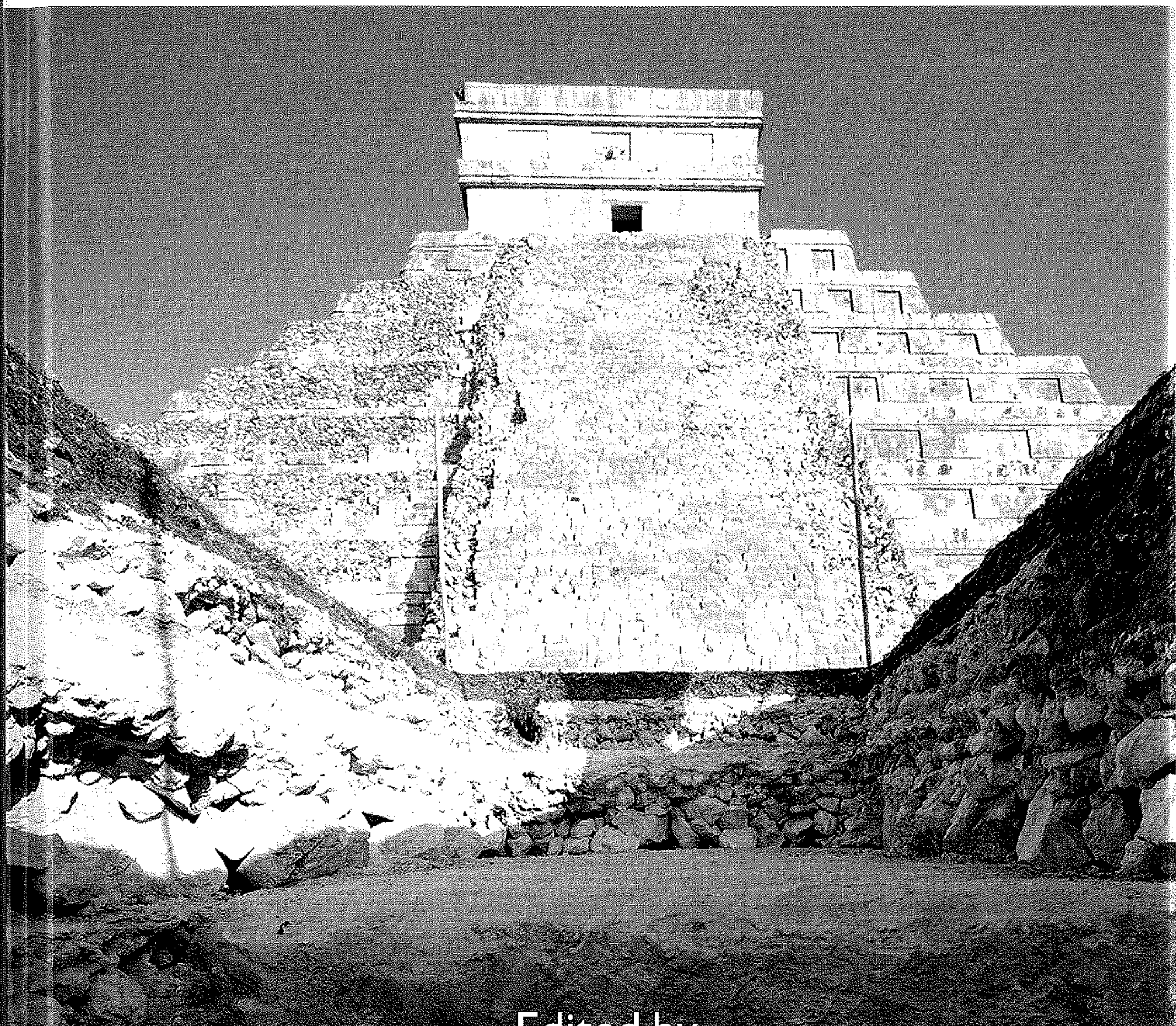
APPROACHES TO ANTHROPOLOGICAL ARCHAEOLOGY

The Ancient Maya of Mexico

Reinterpreting the Past of the Northern Maya Lowlands



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12 Poor Mayapan

Clifford T. Brown, April A. Watson, Ashley Gravlin-Beman, and Larry S. Liebovitch

Abstract

The material culture of Mayapan (ca. A.D. 1250–1400), the last great capital city of the northern Maya lowlands, has often been described as "decadent." Such descriptions, however, are highly subjective. In this chapter, we consider poverty and wealth at Mayapan from a perspective based in modern economics. We find that, as in modern societies, wealth (as measured by house size) at Mayapan fits a Pareto distribution. Nevertheless, compared to two Classic-period sites in Mexico—Palenque and Sayil—the distribution of wealth was more equal at Mayapan, suggesting that economic inequality was less extreme at the Postclassic city. One cause for the decadent material culture of Mayapan, therefore, was that the city was impoverished when compared to its Classic predecessors.

