3.2	–
Subtotal misc. biface	7.4	5.3	2.9	6.9	5.7	2.2
Perforator/drill	1.1	1.8	1.9	0.6	1.4	1.1
Narrow biface informal	–	–	–	1.1	–	–
Perforator/drill/bifacial point	–	–	1.0	–	0.3	–
Subtotal perforator	1.1	1.8	2.9	1.7	1.7	1.1
Subtotal graver	16.8	10.6	4.8	16.6	16.9	3.3
Scrapers (includes only 1 bifacial, and 2 graver/scrapers)	4.2	1.8	1.0	0.6	4.0	1.1

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Table 6.27—*continued*

Type	*Temple H-17 (percent)*	*House I-55 (percent)*	*Workshop I-57 (percent)*	*House Q-176 (percent)*	*House Q-39 (percent)*	*House Q-40a (percent)*
Unifaces/retouched flakes	49.5	52.2	63.5	48.0	58.7	70.0
Blade/flake blade	2.1	–	1.9	1.1	1.1	–
Subtotal misc. uniface	55.8	54.0	66.3	49.7	63.9	71.1
Greenstone ax	1.1	0.9	–	0.6	0.6	1.1
Limestone disk	1.1	–	–	–	–	–
Polished pebble/cobble smoother	1.1	0.9	–	1.1	0.3	1.1
Subtotal misc. crafting tools	3.2	1.8	0.0	1.7	0.9	2.2
Hammerstone	–	–	–	–	–	1.1
Pointed biface preform	–	–	1.9	–	–	–
Projectile point preform	–	–	–	0.6	0.9	–
Projectile point preform obsidian	–	2.7	1.0	1.7	0.3	1.1
Core/core fragment	2.1	3.5	1.0	2.9	1.4	1.1
Core used	1.1	2.7	1.9	–	0.3	–
Core burin	–	0.9	–	1.7	0.3	–
Subtotal production tools	3.2	9.7	5.8	6.9	3.2	3.3
Total postclassic tools	95	113	104	175	349	90

Type	*House H-11 (percent)*	*Hall H-15 (percent)*	*Hall H-15 grave (percent)*	*House L-28 (percent)*	*House X-43 (percent)*	*House Y-45 (percent)*	*Grand total (number)*
Projectile point	14.3	43.5	80.0	22.7	18.8	47.1	149
Projectile point obsidian	–	–	–	50.0	0.0	8.3	45
Subtotal projectile point	14.3	43.5	80.0	72.7	18.8	55.4	16.7
Pointed biface	11.4	8.7	10.0	–	12.5	11.6	51
Biface stemmed lanceolate		–	–	–	–	–	2

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Table 6.27—*continued*

Type	*House H-11 (percent)*	*Hall H-15 (percent)*	*Hall H-15 grave (percent)*	*House L-28 (percent)*	*House X-43 (percent)*	*House Y-45 (percent)*	*Grand total (number)*
Biface informal knife	2.9	–	–	–	–	–	4
Biface informal pointed	8.6	–	–	–	–	–	6
Stemmed biface asymmetrical	2.9	–	–	–	–	–	1
Subtotal knife/ lanceolate	25.7	8.7	10.0	0.0	12.5	11.6	5.5
Wedge-shaped biface	5.7	–	–	4.5	–	1.7	10
Oval biface celt	2.9	–	–	4.5	12.5	2.5	9
Biface informal celtiform	2.9	–	–	–	–	–	1
Subtotal ax	11.4	0.0	0.0	9.1	12.5	4.1	1.7
Biface formal fragment	–	–	–	–	–	–	11
Biface informal	2.9	–	–	–	–	–	11
Biface informal discoidal	2.9	–	–	–	–	0.8	2
Biface informal planoconvex	5.7	–	–	–	–	0.8	10
Biface informal thick	–	–	–	–	25.0	1.7	8
Biface informal “gub”	–	–	–	–	–	–	3
Biface fragment	–	–	–	–	6.3	–	18
Subtotal misc. biface	11.4	0.0	0.0	0.0	31.3	3.3	5.4
Perforator/drill	2.9	4.3	–	–	6.3	1.7	17
Narrow biface informal	–	4.3	–	–	–	–	3
Perforator/drill/ bifacial point	2.9	–	5.0	–	6.3	5.8	12

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Table 6.27—*continued*

Type	*House H-11 (percent)*	*Hall H-15 (percent)*	*Hall H-15 grave (percent)*	*House L-28 (percent)*	*House X-43 (percent)*	*House Y-45 (percent)*	*Grand total (number)*
Subtotal perforator	5.7	8.7	5.0	0.0	12.5	7.4	2.8
Subtotal graver	8.6	4.3	–	–	–	4.1	133
	–	–	–	–	–	–	
Scrapers	5.7	4.3	–	4.5	–	1.7	29
Unifaces/ retouched flakes	8.6	21.7	5.0	9.1	6.3	4.1	541
Blade/flake blade	–	–	–	–	–	3.3	14
Subtotal misc. uniface	14.3	26.1	5.0	13.6	6.3	9.1	50.2
Greenstone ax	2.9	8.7	–	–	–	0.8	10
Limestone disk	–	–	–	–	–	0.8	2
Polished pebble/ cobble smoother		–	–	–	–	–	6
Subtotal misc. craft tools	2.9	8.7	0.0	0.0	0.0	1.7	1.5
Hammerstone	2.9	–	–	–	6.3	0.8	4
Pointed biface preform	2.9	–	–	–	–	–	3
Projectile point preform	–	–	–	4.5	–	0.8	6
Projectile point preform obsidian	–	–	–	–	–	–	9
Core/core fragment	–	–	–	–	–	1.7	20
Core used	–	–	–	–	–	–	7
Core burin	–	–	–	–	–	–	5
Subtotal production tools	5.7	0.0	0.0	4.5	6.3	3.3	4.6
Subtotal eccentric							1
Total Postclassic tools	35	23	20	22	16	121	1,163

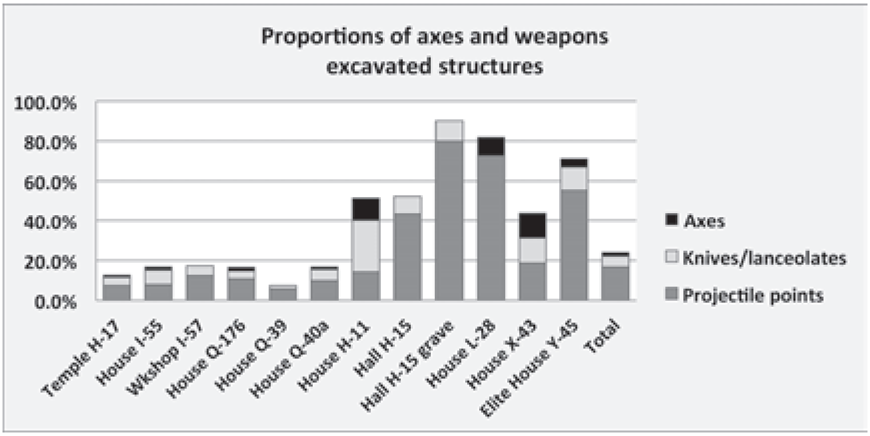

Figure 6.27. *Comparison of proportions of weaponry to axes per structure at horizontally excavated PEMY structures. Note that non-crafting Houses H-11, L-28, and X-43 have slightly more axes.*

among contexts are not great (table 6.28). The percentages of tools per context reveal that House X-43 has the most relative miscellaneous bifaces (31.3 percent), followed by House H-11 (11.4 percent). Lower proportions ranging from 2.2 to 7.4 percent are present at Temple H-17, Houses Q-176, Q-39, I-55, Y-45, and Q-40, and Workshop I-57 (table 6.27). They are absent at Hall H-15 contexts and House L-28. High proportions of miscellaneous bifaces are not associated with biface Workshops Q-39 and I-57 (5.7 percent and 2.9 percent, respectively), perhaps due to a low error rate. Miscellaneous bifaces with varied morphologies performed a range of functions and have less potential to differentiate activities as an aggregate group. There are no other distinguishing attributes of House X-43 that help to explain its high proportions of these tools, except that it also had among the highest proportions of axes.

Projectile points are slightly more ubiquitous at the Hall H-15 mass grave per square meter compared to other contexts, but per cubic meter, the quantity (0.6) is not significantly different from Houses Q-176, Q-39, L-28, and others. But projectile points make up 80 percent of the stone tools in the mass grave. While Houses Y-45a and L-28 also have high proportions of projectiles (55 percent and 73 percent, respectively), as does Hall H-15 (44 percent), all other contexts have less than 20 percent (table 6.27). The predominance of projectiles at the massacre locality is not surprising. Points are a standard component of

Table 6.28 Aggregated tool quantities per square meter and per cubic meter at fully excavated contexts.

	Structure					
	Temple H-17	*House I-55*	*Workshop I-57*	*House Q-176*	*House Q-39*	*House Q-40a*
Square meter	601.650	196.00	72.25	136.00	120.00	88.50
Cubic meter	328.200	47.35	18.91	33.07	34.23	21.74
Projectile points/square meter	0.010	0.05	0.18	0.14	0.17	0.10
Projectile points/cubic meter	0.020	0.20	0.70	0.60	0.60	0.40
Knives/lances/square meter	0.010	0.04	0.07	0.05	0.05	0.06
Knives/lances/cubic meter	0.010	0.20	0.30	0.20	0.20	0.20
Axes/square meter	0.002	0.01	0.00	0.02	0.00	0.01
Axes/cubic meter	0.003	0.04	0.00	0.09	0.00	0.05
Misc. bifaces/square meter	0.010	0.03	0.04	0.09	0.17	0.02
Misc. bifaces/cubic meter	0.020	0.10	0.20	0.40	0.60	0.10

	Structure						
	House H-11	*Hall H-15*	*Grave H-15*	*House L-28*	*House X-43*	*Elite House Y-45*	*Grand total*
Square meter	133.30	475.340	40.25	212.00	252.00	376.00	2703.290
Cubic meter	35.88	126.420	28.66	30.44	18.59	176.13	899.616
Projectile points/square meter	0.04	0.020	0.40	0.08	0.01	0.18	0.070
Projectile points/cubic meter	0.10	0.080	0.60	0.50	0.20	0.40	0.200

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Table 6.28—*continued*

	Structure						
	House H-11	*Hall H-15*	*Grave H-15*	*House L-28*	*House X-43*	*Elite House Y-45*	*Grand total*
Knives/lances/square meter	0.07	0.004	0.05	0.00	0.01	0.04	0.020
Knives/lances/cubic meter	0.25	0.020	0.07	0.00	0.10	0.08	0.070
Axes/square meter	0.03	0.000	0.00	0.01	0.01	0.01	0.010
Axes/cubic meter	0.10	0.000	0.00	0.07	0.10	0.03	0.020
Misc. bifaces/square meter	0.03	0.000	0.00	0.00	0.02	0.01	0.020
Misc. bifaces/cubic meter	0.10	0.000	0.00	0.00	0.30	0.02	0.070
	Temple H-17	*House I-55*	*Workshop I-57*	*House Q-176*	*House Q-39*	*House Q-40a*	
Square meter	601.650	196.00	72.25	136.00	120.00	88.50	
Cubic meter	328.200	47.35	18.91	33.07	34.23	21.74	
Perforators/square meter	0.002	0.05	0.08	0.14	0.31	0.05	
Perforators/cubic meter	0.003	0.20	0.30	0.60	1.10	0.20	
Gravers/square meter	0.030	0.06	0.07	0.21	0.49	0.03	
Gravers/cubic meter	0.050	0.30	0.30	0.90	1.70	0.10	
Misc. unifaces/square meter	0.090	0.31	0.96	0.64	1.86	0.72	
Misc. unifaces/cubic meter	0.200	1.30	3.60	2.60	6.50	2.90	
Misc. crafting tools/square meter	0.005	0.01	0.00	0.02	0.03	0.02	