In this essay we analyze the magnitude and distribution of wealth at Mayapan and explore the implications of our findings for the general interpretation of the economy, society, and culture of that city. Mayapan, Yucatan, Mexico, is the largest and most important Maya archaeological site dating to the Late Postclassic period, and therefore inspires a lot of curiosity among archaeologists. Their interest is piqued because, founded by the legendary Kukulcan, Mayapan was the political capital of the largest and most powerful Maya state of its period. Because of its size and power, Mayapan also served as the social and cultural capital of the northern lowlands at the same time. Because it was a late prehistoric site, Mayapan was discussed in many historical chronicles from the early colonial period, and so we possess unusually detailed information about it. As an archaeological site, Mayapan is exceptionally well preserved, and it has been excavated more extensively than most sites; as a result, we have an unusually large body of data from it. For all these reasons, Mayapan plays a central role in the scholarship of the Late Postclassic period. We ought, therefore, to understand Mayapan society rather well, but this does not seem to be true.

We pay a price for our ignorance. Mayapan culture is a vital link between the historic period and the Classic period (A.D. 250–900). If we cannot understand Mayapan society—given the bright, historical portraits we have of Hunac Ceel (Chapter 10), of the Xiu and the Cocom, the Chel and the Canul—what can we claim about our comprehension of the Maya of the Classic period?

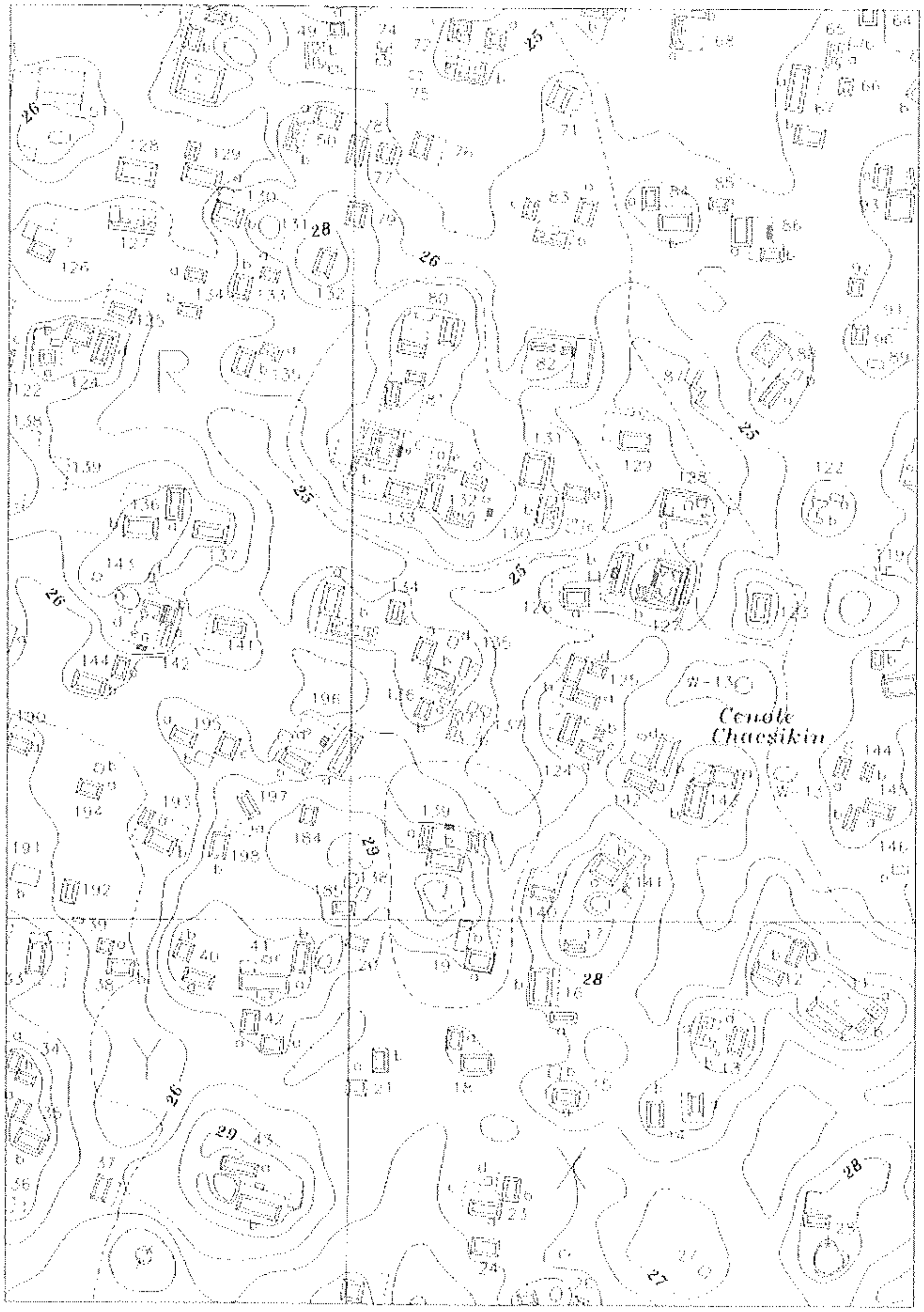

Figure 12.1. Detail from map of Mayapan
(redrawn and edited from revised map in Pollock et al. 1962).

Views of Mayapan

Our understanding of Mayapan has evolved over the decades, influenced inevitably by both intellectual trends in archaeological theory—which are in turn molded by their social and cultural milieus—and also by the growing body of archaeological data produced by archaeological investigations. Over the past few decades, our views of Mayapan have changed significantly (Aldana 2003; Aveni et al. 2004; Brown 1999, 2005, 2006; Brown and Witschey 2003; Milbrath and Peraza Lope 2003; Peraza Lope et al. 2006; Pugh 2001, 2003; Rathje 1975; Russell and Dahlin 2007). Here, we limit our discussion to two of the most prevalent perspectives: the traditional view that Mayapan was "decadent" and the newer idea that the economy of the polity used cost-control measures to develop efficiencies.

Late Postclassic Decadence

In the middle decades of the twentieth century, Mayapan and its regional culture were considered decadent by archaeologists. Even as late as 1984 (Freidel and Sabloff 1984), archaeologists continued to call the Late Postclassic the "Decadent" period. This view arose for at least three reasons. First, as expressed by the most influential Mayanist of the pre-War years, "the archaeological importance of Mayapan...appeared to be far less than its political preeminence in the thirteenth, fourteenth, and fifteenth centuries...would have demanded" (Morley 1938:141). In other words, Morley thought the ruins *called* Mayapan seemed too small to really be *the* Mayapan of chronicles and histories. Morley revised his opinion, however, after Ralph T. Patton conducted a preliminary survey of the site in 1938, partly at his own expense, but under the auspices of the Carnegie Institution (Figure 12.1).

Patton's survey followed the great wall in its circuit around the site and also included the ceremonial center. He traced the course of the great wall and briefly described its construction. He showed that the masonry consists of large irregular blocks laid without mortar. It measures about nine kilometers in circumference, is three to four meters thick, and stands about two meters high when viewed from the exterior. Patton identified the parapet along the outer edge, the interior stairways, and nine of the portals or entryways. The survey of the ceremonial center revealed large colonnades and four round structures, both rare forms of architecture in the Maya canon. Patton also located a number of stelae with short-count dates (Morley 1938:142). It is apparent from other evidence that Patton located and mapped the main *sacbe* at the site and the large residential groups associated with it. Thus, a modified perspective on the city emerged:

> although Mayapan reached a position of first importance only at the close of Maya history when architectural decadence was well under way, its size satisfactorily agrees with the political preeminence ascribed to it by both the native and the Spanish chroniclers (Morley 1938:142).