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TABLE 6.28—*continued*

	Temple H-17	*House I-55*	*Workshop I-57*	*House Q-176*	*House Q-39*	*House Q-40a*	
Misc. crafting tools/cubic meter	0.010	0.04	0.00	0.09	0.09	0.09	
Flintknapping tools/square meter	0.005	0.06	0.08	0.09	0.09	0.03	
Flintknapping tools/cubic meter	0.010	0.20	0.30	0.40	0.30	0.10	
	House H-11	*Hall H-15*	*Grave H-15*	*House L-28*	*House X-43*	*Elite House Y-45*	*Grand total*
Square meter	133.30	475.340	40.25	212.000	252.000	376.00	2703.290
Cubic meter	35.88	126.420	28.66	30.440	18.590	176.13	899.616
Perforators/square meter	0.05	0.004	0.02	0.000	0.030	0.03	0.040
Perforators/cubic meter	0.20	0.020	0.03	0.000	0.400	0.07	0.100
Gravers/square meter	0.02	0.002	0.00	0.000	0.000	0.01	0.050
Gravers/cubic meter	0.08	0.010	0.00	0.000	0.000	0.03	0.100
Misc. unifaces/square meter	0.04	0.010	0.02	0.010	0.004	0.03	0.220
Misc. unifaces/cubic meter	0.10	0.050	0.03	0.100	0.100	0.10	0.600
Misc. crafting tools/square meter	0.01	0.004	0.00	0.000	0.000	0.01	0.010
Misc. crafting tools/cubic meter	0.03	0.020	0.00	0.000	0.000	0.01	0.020
Flintknapping tools/square meter	0.02	0.000	0.00	0.005	0.004	0.01	0.020
Flintknapping tools/cubic meter	0.06	0.000	0.00	0.030	0.050	0.02	0.060

the assemblages of any structure at Mayapán, and none of our horizontally excavated structures lacked them. Major differences are not obvious in the continuum of values of projectile points per square meter or per cubic meter. Surplus crafting houses (Q-176, Q-39, and Q-40a) had lower percentages of points (5.7 percent to 10.9 percent), presumably due to the abundance of other types of informal tools used at these contexts (table 6.27).

According to the percentage of tools, H-11 exhibits the most knife/lanceolate tools (25.7 percent) while other contexts have frequencies ranging from 1.7 to 12.5 percent. House X-43 (12.5 percent), Y-45 (11.6 percent), and the H-15 mass grave (10 percent) are at the upper end of this range (table 6.27, figure 6.27). The quantity of knives per square meter or per cubic meter fails to distinguish fully excavated contexts from one another, with the exception of House H-11 (0.25 per cubic meter, table 6.28), which may signal the importance of activities calling for pointed bifaces at H-11.

House Y-45, the H-15 mass grave, and X-43 had among the highest percentages of projectile points and lanceolate/knives compared to other localities (figure 6.27). This correspondence was not observed for House H-11, which had points in proportions below these other edifices (but more than five other domestic contexts) yet had the greatest relative quantity of lanceolates/knives. Mayapán's pointed knives were used as weaponry, as indicated by their iconographic contexts in codices and art at the site. Their general co-occurrence with points at some contexts may help to identify the importance of martial activities. But these implements would have also been useful as knives in a domestic setting, as their wide distribution suggests. The recovery of pointed biface preforms in low numbers at I-57 suggests that these tools were among those manufactured at this workshop (Masson and Escamilla Ojeda 2012:figure 18.20).

Percentages of perforators are highest at House X-43 (12.5 percent), followed by Hall H-15 (8.7 percent) and House Y-45a (7.4 percent); all others have 5.7 percent or fewer (table 6.27, figure 6.28). Quantities per square meter and per cubic meter distinguish crafting House Q-39 (1.1 per cubic meter, 0.3 per square meter) above all others (table 6.28). Beyond this observation, other commoner houses have similar densities to one another (0.2 to 0.6 per cubic meter), and these are more abundant than observed for elite House Y-45 or public buildings (0.02 to .003 per cubic meter). There is little agreement among the relative percentage and density data for these objects. But the density data reveal the importance of low numbers of perforators at all types of commoner houses, and perhaps an emphasis on textile working at Q-39. It is perhaps noteworthy that a spindle whorl was placed as an offering in

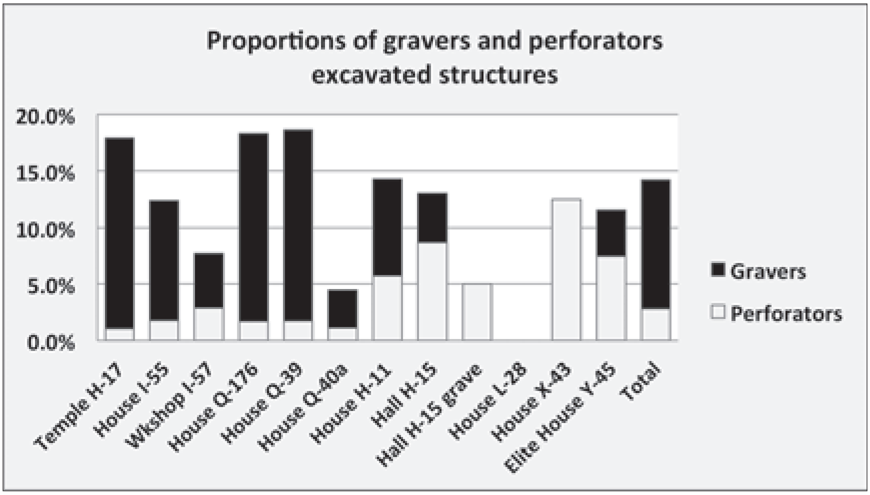

FIGURE 6.28. *Proportions of gravers and perforators at horizontally excavated PEMY structures.*

the family grave at this house. Perforators are low-frequency objects that are made on carefully crafted narrow bifacial tools (figure 6.24i), unlike gravers, which are more ubiquitous, as they are made expediently on various pointed flakes (figure 6.26).

Gravers form the greatest proportion of the assemblages at Houses Q-39 and Q-176 and at the H-17 temple; these contexts have percentages ranging from 16.6 to 16.8 percent (table 6.27, figure 6.28). Shell working at the two houses would seem to explain these high frequencies. The abundance of gravers at these two shell workshops is confirmed by the quantity per square meter and per cubic meter, which far exceed other contexts (table 6.28); their density is low for Temple H-17. Although gravers formed 10.6 percent of House I-55's assemblage, density was low for this additional shell workshop and indicates that the use of gravers was less important relative to other activities at this locality (table 6.28). All others have gravers in the amount of 3.3–8.6 percent. House Q-39 seems to be particularly distinguished from the others by the quantity of gravers and perforators. Such subtle patterns hint at variability in emphasis at houselot workshops and suggest that perishable industries such as textiles probably existed alongside those dedicated to chert, obsidian, pottery, and shell. Gravers are often associated with shell working, but they are simply pointed protuberances on flakes that exhibit a great deal of variation at the individual artifact level and could have been used for a range of purposes. Work

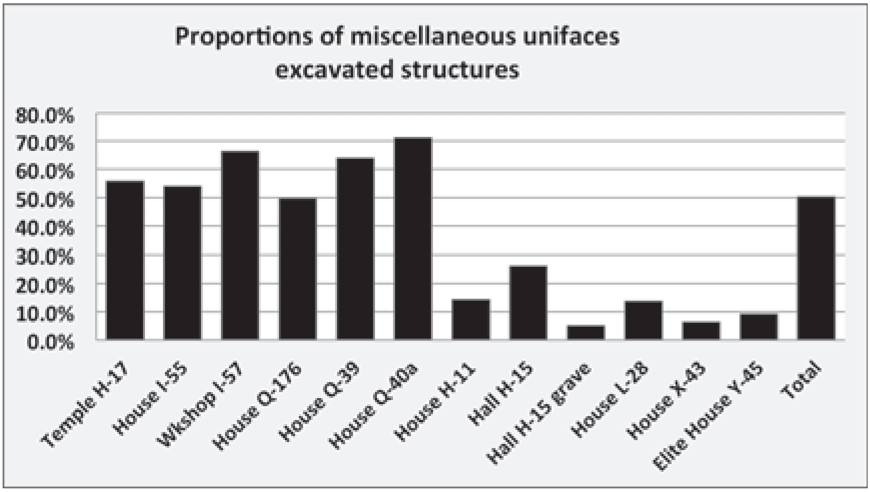

FIGURE 6.29. *Proportions of unifaces at horizontally excavated PEMY contexts. In general these were more significant at crafting houses versus non-crafting houses.*

on Mayapán's gravers is ongoing, and evidence is emerging for patterned variants of pointed flakes that are systematically modified in one or more places on the dorsal and ventral flake surfaces.

Unifaces (other than gravers) were often the most common tool at the contexts that we compared, representing 50.2 percent of the fully excavated structure tool sample (figure 6.29). This term encompasses a wide variety of informal tools. As a group, these tools were most frequent at crafting localities Q-40a, I-57, Q-39, I-55a, Q-176, and at Temple H-17, with percentages ranging from 54 percent to 71 percent (table 6.27). All other contexts had half or less of this percentage range. Density values reveal nearly identical results for crafting houses and indicate that unifaces were not abundant overall at the temple. Unifaces were most ubiquitous at Q-39 (6.5 per cubic meter), I-57 (3.6 per cubic meter), Q-176 (2.6 per cubic meter), Q-40a (2.9 per cubic meter), and I-55a (1.3 per cubic meter); all other contexts had densities well below 1 per cubic meter (table 6.28). Multi-crafting activities seem to have required a greater number of flake tools than at other houses.

Stone artifacts related to flintknapping (hammerstones, preforms, cores) are not present in greater abundance at lithic workshops that are identified from flaking debris (I-57 and Q-39). Such artifacts form 3.2–9.7 percent of fully excavated contexts, with the greatest frequency at House I-55a (table 6.27, figure 6.30). They form from 0.02 to 0.1 per cubic meter of residential structures

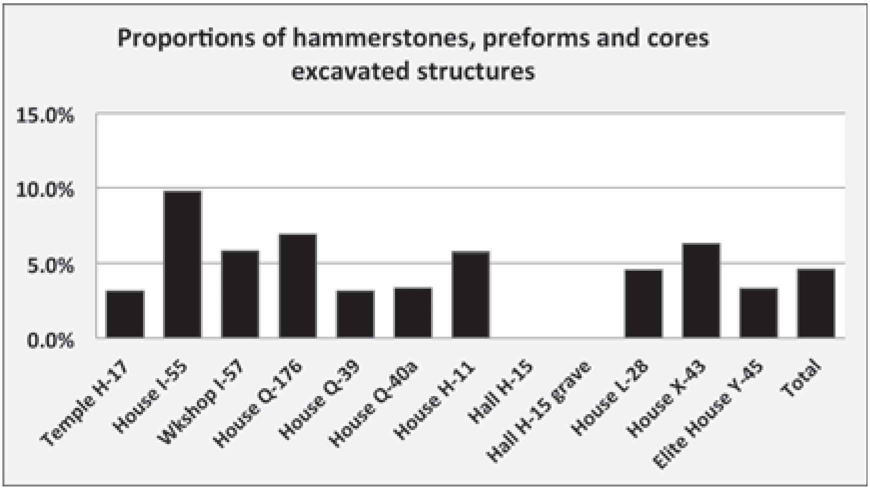

Figure 6.30. *Proportions of stone tools used in lithic production (hammerstones, preforms, cores) at horizontally excavated PEMY contexts. Lithic working is not distinguished by high amounts of these materials.*

and are scarcer at public buildings (table 6.28). We conclude that the presence of such objects is not a strong indicator of a stone tool workshop and that household tool kits included such items for expedient use. The lack of high numbers of preforms suggests a low failure and discard rate at flintknapping houselots. Pointed biface preforms were recovered at only two localities: House H-11 and Workshop I-57.

Projectile point preforms were present at Q-176, Q-39, L-28, and Y-45. We surmise that projectile point making was a regular household activity and that men were not dependent on workshops for obtaining this type of weapon. Mayapán's typical side-notched points are not technologically complex and involve edge retouch and side notching of otherwise non-elaborate elongate flake blades. Most points are not fully bifacially flaked. These elementary lithic modification skills were probably widely shared, enabling hunters or warriors to replenish this low-investment tool type without constraint. Points could be made easily on flakes from small polyhedral flake cores. Pointed knives, however, involve greater skill in thinning and shaping and require access to cobbles of a greater size than is evident in Mayapán's collection of flake cores. The average maximum dimension of cores in the sample was 4.4 centimeters (standard deviation 1.7, range 2.1–7.2, N = 13), whereas the mean length for whole pointed bifaces is 6.6 centimeters (standard deviation 1.6, range 4.3–9.9, N = 19), including smaller, resharpened examples. To illustrate this discrepancy more fully, only one core in the sample had a maximum dimension of 7.2 centimeters, while eight of nineteen pointed bifaces were 7.2–9.9 centimeters long. A sample (N = 35) of whole pointed bifaces from the INAH project had a mean length of 8.8 centimeters (standard deviation 3.8) and twenty-three of the thirty-five were at least 7 centimeters long. Large cores were needed for new pointed bifaces, and such cores were not widely available to the city's residents. Biface manufacturing workshops may have had special access to them. Intensive reduction and use of cores is reflected by the absence of large examples at the city.

Miscellaneous crafting tools, including greenstone axes, limestone disks, and polished pebbles or cobbles, represent different types of activities. Miniature greenstone axes, usually made of dark green serpentine-like or other river cobble material, were present at Houses I-55, Q-176, Q-39, Q-40, H-11, and Y-45 and were absent at two houses (L-28 and X-43) and the I-57 workshop. Our data suggest that commoners regularly possessed greenstone axes; similarly, Payson Sheets (2000) points out that houses preserved by a volcanic eruption at the site of Cerén usually possessed one ax. Limestone disks were rare in our sample, found only at Temple H-17 and elite House Y-45. Freidel and Sabloff (1984:33) were among the first to discuss the use of limestone disks as beehive covers. Polished pebbles were present at H-11, I-55, Q-176, Q-39, and Q-40 and absent elsewhere. Such objects are expected from crafting houselots, perhaps for polishing artisanal objects.

The differences and similarities of stone tool types in household assemblages reveal, on the one hand, a tendency toward task specialization and on the other hand, well-equipped household tool kits that were suitable for an array of daily tasks. Chi-square tests were performed to evaluate the variation that we have described. These tests compared tool assemblage frequencies of each conceivable pair of dwellings from our fully excavated sample (table 6.29). Four of twenty-eight tests failed to reject the null hypothesis of no difference, suggesting that it is highly probable that twenty-four pairs of houses were drawn from a different population (df = 5, p = 0.05). Chi-square tests did not suggest significant differences between Houses I-55 and Q-176 or I-55 and Q-40a, all of which are multi-crafting houselots. Significant differences were also not detected for H-11 and X-43 or for L-28 and Y-45; none of these are surplus crafting localities, however, more differences might be expected for Y-45, an elite house, and L-28, a peripheral commoner dwelling. The latter structure has a low sample size that may have skewed the results, but high percentages of projectile points at L-28 and Y-45a also set them apart from other dwellings

Table 6.29 Results (chi-square comparisons of frequencies of axes, bifaces, projectile points, lanceolates, perforator/gravers, and unifaces between fully excavated houses), p = .05, df = 5, values > / = 11.07 reject the null of no difference

	House I-55	*House Q-176*	*House Q-39*	*House Q-40a*	*House H-11*	*House L-28*	*House X-43*	*House Y-45*
House I-55	/							
House Q-176	No difference (4.01)	/						
House Q-39	Different (18.69)	Different (16.78)	/					
House Q-40a	No difference (8.90)	Different (18.87)	Different (24.91)	/				
House H-11	Different (25.64)	Different (35.25)	Different (106.66)	Different (40.82)	/			
House L-28	Different (58.42)	Different (62.74)	Different (155.67)	Different (49.25)	Different (26.83)	/		
House X-43	Different (23.13)	Different (21.41)	Different (65.98)	Different (41.54)	No difference (4.86)	Different (24.89)	/	
Elite House Y-45	Different (82.36)	Different (98.87)	Different (222.01)	Different (91.56)	Different (21.57)	No difference (9.008)	Different (24.49)	/
Total tools	108	176	365	88	36	21	21	119

(table 6.27). Perhaps the most revealing outcome of the chi-square tests is the implication that the stone tools of crafting houselots are more similar to one another than to non-crafting houselots, and vice versa.

In summary, the frequencies and densities of certain stone tools help to pinpoint activity differentiation at Mayapán houselots. Unifaces and greenstone axes tended to distinguish crafting houselots from other commoners. Conversely, axes were more common at some non-crafting houses (H-11 and X-43) where residents may have engaged in agricultural activities. The quantity of pointed knives does not set apart any structure, although these tend to be more ubiquitous at crafting localities and at House H-11. These knives were made at Workshops I-57 and Q-39. Perforators and gravers are absent at L-28 and there are no gravers at X-43. Thus, these objects were not always part of ordinary household toolkits. Perforator and graver quantities at House Q-39 are well beyond those of other contexts, and this ubiquity hints at a perishable textile industry at this houselot. Shell working occurred at Q-39 but graver densities are lower at shell Workshops Q-176 and I-55 (table 6.28). Hammerstones, preforms, and cores did not concentrate at stone tool workshops and were instead stocked routinely at dwellings, presumably for expedient flake tool industries or other broad uses. Projectile points are uniformly ubiquitous and do not tend to differentiate dwellings well from one another. Although higher frequencies of certain tools highlight inter-context differences in our sample, the data also reveal that most dwellings had low quantities of the majority of tools reviewed in this analysis. Most tools served both specialized industries and equipped houses with implements useful for daily tasks. A view emerges of a flexible stone technology in which a suite of formal tools had multiple applications; these implements were supplemented by a wide array of expedient flake tools that were made at home.

Surface Collection and Test Pit Sample Stone Tools

The surface collection and test pit data supplement the observations just presented for larger samples. Twenty-one surface collection contexts had only one stone tool, fourteen had two tools, eight had three, seven had four, and only a few had five (N = 2), six (N = 2), seven (N = 3), eight (N = 1), nine (N = 1) or twelve (N = 1) tools. These data have been fully described elsewhere (Masson, Delu, and Peraza Lope 2008), and here we provide some summary observations. Contexts with three or more tools (tables 6.30, 6.31) hint at interesting patterns. Only five surface collection contexts had two axes (oval biface or wedge-shaped)—four of these were commoner houses not engaged in surplus shell production and one was a shell workshop. Stone tool workshops

Table 6.30 Stone tools from PEMY surface collections where three or more tools were recovered (excluding utilized flakes).

Structure	*Context type*	*Number of tools*	*Tools within 3 meter dog leash collection unit*
Q-176	Obsidian/shell workshop, house	12	3 biface fragments, 1 thick biface, 2 perforators, 1 graver, 1 pointed biface, 1 projectile point, 2 projectile point preforms, 1 retouched flake
R-174	Obsidian workshop, house	9	2 planoconvex bifaces, 1 constricted adze, 1 hammerstone, 1 oval biface, 1 perforator, 2 projectile points, 1 retouched flake
P-146b	House	8	1 thick biface, 2 hammerstones, 1 pointed biface, 2 wedge-shaped axes
BB-12	House	7	1 core, 1 hammerstone polisher, 2 oval bifaces, 1 perforator drill, 1 pointed biface, 1 projectile point
Z-119/ AA-75	Stone tool/obsidian/ shell workshop, houses	7	1 hammerstone, 2 perforators, 2 pointed bifaces, 1 planoconvex biface, 1 projectile point
Z-43	Stone tool workshop, house	7	2 hammerstones, 1 oval biface preform, 1 wedge-shaped ax, 1 planoconvex biface, 1 pointed biface, 1 projectile point
Y-111	House	6	1 biface, 1 discoidal biface, 1 planoconvex biface, 1 pointed biface, 2 projectile points
Z-190a	House	6	1 thick biface, 1 biface, 1 hammerstone, 1 perforator 1 pointed biface, 1 projectile point
Q-39	Obsidian/stone tool/shell workshop, house	5	1 biface, 1 planoconvex biface, 1 projectile point preform, 2 retouched flakes
Z-120	Obsidian/stone tool/shell workshop, house	5	2 bifaces, 1 thick biface, 2 projectile points
L-18	House	4	2 perforators, 1 projectile point, 1 wedge-shaped ax
L-23	House	4	2 bifaces, 1 pointed biface, 1 retouched flake
P-114	Obsidian/stone tool/ shell workshop	4	1 thick biface, 1 perforator, 2 projectile points

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Table 6.30—*continued*

Structure	Context type	Number of tools	Tools within 3 meter dog leash collection unit
Q-244b	Elite house	4	1 oval biface, 2 perforators, 1 retouched flake
Q-188	Obsidian/stone tool workshop	4	1 biface, 1 core, 1 projectile point, 1 retouched flake
Q-196	Obsidian workshop	4	1 pointed biface, 3 projectile points
10-O-3	House	3	1 core, 1 perforator, 1 pointed biface
I-57	Stone tool workshop	3	1 thick biface, 1 projectile point, wedge-shaped ax
P-115b	House	3	1 perforator, 1 pointed biface, 1 wedge-shaped ax
R-184	House	3	2 oval bifaces, 1 pointed biface
R-168b	House	3	2 oval bifaces, 1 pointed biface
R-170a	House	3	1 perforator, 1 pointed biface, 1 projectile point
R-172a	House	3	1 thick biface, 2 projectile points
Z-47	Shell workshop, house	3	2 oval bifaces, 1 hammerstone

tended to have a range of bifaces, including fragments, thick (unfinished or expedient) bifaces, and formal bifaces (axes, pointed bifaces) that may have been made at these locations. Hammerstones, as noted previously, occur in all sorts of dwellings. In the surface collections, three were present at workshops and two were at ordinary houses (table 6.30).

Test pit stone tool frequencies provide little definitive information regarding houselot specialization. Of fifteen contexts with three or more tools from test pits, only four axes (oval or wedge) were found; three of these were from houselots with stone tool workshops associated with them (table 6.31). Test pits at non-crafting houses revealed no axes that might indicate a focus on agrarian production. As with the surface collection data, stone tool workshop houselots had a diverse array of tools that point to bifacial reduction, household activities and other craft-working. Most of the workshops were involved in multi-crafting.

Despite the limitations of sample size, some interesting comparisons emerge in charts of the distribution of agricultural bifaces (wedge-shaped and oval) versus potential weaponry (projectile points and pointed bifaces). These items

Table 6.31 Stone tools from test pit contexts where three or more stone tools were recovered (excludes utilized flakes).

Structure	*Context type*	*Number of tools*	*Type of tools in test pit sample*
S-10b/c	Obsidian/stone tool/ shell workshop, house	17	1 oval biface, 6 perforators, 2 pointed bifaces, 7 projectile points, 1 projectile point preform
S-12ab	Stone tool/shell workshop, house	10	8 projectile points, 2 projectile point preforms
Z-120	Obsidian/stone tool/ shell workshop, house	10	1 biface fragment, 3 perforators, 5 projectile points, 1 wedge-shaped ax
Z-43	Stone tool workshop, house	6	2 perforators, 1 pointed biface, 1 projectile point, 2 flake blades
BB-12	House	5	1 oval biface, 1 projectile point, 2 flake blades, 1 scraper
Q-176	Obsidian/shell workshop, house	5	1 oval biface, 4 projectile points
X-43	House	5	1 biface, 4 projectile points
F-13	House	5	1 perforator, 4 projectile points
P-151	House	4	1 core fragment, 1 perforator, 2 projectile points
S-132	House	4	1 biface, 1 core fragment, 2 projectile points
P-114	Obsidian/stone tool/ shell workshop, house	3	1 perforator, 1 projectile point, 1 projectile point preform
P-115b	House	3	1 core fragment, 1 perforator, 1 projectile point preform
P-150	House	3	1 pointed biface, 1 projectile point, 1 projectile point preform
Z-39	Obsidian/stone tool/ shell workshop, elite house	3	3 projectile points
Z-47b	Shell workshop, house	3	1 biface, 1 hammerstone, 1 perforator

only rarely overlapped in systematic surface collections (figure 6.31). Of forty-seven cases with any of these tool types, ax forms were recovered together with pointed bifaces or projectiles in only eight cases. Remaining contexts either had only pointed knives (N = 15), only projectiles (N = 7), only knives and projectiles (N = 6), or only axes (N = 11). We have shown from the fully excavated assemblages that projectile points tend to be constantly ubiquitous at Mayapán houselots and that axes tend to be scarce. The surface collection data suggest that more full-scale investigations of Mayapán's houselots are merited to determine the degree to which non-crafting residents devoted their time to agricultural or military pursuits.