Another reason why earlier archaeologists considered Mayapan culture to be decadent was that the art, architecture, and material culture displayed strong influences from central Mexico, from the widespread International art style (also called "Mixteca-Puebla"). This is not surprising given: (1) the broad geographical distribution of the International style during this period; and (2) the presence of Aztec mercenaries brought to Mayapan from Tabasco by the Cocom rulers. The International style is manifest particularly in the mural paintings, whereas more generic central Mexican influence can be seen in the extensive use of columns, beam-and-mortar roofs, the frequency of round temples and serpent temples, the presence of double temples, the use of arrowheads, the famous Chen Mul effigy incense-burners depicting Mexican gods (Taube 1992; Thompson 1957), and many other attributes.

To call Mayapan decadent, therefore, is to call the International style and central Mexican culture decadent. This reflects a prejudice that judged the culture of the Maya to be superior to that of their central Mexican counterparts. This chauvinism was particularly pronounced among North Americans who saw Maya writing, astronomy, and mathematics as evidence of cultural superiority (Proskouriakoff 1955; Thompson 1966). They contrasted the supposedly peaceful Maya with the sanguinary and militaristic Aztecs and found the latter lacking (Pollock et al. 1962; Thompson 1966). Archaeologists extended this view to art and architecture too, calling Classic Maya art a high art style and thereby denigrating the other Mesoamerican aesthetic traditions by comparison. Obviously, these kinds of aesthetic judgments are by their very nature subjective.

The third reason why Mayapan culture was considered to be decadent was the apparent low quality of the material culture, which seems shabby and impermanent. We think of this as "expedient" architecture, by analogy to expedient stone tools, which are casually made by the most convenient and cost-effective method. Mayapan masonry, for example, is poor when compared to that of Chichen Itza or the Puuc sites (Smith 1962). Stones are rarely squared, and many of those that are dressed—particularly in the ceremonial center—appear to have been scavenged from earlier Puuc-style sites. Not only is the masonry at Mayapan generally made of rough stones, but also it is poorly mortared. The bonding in Classic buildings can be irregular but is, typically, better than that of the Mayapan-style constructions. The Puuc-style masonry that immediately precedes Mayapan-style masonry in the northern lowlands does not usually have true bonding because the veneer masonry is not load bearing. As a result of the low-quality masonry, Mayapan-style architecture is uneven and irregular and was therefore commonly covered with thick layers of stucco. Mayapan-style buildings also collapsed faster than those built in earlier styles. Even the dry-laid stone houselot walls (*albarradas*) at Mayapan were built using less labor-intensive techniques than in earlier times (Brown 1999:126-127).

Mayapan ceramics are equally expedient in that they are coarse, soft, and friable compared to most Late and Terminal Classic pottery. One can characterize the lithic assemblage as dominated by expedient tools (Brown 1999:450-451, 455-456). Formal tools are rare, particularly in residential areas. Thus, the view of Mayapan as decadent was in part a reflection of the perceived quality of many aspects of the material culture.

Efficiency and Economy

William Rathje (1975) provided an alternative economic explanation for the expediency of Mayapan culture. In this work, "The Last Tango at Mayapán," Rathje applied General Systems Theory to the economic system of Late Postclassic Period Maya society. The kind of systems theory he employed is now outdated, but it earned him a few paragraphs in the history of archaeological theory (Trigger 1989:324-325). In contrast to the transience of systems theory, his economic reinterpretation of Mayapan culture successfully displaced the traditional decadent view.

Rejecting the frankly prejudiced view that Mayapan represented a decadent culture in decline, he argued that the expedient quality of Late Postclassic material culture was a consequence of greater efficiencies that evolved in the context of a rapidly expanding mercantile trading system.

> In the Classic/Postclassic transition, the role of material culture seems to have changed in relation to population integration. Over a period of time, the cost-control trajectory is proposed to have led to lower production costs per item and greater resource dispersion over social and geographical space. By the Postclassic, these trends in material culture production-distribution may have fostered interdependence among populations through an expanding social and economic (rather than ideological) order..., while at the same time they produced variety in response to local information-processing and -deciding needs... Thus, while Classic populations were to a large extent integrated through the costly maintenance of an elite minority, Postclassic populations were most probably integrated through a rising standard of living locked into large scale population participation in a commerce which emphasized economic efficiency and mass consumption (Rathje 1975:435-436).