The tendency for axes and weaponry to be recovered in different sample units is not strongly indicated for test pit samples (figure 6.32), due in part to the mixed assemblages from three lithic workshop contexts where a variety of tools were made (Z-120, Q-176, and S-10). Figure 6.32 shows that a single projectile point was recovered from sixteen test pits, and pointed knives were present in only five contexts. Contexts with three to eight projectile points included four stone tool workshops—Z-39, S-12, Z-120, and S-10—and House Q-176, where surplus chert tools were not manufactured. House X-43 is the only non-crafting locality with more than three projectiles. Despite the likelihood that Mayapán's residents made their own technologically simple projectile points, the ubiquity of points at these stone tool workshops implies that point making may have also been undertaken by specialists. It is conceivable that access to preferred raw material and well-executed elongate flakes at the city's workshops would have encouraged point making, even if residents were otherwise capable of doing the job.

MILITARISTIC INDUSTRIES AT MAYAPÁN

The quantities of projectile points and knives at Mayapán attest to the importance of warfare at the city. Kenneth G. Hirth (1993a:136) determined that elites had more projectile points at Xochicalco, which may indicate their association with militaristic activities. Elite contexts in our sample (Hall H-15, Y-45) had among the highest relative percentages, but overall, densities were low (tables 6.27, 6.28). Warfare was one activity that elites shared with commoners at Mayapán, and war captains and conscripted warriors assuredly resided within the city.

David Webster (2000:79) argues that Maya militia armies were quickly mobilized to fight the Spaniards at the time of contact. In the Maya highlands, military operations were organized under a pair of war chiefs, including one hereditary and one rotating position. Four war gods were recognized. Women carried supplies for armies and battles were loud, with shouting, drums, sticks, whistles, and conch shells adding to the din (Follett 1932:376–78). Warfare was employed to acquire slaves, for revenge, or to control strategic resources such

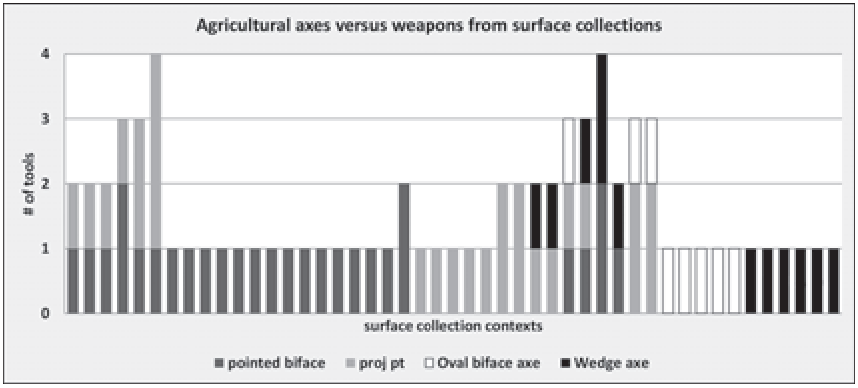

Figure 6.31. *Comparisons of ax to weaponry frequencies from surface collection contexts.*

as land or salt sources (Webster 2000:81). Weapons included spear-throwers, slings, bows, thrusting spears, blade-edged swords, war clubs, knives, hatchets, and "bee bombs" (Follett 1932:380; Webster 2000:79). Slings have not been documented archaeologically but were definitely used (Tozzer 1941:note 1150). It is possible that spherical hammerstones doubled as sling stones. Stanley Serafin (personal communication, 2010) has identified a healed cranial blow made with a dull, sling stone-like weapon on one of the burials near House I-55. As mentioned previously, hatchets were weapons for decapitation in some scenes of the Postclassic Maya codices. Tools of agriculture and flintknapping probably doubled as weapons of warfare.

The size ranges of Mayapán's projectiles suggest that both atlatl darts and bows and arrows were used, although these points are technologically similar and are distinguished mainly by the length of the projectile. The most common point type is made from an elongate, triangular side-notched flake (figure 6.24a). These points are usually not fully bifacially flaked, but bifacial edge trimming is common; retouched bases can exhibit a square, round, or concave shape. A sample of 55 whole points reveals an average length of 2.8 centimeters (standard deviation .9, range 1.2–6.1). Some side-notched points at Mayapán are fully bifacially flaked; these exhibit a similar size range to that of predominantly unifacial points. The mean length for a sample of five complete bifacial examples is 2.8 centimeters, with a standard deviation of 0.7 and a range of 2.1–3.5. Fully bifacial points are not common, nor do they concentrate in specific spatial contexts that would link them with different ethnic groups. Compared to unifacial points, bifacial points are often narrower,

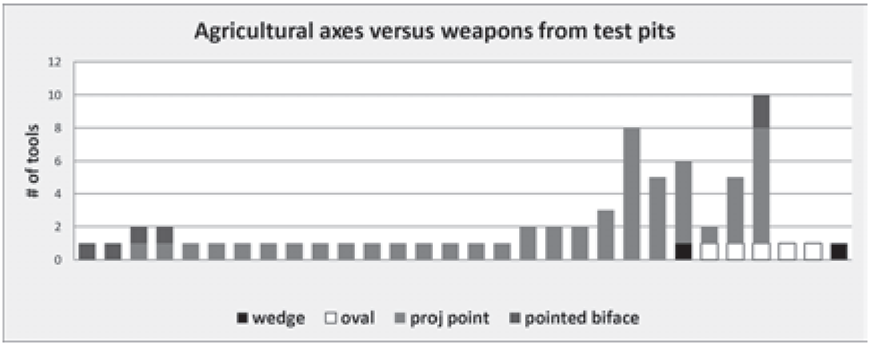

Figure 6.32. *Comparisons of ax to weaponry frequencies from test pit contexts.*

longer, and exhibit greater workmanship (figure 6.24). Smaller, shorter, unifacial points have a more pronounced, wider or more elongated triangular shape above the base; base sizes tend to be the same size irrespective of point length. Large bases with short point lengths often represent resharpened points; in other cases, short points have more proportionate bases and were probably small arrow points to begin with. Obsidian points include both elongate and shorter side-notched forms observed in chert/chalcedony examples. The differences in point lengths, triangular proportions, and base sizes likely reflect that fact that side-notched flake points were commonly made and refurbished by a variety of hunters and warriors at Mayapán. While general similarities were important, the details of length, proportion, and base shape were not tightly standardized. Projectile point assemblages from individual fully excavated structures show considerable variety, and we infer that shape and size do not closely reflect systematic stylistic choices made by family groups. For example, we found concave, round, and square base points at a single residence, Y-45.

Despite prior efforts to seriate some of these variations in Postclassic Maya projectile forms (Shafer and Hester 1988:112; Simmons 1995), the co-occurrence and overlap in technology, context, and raw material of tiny triangular projectile points and more elongated examples at Mayapán and the hinterland site of Laguna de On suggest they were contemporary (Masson 2000; Masson and Peraza Lope 2010:90). As Mayapán was abandoned during the mid-fifteenth century AD, these points cannot be assigned to an exclusively Terminal Postclassic or Colonial Period date.

Projectile points were used in hunting and warfare, and they provide a good indication of the importance of the latter when combined with other archaeological and iconographic evidence for conflict and the importance of war and sacrifice. The evidence for white-tailed deer husbandry practices at Mayapán suggests that fewer projectiles were needed for deer hunting (Masson and Peraza Lope 2008). Other staples include turkey (also home-raised) and iguana, neither of which needed to be hunted with projectiles. We do not deny, however, that Mayapán's residents hunted; some portion of the white-tailed deer population is of a more advanced age and was likely hunted; snares were also key hunting devices.

Warfare would have been essential to the commercial interests of the Mayapán state, as for other Postclassic Maya centers (Carmack 1981a; Blake 1985:24). War captives became slaves, and some slaves were sold commercially (Scholes and Roys 1938; Roys 1972:34–45; Sabloff 2007:24). Although we have yet to identify slave dwellings archaeologically, or distinguish them from other low-status residences, the slave industry provided a motive for martial activities, and this research question looms significantly in the background of any consideration of warfare at Mayapán.

ANIMAL INDUSTRIES: MAYAPÁN FAUNA

Hunters, or *ah ceh* (he of the deer), during the Contact Period employed pit capture, snares (spring pole), and projectiles to obtain deer, armadillo, peccary, and other animals (Carr 1996). Another name for hunters was *tok bate*, or "flint warrior" (Von Nagy 1997:58). The use of dog, deer, and peccary goes back to the Formative Period at early sites such as Cerros or Colha (Carr 1996:254; Shaw 1999), but their signifance varies greatly at Maya sites in different locations and time periods (Masson 1999a, 2004). For example, deer were rare at Cozumel Island, where fish and turtles were more important (Hamblin 1984). Deer products, including antler and bone (and presumably perishable hides), were traded to coastal sites like Cozumel and Isla Cerritos (Carr 1996:255, table 15.1).

Animals were used in ritual as well as for food (Pohl 1981, 1985a, 1985b, 1990; Moholy-Nagy 2008; Masson and Peraza Lope 2013). As scenes in the Madrid Codex (pages 40, 41) show, deer were ritually hunted and sacrificed in a variety of ways that were also employed for humans. Spear-throwers, spears, heart extraction, disembowelment, beheading (perhaps after death) were used, and deer head offerings were sometimes displayed on platforms (Von Nagy 1997:50). The use of deer heads for offerings continued into the Contact Period along with bread and cacao at the town of Hocabá (Scholes 1938:139; Von Nagy 1997:52).

Harry E. D. Pollock and Clayton E. Ray (1957) were the first to study animal use at Mayapán, concentrating mainly on monumental center contexts and lots with large samples. Their findings were similar to our own, in that the major mammals included white-tailed and brocket deer, dog, and two types of peccary (1957:638). According to these authors, turkey, iguana, rabbit, catfish, and other kinds of marine fish are also common. White-tailed deer were the most important animal resource and dog were used primarily in ceremonies of the site center (1957:653). Exotic animal bones were found in the site center in low numbers (puma and jaguar foot bones, a spider monkey bone, a manatee rib, tapir teeth) that suggest they were imported as isolated elements (1957:653). Pollock and Ray observe that most of the fish were marine, lending support to Landa's (1941:40) claim that fish trade was important for inland sites. Tozzer (1941:notes 993–1147) provides lengthy notes regarding a wide range of plant and animal species used in Yucatán.

Birds identified by Pollock and Ray (1957) include wild turkey (*Meleagris ocellata*), heron, hawk, parakeet, motmot, chachalaca, great curassow, and pigeon or dove (Columbidae). Identified turtles include primarily aquatic terrapin (*Pseudemys scripta*), box turtle, *Geomyda areolata*, mud turtle (Kinosternidae), and *Dermatemys mawii* (Pollock and Ray 1957:648). They found a skeleton of a toad with hallucinogenic properties that was regularly exploited by Mesoamerican peoples, *Bufo marinus*. Most fish were marine except for a Cichlid (mojarra) that could have survived in freshwater cenotes. Catfish included the saltwater variety, and *Rhamdia guatemalensis* (a common cenote catfish) is absent (Pollock and Ray 1957:650). Other identified marine fish include sergeant fish, snook, grouper, mullet, sheepshead, and spadefish, as well as sharks (tiger and great white) and rays.