Rathje's (1975) article remains a landmark because it successfully shifted the terms of the debate about Late Postclassic culture from the frankly subjective and poorly defined discussion of decadence to the economic arena where it belongs—at least in part. This was a major change that has had a far-reaching influence on the study of the Maya Postclassic.

An Alternative Perspective on Mayapan: Poverty and the Distribution of Wealth

Unpersuaded that the shoddy material culture of Mayapan is the inevitable result of a universal systems trajectory, we decided to explore a more specific historical explanation that nonetheless carries broad implications. Calling the material culture of Mayapan "expedient" is merely a polite, technical way of saying that it was *cheap*. We think that the expedient quality of the artifacts and architecture of Mayapan reflect an inability to purchase expensive items, and therefore indicate that poverty was widespread. Our position, therefore, contrasts with Rathje's view of a "rising standard of living" during the Late Postclassic.

The issues of poverty and inequality are interrelated. For example, in the modern world much poverty is not the result of an overall absence of wealth or resources but rather of their extremely unequal distribution within society. Poverty and inequality are large topics in many fields, such as sociology, economics, anthropology, and development. Poverty can be difficult to define, is not exclusively economic, and any definition should include cultural and psychological factors. We are concerned with both total wealth and its distribution because the lack of the first and great inequality in the second can produce widespread poverty.

In the large literature on these topics, we find many measures of poverty and inequality (Cowell 2000). Each provides a different summary of the characteristics of the phenomenon. We have chosen three approaches to the study of the distribution of wealth: (1) fitting Pareto and exponential distributions to our empirical data; (2) calculating Gini coefficients; and (3) using absolute measures of wealth that contrast with the first two approaches, which both measure relative distributions. We describe these below.

Pareto and Exponential Distributions

Wealth and income are most often modeled as following a type of power-law called the Pareto distribution, named after a sociologist who first applied it in his study of income (Pareto 1897, 1971). Pareto recognized that income was not distributed in society in accordance with a "bell curve" or normal distribution. If it were, then there would be a few rich, a few poor, and a large number of middle class citizens. In modern economies, there are only a very few truly rich people, and ever-increasing numbers of people in ever-lower income classes. The poor actually outnumber the middle class, even in the United States where almost everyone likes to define themselves as middle class.

Pareto observed that the distribution of income forms a power-law. Simple power-law distributions take the form

$$y = kx^{-c}$$

where y is the probability of observing a particular value of x, k is constant, x is the variable (income or wealth in our case), and c is a parameter defining the distribution. Power-law distributions are extremely skewed—most of the data cluster with low values of x—and they have a long right tail, meaning a few extreme outliers with very high values of x—the super-rich. This skew means that income and wealth are distributed very unequally. Economists have studied why this should be and particularly why the statistical distributions of wealth and income take the form they do (e.g., Champernowne 1953; Davies and Shorrocks 2000; Mandelbrot 1960, 1961; Sargan 1957; Stiglitz 1969; Yakovenko and Silva 2005).

Recent studies, however, show that modern distributions of wealth and income may not all be strict power laws, but rather form more complex curves. For example, Drăgulscu and Yakovenko (2001) show that although the right tail of the income and wealth curves in the United States and Britain do match power laws, the portion of the curve with low incomes is actually best modeled as an exponential distribution or perhaps even as a lognormal distribution (e.g., Clementi and Gallegati 2005). Exponential distributions are also skewed, but much less so than power laws, so that a society with an exponential distribution of wealth is somewhat more egalitarian than one with a power law distribution. The consensus is that the wealth (and income) of the rich is distributed as a power law, but the functional form of the lower end of the curve may be more ambiguous (Davies and Shorrocks 2000).

In our study of Mayapan and other sites, presented here, we evaluated the functional form of empirical wealth distributions by using the multihistogram method developed by Liebovitch. This method is particularly effective in determining the precise form of skew functions (power-laws, exponentials, etc.) and also in estimating their parameters (Brown and Liebovitch 2010:26-39).