Faunal analysis from the INAH and PEMY projects has been comprehensive (Masson and Peraza Lope 2008, 2013); we are currently finishing the analysis of the 2008 and 2009 seasons that include fully excavated contexts. Animals were commodified and manipulated for different social and functional occasions, much like other material goods. Some animal products represented exotic, valuable trade items. Other more common animals were imported or obtained from nearby forests or *aguadas* (ponds), and supplemented daily staples. Animals, including staple faunas, were also valued for ritual sacrifice and consumption.

The highlights of our faunal research can be summarized as follows. An analysis of 97,416 bones has been published for the monumental center and outlying settlement zone (Masson and Peraza Lope 2008:tables 1–3). White-tailed deer comprised 23 percent of the sample (an additional 26 percent is represented by deer-sized large mammal long bone fragments that are likely to be deer), and this taxon was clearly the dominant meat source for the city. Wild turkey, probably raised in captivity, forms 12.9 percent of the sample. An additional 6.6 percent of the faunal remains consist of large bird long bone fragments that are likely to be turkey. Iguana forms 10.2 percent of the sample and dog represents 4.4 percent. Less frequent, but regularly recovered taxa include brocket deer (2.6 percent) and peccary (1 percent). The proportions described above are for the monumental center, but deer retained its status as the major meat source in the residential zone, followed in importance by iguana, turkey, and dog. Fish, primarily marine, formed 1.2 percent of the samples in the monumental center and 3.6 percent of the settlement zone samples (Masson and Peraza Lope 2008:table 3).

White-tailed deer remains are ubiquitous across Mayapán, and we have argued that at least one-third of the deer consumed at the city were raised through animal husbandry in houselots, based on the fact that as many as 42 percent of the long bones of these animals are adult-sized but exhibit unfused (late-fusing) epiphyses. This high proportion of young animals in their prime is an expectation of the processes of domestication—or alternatively, careful wildlife management or animal husbandry. This demographic profile for Mayapán's white-tailed deer matches that of dog, a known domesticate, and contrasts with patterns for peccary and brocket deer (Masson and Peraza Lope 2008:177). Dog remains are most often those of full-sized subadults while it is rare to find unfused long bones of peccary or brocket deer. Measurements of white-tailed deer long bone ends by Karime F. Gazdik (2009) confirm that the size of large subadult deer (with unfused epiphyses) matches that of adult animals at Mayapán, and this age profile indicates that these animals were generally butchered upon reaching full size but before bone fusion was complete. Such animals were in the prime of life and should not represent nearly half of a sample hunted in the wild (Masson and Peraza Lope 2008). Game was an important resource for the city, and Contact-era accounts suggest that game exports from the Mayapán region were essential for obtaining fish and salt from coastal sites (Landa 1941:40). The fact that white-tailed deer, turkey, and dog formed as much as 73 percent of the site's protein sources (counting long bone fragments only provisionally identified to species)—49 percent of which may have been white-tailed deer and 20 percent of which may have been turkey—points to a commitment at the city to ensuring dietary stability through engaging in husbandry of white-tailed deer and oscellated turkeys. Opportunistic hunting and the capture of iguana and turtles supplemented the diet, as did the trade for marine fish—but these contributions were minor by comparison. Enclosed pens are frequently found in the city's houselots, and these probably sheltered animals (chapter 5). The city's *albarrada* houselots themselves represent enclosures that would have contained turkeys, dogs, and tethered deer (e.g., Madrid Codex:42c; Villacorta C. and Villacorta 1976).

AGRICULTURE AND PROPERTY

Mayapán is one of several northern Maya sites that are distinguished by residential boundary walls and a large circumferential wall around the densest portion of the settlement zone (chapter 5). Residential property was not strictly delineated by walled houselot enclosures (A. Smith 1962). As we observe in chapter 5, boundary walls seem to reflect a concern for privacy and containment as a consequence of urban life. Lot sizes do not correlate well with factors of wealth, status, or location. Cycles of family growth best account for the division of residential space within the city. In outer Mayapán, where vacant land was ample, many houselots tightly circumscribed their dwellings with boundary walls, presumably for the safekeeping of domestic resources.

Access to agricultural lands was institutionalized, yet it was also subject to negotiation (Freidel and Sabloff 1984). Residents would have cultivated gardens within or near their houses. Other orchards or infields may have existed at Mayapán, as indicated by tracts of enclosed nonresidential fields or nonenclosed vacant spaces. Outfield cultivation would have also been important. The system would have been more complex than a simple infield-outfield model due to options for small-plot agriculture closer to home (Killion 1992a:figure 6.3, Alexander 1999a:83–84). Household gardens and outlying milpas are the primary cultivated spaces for residents of modern Telchaquillo (1 kilometer north of Mayapán). This mixed strategy has great time depth in the region (Alexander 1999a:87).

How much land could have been cultivated within the city wall? Figures 6.33 and 6.34 illustrate the amount of cultivable space in mapped milpas of the PEMY project. All nonresidential space was calculated by including the area of enclosed fields (that lacked houses), open spaces, and other nonresidential areas per milpa. Milpas with more than 50 percent nonresidential space were predominantly located near or outside the city wall. Only two mid-city milpas exhibited this pattern. Of twenty-one milpas consisting of a majority of nonresidential space, all but one had more than 60 percent nonresidential space, and fourteen of these had more than 80 percent nonresidential space. For those located specifically within the city wall, twelve milpas located toward the outer edges of the settlement and one mid-city milpa had more than 60 percent nonresidential space. Seven other milpas outside the wall were at least 60 percent vacant. Only four milpas near the city wall had less than 50 percent nonresidential space. Eight milpas had less than 30 percent nonresidential space. Downtown residents of Mayapán did not live next to ample infield or orchard space. Land available for gardening varied according to settlement density, which was denser near the site center. Motivations for living in downtown Mayapán seem to have trumped the advantages of living next to generous tracts of open land, at least for a significant portion of the urban population. During the Contact Period, Maya communities of Yucatán, including farmers, also generally preferred town life (Restall 2001). Walking to moderately distant agrarian plots is a tradition that continues today.

To what degree were local lands farmed to supply the city? We suppose that the periphery of Mayapán was a hub of agrarian activity, although more research is needed beyond the city wall. Land was ample within at least 1 kilometer of the wall, according to surveys performed thus far. Russell's (2008a, 2008b) survey reveals an extensive landscape that was partly inhabited and partly cultivated. Within 500 meters of the wall, Russell has documented fields, pens, possible granaries or apiaries, and low densities of modest dwellings, many of which were contemporary with Mayapán. Artifact densities are low in this area and it is difficult to know whether agriculturalists living and working outside of the wall were permanent or temporary occupants. Sayil's dispersed rural houses may have been occupied seasonally, according to Kelli N. Carmean, Nicholas P. Dunning, and Jeff Karl Kowalski (2004:440), as they had no water supply features. At Mayapán, however, cenotes exist both within and outside the city wall and were shared by families who would have had to walk daily to fill vessels to supply their homes. Most houses are within 250 meters of a water source (Russell 2008a). Unlike the Puuc area, chultuns are rare at Mayapán. More water sources exist at the city than are currently documented (chapter 5).

Joseph Hester (1952) thought that agricultural soil was poor around Telchaquillo and explored aguadas within 15 kilometers of that vicinity. His assumption about the low productivity of land within and adjacent to Mayapán was overstated. Many modern milpas successfully feed families from this terrain, and we have observed corn growing from pockets of soil even where bedrock outcrops on the surface. Hester (1952:270) found no evidence that aguadas were used for dry-season agriculture, and this is not surprising, as population pressure seems to have been low outside of Mayapán's urban zone. More extensive slash and burn methods were probably viable closer to the city throughout its occupational history. Soils outside of downtown Mayapán are poor in the sense that they tend to be shallow, hold little water, and have some

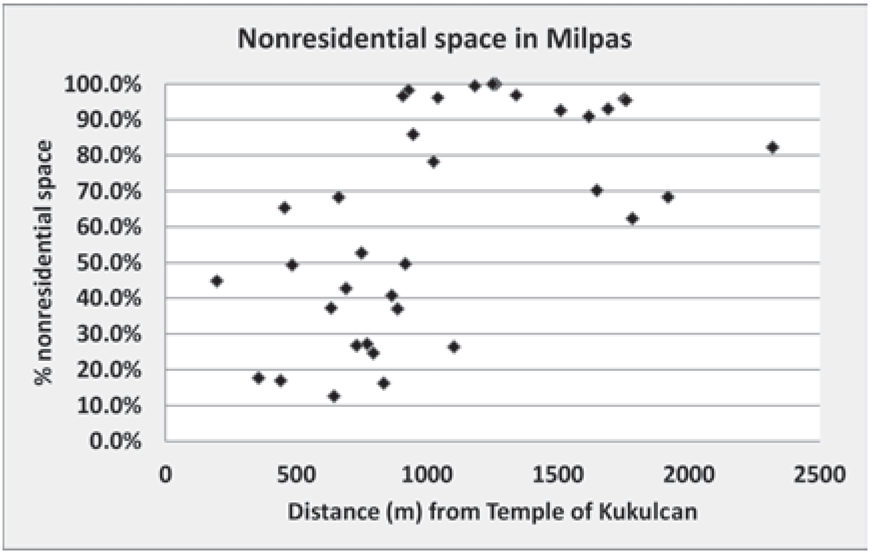

FIGURE 6.33. *Amount of nonresidential space in milpas plotted against distance from the Temple of Kukulcan.*

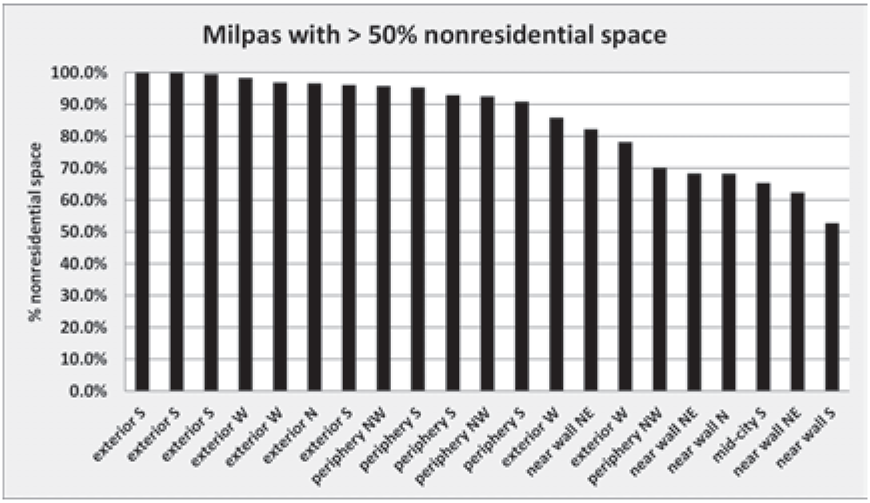

FIGURE 6.34. *Milpas with greater than 50 percent nonresidential space tend to be located near the wall (inside it and within 200 meters), exterior to the wall (within 200 meters), or in the peripheral areas farther from the wall. Only one mid-city location in our sample is in this group (Milpa 3, a relatively open space with two cenotes).*

mineral deficiencies (Beach 1998), whereas soil in the more densely inhabited areas of the city has been enhanced by high charcoal and other organic contributions by the ancient inhabitants. The Mayapán dark earth midden is an anthropogenic horizon (Brown 1999). Figure 6.35 illustrates Russell, who is 6 feet 4 1/2 inches tall, in a field of tall corn in downtown Mayapán (Milpa 1) in August 2009; the Mayapán dark earth is a meter or more deep in this part of the city. Gardens within the city's houselots would have supplemented more distant milpa plots. The potential existed in parts of Mayapán for rich agricultural harvests. All modern farmers do not have the luxury of cultivating in Mayapán's dark earth middens that concentrate in the central part of the city. Much of the site and its environs have shallow kancab soils that are adequate in normal years for productive milpas.

During droughts, Mayapán's environment would have been especially harsh. Evidence suggests that such perils struck regularly from the time of the city's rise to power by AD 1200 to its fall in the mid-fifteenth century and beyond (chapter 8). Pollen records suggest that vegetation was dominated by a combination of maize and disturbance taxa (Leyden 2002:96). The collapse of the city's government and its subsequent abandonment may be linked to a constellation of severe climatic events that resulted in drought and colder conditions. Richardson B. Gill and Jerome P. Keating (2002:136–37) outline correlating events that include volcanic eruptions, droughts, and the onset of the Little Ice Age that began around AD 1450. They note that droughts and cold are mentioned in the books of the Chilam Balam of Mani and Chumayel—"the fields, having been impoverished shall be searched for food and water which will not be found anywhere . . . the people . . . were chilled"—during K'atun 8 Ahau, possibly corresponding to the K'atun 8 interval when Mayapán fell (AD 1441–1461). A parallel event includes the famine of 1 Rabbit in central Mexico in AD 1454, which prompted starving people to sell themselves into slavery. In 2009 we witnessed the effects of a one-year drought. Corn failed to grow and cattle were dying regularly of starvation. The Chilam Balam of Maní describes the risks vividly: "Three times it has been necessary to make bread with the cup root because of the famine" (Craine and Reindorp 1979:84–85).

TRANSPORTATION OF FOOD

Regional exchange within Mesoamerican states has been traditionally viewed as limited by the constraints of transporting food with human porters, who must be fed. Michael H. Logan and William T. Sanders (1976:46) argue that large cities like Tenochtitlan could not transport food effectively beyond

Figure 6.35. *Bradley Russell (6 feet 4 1/2 inches tall) stands in a farmer's cornfield in Milpa 1, just west of the monumental center (photo taken in August 2009). Mayapán soils are sufficiently productive for corn agriculture today, as in the past.*

a maximum distance of 150 kilometers—smaller urban places would have a range of up to 50 kilometers. Robert D. Drennan, Philip T. Fitzgibbons, and Heinz Dehn (1990:179) and Sanders and Santley (1983:246–49) suggest 150–275 kilometers as the maximum distance for urban food supplies. Both sets of scholars favor the model that prestige goods (and not food) were traded over greater distances.

Theoretical limitations on food exchange are pertinent to the question of drought relief. Although surplus food is often available and within reach of settlements undergoing famine, failures of communication, logistics, or politics can intervene in successful transfers (Pounds 1973:433; Gill 2000:76; Davis 2001). Plainly stated: for the right price, food is for sale even in times of shortages. Droughts do not affect all areas evenly, including the Maya lowlands, which has a mosaic of soils and hydrology (Dunning, Beach, and Luzadder-Beach n.d.). Freidel and Shaw (2000) argue that storage limitations on maize in the Maya area presented a major obstacle, and they propose that Maya states resolved this problem with a currency system. More easily stored cacao bean and shell monies could be exchanged for surplus grain in times of hardship, and arguably, to supply cities like Mayapán on a regular basis. Freidel and Shaw (2000) and Freidel and F. Kent Reilly III (2010) analyze the conspicuous symbolism that links heads of Maya states with the maize deity and cacao. They argue that these associations were an integral component of assigning value to these items in the commercial realm. Gill (2000:79) takes a more pessimistic view for the Classic Period: "the ability to redistribute foodstuffs to famine stricken areas in the Lowlands . . . was most likely non-existent." We would agree that there is little evidence for chiefly accumulation and direct redistribution of foodstuffs and argue instead that food would have at times been a lucrative trade good. Given the ongoing exchange of foodstuffs during times not plagued by droughts in northern Yucatán during the Postclassic (e.g., Landa 1941:40), we think it likely that opportunities for profit during food shortages would have fostered supply networks during all but the most severe episodes. For those who could afford it, the stores were open. A monolithic view of food exchange in the context of shortfalls is not helpful, as the scope of dire impacts fluctuated in space and time. Clearly the mid-fifteenth-century suffering, which coincides with the fall of Mayapán, proposed challenges that could not be met by political will or institutions of exchange. Prior to the city's collapse, it is reasonable to consider that food flowed regularly across the *cahob* of the northern peninsula. Gill (2000:77) points out the need for military enforcement and security in desperate times. The militaristic nature of the Mayapán state may have been geared in part toward such challenges.

The area of northern Quintana Roo is more humid and lush than the arid environs of Mayapán. For example, around Punta Laguna, situated in a rich agrarian zone between Valladolid and Cancun, annual rainfall averages 1,519 millimeters (Curtis, Hodell, and Brenner 1996:37) compared to less than half that amount (about 777 millimeters per year) around Mérida (and Mayapán). This lush area was one potential breadbasket for drier northwest Yucatán, including Mayapán, although it was probably not the only one. Ancient settlements around Valladolid and Tizimin lie near the Quintana Roo/Yucatán state borders and are 150 kilometers from Mayapán, within the arbitrary distance constraint imposed by Logan and Sanders (1976) for the transportation of maize in supply of major urban places.

It is also important to remember the advantages of coastal transportation networks that thrived during the Postclassic Period (Sabloff and Rathje 1975). The significant differences in moisture and vegetation between Mayapán's heartland in northwest Yucatán and the eastern Caribbean area (now the state of Quintana Roo) merit more concerted scholarly attention. Crops from the eastern breadbasket could have been traded through coastal sites such as Tulum, Cozumel, and other localities and could have been brought by canoe to ports closer to the northwest coast. The historical port town of Progreso, Yucatán, is located within 70 kilometers of Mayapán, well within the most conservative transport ranges proposed for human porters. This part of the north coast is dotted with dozens of other settlements within 100–150 kilometers of Mayapán that could have serviced the city in the way that Isla Cerritos may have functioned for Chichén Itzá (Andrews et al. 1988). Modern towns have obliterated Pre-Columbian port remains along the north coast, some of which were occupied during the Postclassic Period (A. Andrews 2008:figure 1).

Overland transport networks in the Yucatán would have been important for transporting all manner of goods, including food, when environmental hazards were confined to specific locations. Hurricanes provide an example of localized effects. The devastation of Cancun (Hurricane Wilma in 2008) or small towns near Mérida (Hurricane Isidore in 2002) has been recently witnessed; when one of these areas was hit, the other scarcely noticed the effects.

AGRICULTURAL FOOD PROCESSING

Agricultural processing tools such as manos and metates are regularly found in low numbers at Mayapán houselots. Metates are made from very large limestone boulders and were often reused in architecture. House Q-40a had five manos that may have been used for grinding corn or for stucco production. We favor the latter function, as one mano was found in a grave at this house that was covered with fine plaster. Manos were found at other houses too: four were recovered at H-11, one at L-28, and fifteen at elite House Y-45. Hall H-15 had seven manos. All structures except X-43 had groundstone; occupants of this house may not have processed their own food. The abundance of manos from elite House Y-45, which had an associated kitchen structure, may be related to the hosting of large feasts in the frontal gallery; high numbers of polychrome serving vessels at this house also imply such activities.

HEALTH OF MAYAPÁN'S POPULATION

Mayapán's population seems to have had ample access to game and fowl. Animal bones are ubiquitous at domestic and public contexts, and we have argued that deer and turkey were raised in abundance at the city's houselots. Although raising deer may have been uncommon at other contemporary Postclassic sites, the availability of rich animal proteins seems to link lowland Maya towns across the peninsula, with variations in emphasis on fishing and hunting strategies (Hamblin 1984; Coyston, White, and Schwarcz 1999; Masson 2004). In comparison to southern sites of the Terminal Classic, Mayapán and its contemporaries enjoyed an abundance of meat, fowl, and fish. The paucity of animal bone at Terminal Classic sites in northern Belize suggests severe levels of game depletion in some portions of the Maya lowlands (Masson 2004).

The proportion of maize and other crops in the diet are more difficult to assess, although grinding stones are common. Analysis of stable carbon and nitrogen isotopes by Lori Wright (2007:5) suggests that, like other Maya sites, maize was a staple in the Mayapán diet. The carbon isotope results indicate slightly lower levels than are observed at most southern Classic Period sites, perhaps because marginally lower levels of maize were consumed at Mayapán. The importance of terrestrial proteins is affirmed by nitrogen isotope data that is similar to some earlier cities (Wright 2007:5). Disease may have plagued the city, as infant and child graves are regularly found, although it is hard to know whether this is due to the excellent preservation of human bone at the site. Child mortality is generally high in ancient societies. Mass graves that might be attributed to epidemics have not been found, but those related to warfare and violence have been revealed in the site center and at the Itzmal Ch'en group (Adams 1953; Peraza Lope et al. 2006; chapter 3). The greatest threat to Mayapán's population was likely warfare, as we have previously discussed.

According to Serafin (personal communication, 2010), a human osteologist, childhood stress was a considerable problem for Mayapán's residents, as indicated by linear enamel hypoplasia and porotic hyperostosis. Caries were relatively low. Serafin (2009) suggests that crowded urban living conditions and proximity to animals (deer, turkeys, dogs) resulted in significant infectious disease—one case of treponemal disease has been identified along with other evidence for systemic infections. Rampant disease cycles are described in the Chilam Balam chronicles in the years prior to and following Spanish contact, as are drought cycles that can lead to famine and epidemic diseases. A pestilence in K'atun 4 Ahau (AD 1480–1485) may have been experienced by lingering occupants of Mayapán, according to Tozzer (1941:note 205). We do not currently have accurate demographic data from Mayapán. Many skeletons recovered from the site center are disarticulated and probably represent the remains of sacrificed war captives (Serafin and Peraza Lope 2007; Serafin 2010). A small sample of domestic burials from the settlement zone has been recovered that includes infants and adults. Very few individuals of elderly (more than fifty years old) status have been found, although this is normal for a premodern agrarian population.

WEALTH AND STATUS AT MAYAPÁN

Two types of data are particularly amenable to tracking wealth and status variation archaeologically: architectural size and elaboration and the quantification of valuable local and nonlocal items. Hirth's (1998) distributional approach compares fancy and imported artifact frequencies across social status contexts to evaluate the importance of marketplace exchange for making valuables available in relatively equitable quantities to elites and commoners. This approach has proven valid in at least one ethnohistorically documented market society in the Aztec towns of Morelos, Mexico (M. Smith 1999), and much equitability is reported for the central Mexico Epiclassic center of Xochicalco (Hirth 1993b, 1998; Cyphers and Hirth 2000). At Mayapán, four types of contexts have been tested by our project that are relevant for these comparisons: surplus craft production houselots, other houselots not engaged in significant craft production, elite houses, and public buildings (the Itzmal Ch'en colonnaded hall and temple). The majority of our contexts are commoner dwellings, and prior analysis has determined that surplus craft production households were wealthier than other commoners. Here we compare the distribution of imported goods, including obsidian, marine shell, greenstone axes, and other greenstone ornaments. As previously discussed, the distribution of imported and fancy locally made goods is widespread among commoner houselot contexts (Hare and Masson 2010).

Obsidian consumption has already been addressed in this chapter and will only be summarized here. To reiterate our findings, 37 percent of the test pit contexts had 1–31 obsidian blades per chert tool, and these intervals were made up of 71–89 percent non-crafting commoner houselots. Including used flakes in the calculation reveals that 30 percent of the test pits had 1–8 obsidian blades per chert tool, and these contexts included 56–100 percent non-crafting commoner houselots (table 6.21). The fact that craft producers tended to have more obsidian than non-crafting houselots is indicated by the fact that seven of twelve contexts, with 9–15 pieces of obsidian per square meter, were non-crafting houselots (two were crafting houselots), whereas the 17–25 piece-per-square-meter interval includes only one non-crafting houselot, two crafting houselots, and one elite context. Elite House Y-45a had obsidian/chert tool ratios that were on par with commoner House L-28 (table 6.22). Other specific details add to this argument of equitability in access to obsidian. Three non-crafting houses (H-20, F-13, and P-117) had 12–15 pieces per square meter of obsidian (or 40–67 pieces per cubic meter)—more than elite House R-103/104 (12 pieces per square meter, 33 pieces per cubic meter) and equivalent to or more than elite House Q-41b (16 pieces per square meter, 29 pieces per cubic meter). Commoner House Z-43 had 22 pieces per square meter (54 pieces per cubic meter), more than elite House S-131/132 (17 pieces per square meter, 21 pieces per cubic meter). Non-obsidian crafting Houses P-115 and Z-47 also had much obsidian (11.7 and 12.8 pieces per square meter and 15 and 22 pieces per cubic meter, respectively). These results are also confirmed by fully excavated contexts (table 6.19). Non-crafting House H-11 had 4.1 pieces per square meter (15 per cubic meter), more than elite House Y-45a (0.7 pieces per square meter, 1.6 pieces per cubic meter). Two other non-crafting houses (X-43 and L-28) had less obsidian than other dwellings (0.1 and 0.3 per square meter and 0.8 and 1.8 per cubic meter, respectively), which reveals the important fact that commoners differed in terms of their wealth. Overall, our patterns reveal that some commoners had access to obsidian in levels equivalent to those of elites and meet expectations of the distributional model for obsidian marketplace accessibility.

Copper Bell Distribution

Bells in consumer contexts are found in both elite and non-elite residences and meet expectations of a marketplace distribution (Paris 2008:60, table 7). One commoner context with three bells is House X-43, an isolated and otherwise relatively impoverished residence near the southeast portion of the city wall. Other humble houses excavated by the Carnegie project similarly yielded bells or other metal objects (Paris 2008:table 7). One burial in House Q-39 (in downtown Mayapán, just west of the monumental center) had a large quantity of bells (N = 36), including one of the city's few bell effigies in the form of monkey head (figure 5.33). This house is located next to one of the site's largest elite residences (group Q-41), and its residents may have had special benefits or a social affiliation with this group. Bells are concentrated in at least one other mortuary context from the Carnegie investigations (J. Thompson 1954:figure 2h).

The frequency of copper bell recovery from general (non-mortuary) excavations reveals few differences in wealth or accessibility across social status lines, as illustrated in figure 6.3. Table 6.32 indicates the context types where bells were recovered from either test pits or fully excavated structures. Regardless of sampling methods, only one or two bells were found from all of these structure or midden contexts. Elite House Y-45a had two bells, as did commoner Houses X-43 and P-117 and Temple H-17. Four other ordinary (non-crafting) houses (P-150, P-71a, P-176, and R-173) each had one bell, as did commoner craft producers at I-55, Q-176, and Q-40.

Greenstone Distribution

Greenstone celts also represent valuable imported items (figure 6.23), and we have already discussed the probability that these objects were part of many ordinary household toolkits. A total of 49 greenstone items have been recovered from surface collections (not systematic, N = 13), test pits (N = 4), horizontal excavations (N = 20), and INAH project work in the site's monumental center (N = 12). The PEMY project greenstone objects are listed by context in table 6.24. These durable artifacts occur in low frequencies and were highly curated. Thus, chances are low of recovering them from one or two test pits at a single locality. Ad hoc surface collections indicate the regular presence of these artifacts at commoner houses (L-23, Y-106, Q-179, R-175b, M-59a, Q-176, Q-185, Q-195, and Q-181) and three elite houses in our survey area (two at Q-42, one at Y-45a). Despite the extensive amount of work done at the monumental center, frequencies at that vicinity are not greater than in domestic contexts outside of this zone. This distribution suggests that greenstone axes were available to commoners in the city's marketplace. They are found in craft-production houselots and at more generalized commoner domestic localities. Only one to two of these objects was found at any single context, irrespective of the amount of area excavated.

Table 6.32 Copper objects recovered in PEMY contexts.

Unit type	*Structure, context type*	*Copper bell*	*Copper fragment, folded copper*	*Ring, tweezers*
Horizontal excavation	H-17 temple	2	–	–
Horizontal excavation	H-15 hall	–	1	–
Horizontal excavation	I-55 surplus craft production house	1	–	–
Horizontal excavation	Q-176 surplus craft production house	1	–	–
Horizontal excavation	Q-40 surplus craft production house, next to elite palace	1	–	–
Horizontal excavation	Q-39 surplus craft production house, next to elite palace	26	8	2
Horizontal excavation	X-43 commoner house	2	–	–
Horizontal excavation	Y-45 elite house	2	–	–
Horizontal excavation	L-28 commoner house	–	–	–
Test pit	P-150 commoner house	1	–	–
Test pit	P-71a commoner house	1	–	–
Test pit	P-176 commoner house	1	–	–
Surface collection	R-173 commoner house	1	–	–
Test pit	P-117 commoner house	2	–	–

Marine Shell Ornament Distribution

Shell distributions are considered at length in a previous section of this chapter. Here we consider specifically the relative quantity of marine shell ornaments that were most likely to have been used as currencies: Olive group ornaments, *Strombus* and *Spondylus* pendants or beads, and other bivalve-shaped pendants. Tables 6.33, 6.34, and 6.35 indicate the low frequencies of these items for surface collections, test pits, and fully excavated structures. All but one of twenty-three surface collections with one to three of these items are commoner dwellings. Shell workshops similarly had from one to three such objects (table 6.33), indicating a low incidence of errors or a focus on making non-currency products. In sixteen test pits with these ornaments (all but one are commoner houses), most contexts had from one to three such objects, including shell workshops. Two exceptions in the test pit sample have from four to six items (table 6.34). Higher quantities of shell ornaments per square

Table 6.33 Selected finished shell objects from PEMY surface collection units.

Structure	*Olive/ Prunum tinkler*	*Strombus bead*	*Strombus pendant/ ornament*	*Spondylus pendant*	*Other bivalve pendant*	*Total*
EE-26b house	1	–	–	–	–	1
Y-51 house	1	–	–	–	–	1
Y-111 house	2	–	–	–	–	2
Q-189 house	–	1	–	–	–	1
Y-107 house	–	1	–	–	–	1
Z-101 house	–	1	–	–	–	1
M-60a house	–	–	2	–	–	2
R-170a house	–	–	1	–	–	1
R-171 house	–	–	–	1	–	1
R-111 house	–	–	–	1	–	1
R-168b house	1	–	2	–	–	3
Q-42 elite house	1	–	–	–	–	1
R-177 craft specialist (shell)	1	–	–	–	–	1
P-24 craft specialist	2	–	–	–	–	2
Q-196 craft specialist	2	–	–	–	–	2
Q-183 craft specialist (shell)	3	–	–	–	–	3
R-110 craft specialist (shell)	1	1	–	–	–	2
S-10 craft specialist (shell)	2	1	–	–	–	3
Z-120 craft specialist (shell)	–	–	1	–	–	1
Q-46 craft specialist (shell)	–	–	1	–	–	1
Z-119 craft specialist (shell)	1	–	2	–	–	3
Q-37 craft specialist	–	–	–	1	–	1
Q-176 craft specialist (shell)	3	2	2	2	1	10

meter and per cubic meter were recovered in fully excavated shell workshop contexts Q-176, Q-39, and I-55a and at Q-40a, where some shell working may also have occurred (table 6.35). It is noteworthy that two of three ordinary commoner houses (L-28 and H-11) had these shell objects in similar quantities to elite House Y-45a, Temple H-17, and Hall H-15. Marine shell ornaments and currencies in particular were nonlocal items of value. They were widely available to commoners at the site, although they are not highly ubiquitous. These two characteristics meet the expectations for monetary units.

THE ECONOMIC FOUNDATIONS OF MAYAPÁN

The economy of the political capital of Mayapán was founded on a complex set of of strategies that fostered interdependence among households within the city and region and with distant trading partners. Evidence that surplus craft production was an important part-time occupation for city households supports a model of an urban place in which residents were bound together in a fabric of local production and consumption.

The most marked finding in our comparisons is the distinction between surplus crafting houselots and those that engaged in other activities. Crafting localities differed among themselves in the types and quantity of debris, and nearly half of these contexts produced more than one type of commodity. Altogether, twenty-nine surplus production localities were found in our settlement zone study areas; four others have been documented by other investigations (table 6.3). All but one was within a houselot, and the exception (I-57) was a self-standing building contained within its own albarrada wall, between two nearby houselots. Crafting houses were of commoner status, with the exception of elite House Z-39, and perhaps House Q-39, a wealthy house next to elite group Q-41. House Q-40a was the only house engaged in spatially attached production, as suggested by its location within the albarrada wall of elite group Q-41 and the fact that its burials had modest, craft-related grave goods (figure 5.32). Fourteen of the twenty-nine workshops that we identified produced a single item: four focused on shell (Q-183, R-177, Z-43, and Z-47), eight on obsidian (R-137, R-173, R-174, R-155, J-130, P-115, P-24, and Q-196), and two on chalcedony/chert tools (I-57 and Q-37). The remaining fifteen produced multiple materials (table 6.3). Two localities made chert and shell objects (S-12 and Z-119), four worked obsidian, chert, and shell (P-114, Z-39, Z-119, and S-10), five worked obsidian and shell (R-110, Q-303, P-28b, Q-46, and I-55), and one worked obsidian and chert (Q-188). More varied crafting industries were observed in Milpa 1 at Q-40a (pottery effigy censers,

Table 6.34 Selected finished shell objects from PEMY test pit samples.

Structure	*Olive/ Prunum tinkler*	*Strombus bead*	*Strombus pendant/ ornament*	*Spondylus pendant*	*Total*
Q-303 craft specialist (shell)	1	–	–	–	1
R-110b craft specialist (shell)	–	–	1	–	1
I-55a craft specialist (shell)	1	1	–	–	2
P-28 craft specialist (shell)	1	–	1	–	2
Q-176 craft specialist (shell)	1	2	1	–	4
F-13a house	1	–	–	–	1
S-80 house	1	–	–	–	1
P-117 house	3	3	–	–	6
P-150 house	–	1	–	–	1
Z-39 elite house	–	2	1	–	3
Z-43 house	–	1		–	1
P-71/O-28 house	–	–	1	–	1
R-155 craft specialist	–	–	–	1	1
P-115b craft specialist	–	–	–	1	1
S-10bc craft specialist	–	–	1	–	1
P-114 craft specialist	6	–	3	–	9

copper bells, and probably shell objects), Q-39 (chert, shell, copper bells, and possibly clay figurines), and Q-176 (obsidian, shell, pottery vessels, and clay figurines). These localities together represent ten locations where chert tools were made, seventeen shell-working contexts, nineteen obsidian workshops, and two ceramic workshops. These workshops were identified using measures of outlier frequency status for the quantity of debris present by surface collection, test pit, and horizontal excavation results.

Most of the identified workshops were located not far from elite residential or public buildings, but evidence for attached patronage is minimal (figure 6.4). Thirteen are present in Milpa 1, just west of the monumental center, in an area that includes two of the seven largest elite residences of the city (figure 6.19). We identify this area as a crafts barrio (Masson, Peraza Lope, and Hare 2008; Hare and Masson 2012). Two other workshops are within 150 meters of the Itzmal Ch'en outlying ceremonial group. As elites did not live in this area, patronage, if it existed, would have been at a distance. Six workshops

Table 6.35 Selected finished shell objects from PEMY fully excavated structures. None were recovered from X-43.

Ornament	*House L-28*	*House H-11*	*Elite House Y-45*	*House Q-176*	*House Q-40*	*House Q-39*	*House I-55a*	*Temple H-17*	*H-15 hall, grave*
Bivalve pendant, ornament	–	3	–	1	2	3	4	–	–
Oliva, *Prunum*, *Cypraea* tinkler	1	2	3	11	5	5	11	6	3
Strombus bead	–	–	2	–	3	9	3	–	5
Spondylus bead	–	1	–	1	–	–	–	–	–
Bivalve bead	–	–	–	–	–	1	1	–	–
Spondylus pendant	1	–	–	–	2	1	–	–	–
Strombus, *Busycon* pendant, ornament	4	1	7	1	3	3	10	4	1
Strombus spatulate, spoon	–	–	1	–	–	–	1	–	–
Total shell objects	6	7	13	14	15	22	30	10	9
Total square meters	212.00	133.30	376.00	136.00	88.50	120.00	196.00	601.65	515.00
Objects per square meter	0.03	0.05	0.03	0.10	0.17	0.18	0.15	0.02	0.02
Total cubic meters	30.44	35.88	176.10	33.07	21.74	34.23	47.35	328.20	155.10
Objects per cubic meter	0.20	0.20	0.07	0.42	0.69	0.64	0.63	0.03	0.06

are found in Milpas 11 and 32, near the eastern and southeastern edges of the monumental center. Four of the seven largest elite dwellings at the city are in these milpas. Two workshops are located in Milpa 2, just south of the site center, where a large public group is present that formed the terminus of the site's central sacbe; elite House Z-39 is one of these two workshops. Exceptions to this pattern exist. Two workshops in Milpa 4 are not near any elite architecture, and three workshops in Milpa 15 do not appear spatially associated with the nearest public building, J-111, 250 meters away. Clifford T. Brown (1999:457–62) found an additional chert/chalcedony biface workshop at S-139, located 120 meters to the south of an elite dwelling (S-133), with which it exhibits no clear association.

In general, craft producers were concentrated in downtown Mayapán, as were the largest elite residences and most of the public architecture. This area of the city would have offered enhanced opportunities for commerce and affluence near the nucleus of political and religious activities. Other clustered craft activity may exist at Mayapán outside of our sample areas, perhaps near the concentration of elite houses in Square K, next to the probable marketplace—but this is unconfirmed. Away from focal architecture, a pattern of outlying, isolated houses or sets of two houses engaged in surplus crafting is observed in the cityscape, as reflected by workshops identified in Milpas 4, 15, and perhaps 16 (Itzmal Ch'en area). These craftspersons may have provisioned the neighborhoods in which they were situated in addition to making goods destined for market exchange. It is unclear at this point whether proximity to elite houses and the monumental center in the downtown areas of Milpas 1, 2, 11, and 32 was fostered by some form of patronage or supervision, or more indirectly, by the concentration of affluent consumers in these zones. Hirth (1993b:141) argues that dispersed producers at Xochicalco produced for market exchange rather than neighborhood vending. Chert, obsidian, and shell products made at Mayapán's workshops are distributed widely and were also probably obtained in the city's marketplace. Simpler tools may have been made at home or were acquired from local markets in the residential zone or neighborhood vendors; more sophisticated items may have been obtained at the larger central market (e.g., Fry 2003; Masson and Rosenswig 2005). Many households probably made or modified some of their own projectile points and expedient lithic tools. Bifaces and flakes or flake cores for expedient use may have been obtained from workshops.

Overlap in shell, obsidian, and chert production occurs among the downtown and outlying workshops, although more obsidian working is concentrated downtown. Qualitative differences are observed among chalcedonies used at the outlying I-57 workshop compared to epicentral House Q-39, where flakes were of much finer material (Kohut et al. 2012). The location of a censer workshop within the albarrada of elite group Q-41 most clearly suggests attached specialization; this is the most specialized and artisanal type of production documented for Mayapán. These data suggest that crafting occurred for a variety of purposes, much of it to provision the city with its basic needs.

Crafting households were affluent compared to other commoner residents at the city, and this pattern contrasts with ethnographic models that propose that crafting was undertaken by the poorest households to buttress meager agricultural options (D. Arnold 1985:192–93). Jeanne Arnold (1995:91–95) identifies affluence among Chumash craft-workers, and this pattern is also observed at the Early Classic Maya city of Chunchucmil, Yucatán (Dahlin 2009:353; Hutson, Dahlin, and Mazeau 2012). Kin-based learning and residential patterns may also account for the growth and concentration of the downtown craft district at Mayapán, as has been proposed for other societies (D. Arnold 1989:181).

The practice of part-time specialization is attested to in a review of ethnohistorical sources (Clark and Houston 1998:38), and this is confirmed by our assessment of the scale of production at Mayapán houselots. The ubiquitous references in the Colonial Period to female roles in textile manufacture suggest to Clark and Houston (1998:38) that cloth production was as essential to daily subsistence as corn. Was this a consequence of amplified Colonial-era demands, as these authors wonder? The low frequency of spindle whorls at Mayapán suggests that women at this city were not as heavily burdened with spinning thread as were their contemporaries at other towns in the peninsula or central Mexico. Other textile industries, such as weaving or embroidery, were probably more important. The regular distribution of pointed bone tools may reflect these later stages of textile producton. Some earlier Maya cities of the southern lowlands engaged in significant thread spinning, as indicated by an abundance of spindle whorls (A. Chase and D. Chase 2004:119), and an emphasis on late-stage textile working may be a pattern specific to northwest Yucatán at sites like Mayapán and Dzibilichaltun.

Documenting occupational specialization in its varied combinations and scales at Mayapán's houselots is a cornerstone category of evidence supporting a model of an integrated and complex economy at this political capital. Craft production also reflects dependence on a regional exchange network of towns and polities connected to the city. The array of crafting activities provides a clear case of diversification in the economic activities of houselots. This dimension of heterogeneity in productive work contrasts with relative homogeneity in the consumption of valuables across social class lines. The scale of production and indicators of wealth vary in degree along a continuum among commoner houselots, as might be expected in any market economy and urban place (Hirth 1998). Production heterogeneity and relative consumption homogeneity meet two essential expectations of a well-developed market economy and match patterns documented for some earlier Mesoamerican political centers discussed at the beginning of this chapter (Masson and Freidel 2012). Despite a diverse set of thriving production industries, Mayapán was not an economic isolate. Producers depended heavily on outside sources—within Yucatán and beyond—for raw materials that were transformed into useful and valuable goods within the city walls. As consumers, residents of the city also fulfilled appetites for regular quantities of finished imported goods such as greenstone celts or Matillas Fine Orange pottery that originated in the distant corners of the Maya area. Mayapán's economy conforms well to general comparative patterns documented across the Postclassic Mesoamerican world system in the degree to which households depended on others, both locally and distantly, to provision themselves with the inventories that they needed or desired (Kepecs, Feinman, and Boucher 1994; Kepecs 2003; Smith and Berdan 2003a). Large quantities of cacao (along with cotton thread or mantles) and basic raw materials (lithic cores, shells) and other perishables (such as hardwoods, copal, and salt) were exchanged into the city from distant lands to supplement local supplies. The city's production economy does not fit simple models that have been proposed for ancient Maya states. Instead, the data exhibit diverse configurations that might be expected from an urban place that was occupied for over two hundred years. The city was neither autonomous nor a "consumer city" that depended largely on its hinterland (e.g., P. Rice 1987; Ball 1993).

The analysis of shell industries in this chapter proposes that certain suspended shell objects served as currencies along with beads, including *Spondylus* (and other bivalve) pendants and Olive group tinkler-type ornaments. Significant quantities of these potential monetary units were exchanged into the city, and they are not well represented compared to more idiosyncratic objects in the city's workshops. Future analyses of market economies at ancient Maya states will benefit from a deeper consideration of valuable items that served not only as adornments but also as currencies (Freidel, Reese-Taylor, and Mora-Marin 2002). Like other material classes at Mayapán, shell objects varied in quality along a continuum of value. Dichotomous classifications of prestige versus utilitarian goods are of limited utility for understanding complex systems of value and exchange (Lesure 1999; Masson and Freidel 2012, 2013).

The most pressing and unresolved question is the scale of food production at Mayapán. Craft-producing houselots may not have been able to fully supply their own food. Martin Biskowski (2000:293, 302) considers the heavy time investment required for maize preparation in Postclassic central Mexico. Full-time tortilla vendors helped to solve this problem by eliminating the need for redundant tasks at every household (Biskowski 2000:296); occupational specialization also alleviates this burden. He suggests that urban residents were supplied with food by agrarian houselots at the city margins through the marketplace, petty vendors, or other mechanisms (Biskowski 2000:293, 302). In general, this model for urban provisioning is a good fit for Mayapán, with two qualifications: not all houselots in the peripheral zone (near or beyond the city wall) were agrarian and a significant number of downtown houses prepared food for themselves and probably for others. One house, Z-43, next to a large public group (Z-50, southern sacbe terminus), had five metates clustered at the surface, surely more than a nuclear family required. Residents of this house likely prepared food for feasts at nearby elite House Z-39 and Hall Z-50, but the possibility that surplus tamales were also produced for sale merits consideration. Houses such as L-28 and H-11 may have been engaged primarily in agriculture or food production; H-11's occupants may have also fulfilled custodial duties for Itzmal Ch'en. In contrast, commoner houses like X-43, whose occupants may have resided temporarily at the city for the duration of their corvée service obligation, had no grinding stones and may have been dependent on others for food.

The agrarian foundations of Mayapán are not well understood. Our sample of fully investigated houses is weighted toward surplus craft producers, and smaller test pit samples of dozens of other locations yield little direct evidence for households devoted to farming or food processing. By default, houses of agrarian specialists may be those that exhibit a more generalized domestic assemblage without an emphasis on crafting or other occupations. Agricultural tools may be infrequent at Mayapán houselots due to the possibility that male farmers discarded broken implements in outfield locations (McAnany 1989; Brown 1999:457), although we doubt that this explanation fully accounts for the problem. Nonresidential walled fields within the city wall, along with scattered residences beyond the city wall that were near to extensive cultivable tracts (Russell 2008a), suggest that agricultural production contributed in an important way to Mayapán's diversified economy. Future work will hopefully provide more detailed information on farming strategies and capacities.

Addressing the question of elite oversight of the city's economy is complex, as the data reviewed in this chapter reveal an array of economic relationships across class lines. In general, elite encouragement of production industries is inferred. In some cases specialized goods were directly commissioned. In other cases, dispersed workshops seemed to operate more independently—a circumstance that was tolerated, perhaps strategically so, by governing authorities. Promoting, organizing, or administering local or central markets that allow residents to self-provision solves basic supply problems for city life and contributes to overall economic and political stability (Garraty 2010:19; Masson and Freidel 2012). Markets also attract the most skilled artisans and merchants, and they provide elites with greater opportunities for wealth (Blanton 1996:83). Instead of viewing the varied manifestations of craft production at Mayapán as a laissez-faire, chaotic system, we interpret these patterns as a complex and layered adaptation to the diverse needs and opportunities of the urban setting. Downtown Mayapán was a hub of activity that would have drawn diverse craft artisans, yet at the same time, residents in the settlement zone would have also benefited from neighborhood workshops. Occupants of outlying houselots had the option to diversify their income through craft production. Other forms of service were probably directly recruited to serve elite needs, such as preparing food, supplying ritual paraphernalia, stucco working, stone carving, or masonry.

The economic foundations of Mayapán thus reflect an intricate, complicated system that supported urban life. Governing elites encouraged diverse local production that provisioned the city with many of its essentials—a wise strategy for polity stability. Opportunities for wealth and exchange stimulated production and would have also contributed to the quantity and diversity of potential tribute payments. The landlocked city was not autonomous, and it depended significantly on the outside world within and beyond northwest Yucatán. Political officials would have been integral in maintaining—peaceably or otherwise—solid relationships with trading partners who were in possession of key resources. It is noteworthy that the city itself sits on no unique mother lode of spatially constrained resources. Most of its workshops did not produce goods that could not have been acquired elsewhere, although it is probable that the urban zone lured artisans who produced objects of top quality for the region. In this respect, Mayapán differs little from earlier Maya cities. Regional traders may have moved Mayapán's game, fruit, and finished products to coastal towns in exchange for fish, salt, marine shell, and other items. Long-distance merchants, including members of the city's noble class, would have traveled these paths as well and brokered valuables farther south along Gulf and Caribbean routes. They would have returned with currencies (cacao, marine shell, copper bells), nonlocal raw materials (obsidian cores, cotton thread, *Spondylus*), or finished products (greenstone axes, jade beads, Matillas Fine Orange vessels). Mayapán's formidable military clout would have guarded these interests across the peninsula. Alliances would have also been maintained through diplomatic channels, including elite marriages, gifts, investiture, and general participation in shared elite culture that included religious beliefs, ritual knowledge, and symbolic paraphernalia (e.g., Pohl 2003a, 2003b; Masson 2003a; Boone and Smith 2003). The study of Mayapán's religious influence on allied hinterland polities and their leaders has been well documented (e.g., Sidrys 1983; Masson 2000; Rice and Rice 2009). In chapter 7 we examine the diversity and distribution of the city's pantheon of gods and other supernaturals portrayed in pottery, stucco, and stone sculptures.