Gini Coefficient

The Gini coefficient is the index most widely used to describe the degree of inequality in the distribution of resources, most often wealth or income. The Gini coefficient describes how much the cumulative distribution of wealth in a population diverges from a distribution in which everyone possesses equal wealth. The index varies from 0 to 1 (or 0 to 100 as used throughout this chapter), with low values indicating a more equal distribution of wealth and high values reflecting a more unequal distribution. The Gini coefficient can be estimated from empirical data in various ways. We use the formula:

$$G = \frac{\sum_{i=1}^{n}(2i - n - 1)x'_i}{n^2\mu}$$

where i is the rank order of an individual, n is the number of total individuals, x'_i is the variable value of the individual, and μ is the population average (Damgaard and Weiner 2000:1139).

Absolute Measures of Wealth

By "absolute measures," we mean the use of descriptive statistics such as the arithmetic mean, median, mode, and sum of wealth for a particular population. Such measures contrast with those described above, which characterize the distribution rather than the magnitude of wealth.

Measurements of Wealth and Inequality in Archaeology and Anthropology

The differences between these three measures of wealth and its distribution are significant. The purpose of studying the type of distribution—Pareto, exponential, or otherwise—is to determine the generic form of the function that describes the overall patterning of the data. This can give us insight into the process that produced the phenomenon. For example, exponential, Poisson, and normal distributions are all produced by simple random processes. In contrast, Pareto distributions are typically generated by complex processes that spontaneously self-organize to produce power law distributions. For example, preferential attachment models (Barabasí and Albert 1999), which in our case would translate to a "rich get richer" process, produce power law distributions. On the other hand, if the probability of an individual being rich or getting richer were a simple random function, then a power-law distribution of wealth would not emerge. Thus, the functional form of the distribution helps us infer how it emerged.

Despite its utility and potential, this approach has not seen much use in archaeology. The only study of the Pareto distribution in prehistory we are aware of is Abul-Magd's (2002) analysis of house sizes at Akhetaten, the New Kingdom capital established by the Pharaoh Akhenaten at what is today Tell el-Amarna. Using data from Kemp (1989), Abul-Magd examined the distribution of house sizes and found a Pareto distribution. Taking house size as a proxy for household wealth, he concluded that the distribution of wealth was similar to that in modern societies. The functional forms of many other archaeological data sets could be profitably studied.

The Gini coefficient has been used in archaeology, which is not surprising given its ubiquity in economics. The advantage of the Gini coefficient is that it simply summarizes the total deviation from equality. But its simplicity and generality may obscure the pattern or structure of that deviation. Therefore, the same Gini coefficient can be derived from substantially different distributions of wealth. For this reason, detailed investigation of inequality usually requires multiple methods.

Anthropologists have used the Gini coefficient to study inequality in different types of societies, with interesting results. Among a sample of hunter-gatherer societies, the distribution of material wealth yields modest Gini coefficients, ranging from less than 10 to above 40, with a mean of 25 (Smith et al. 2010). These relatively low values imply a relatively equitable distribution of wealth. Horticulturalists have a similar range, with Gini coefficients running from near 0 to about 60, with a mean of 26.5 (Gurven et al. 2010). In contrast, both pastoralists and agriculturalists have markedly higher Gini coefficients. For pastoralists, the figures run from 20 to 69 (the mean is 42), a range almost identical to that of modern nations (Borgerhoff Mulder et al. 2010). The inequality in material wealth of a sample of agricultural societies produces the highest Gini coefficients, which vary from 45 to 70.8 with a mean of 57 (Shenk et al. 2010). Economic historians have also reported Gini coefficients for a number of societies around the world, from China to Latin America (Milanovic et al. 2007). The range of coefficients and their means are strikingly close to their modern analogs.

Several archaeologists have also employed Gini coefficients to summarize wealth distributions inferred from archaeological data. Randall McGuire (1983; estimates amended in

McGuire 2001) calculated Gini coefficients using structure sizes as a proxy for Paquime (Casas Grandes) and several Hohokam sites. He found a range of values that span most of the modern spectrum and discussed how they changed over time. He has also used the Gini index to estimate inequality in grave lots (McGuire 2001). Morris (1987:141-143) also used grave lots to estimate inequality using the Gini coefficient, in his case for pre-Classic Greek interments from Athens. Schulting (1995) has used the Gini coefficient to examine inequality in house sizes, and by implication wealth or status, from several sites in the interior of British Columbia. Ames (2008) has discussed the use of the Gini index in archaeology to study social ranking and stratification.

In sum, economists and anthropologists have used these measures to study and evaluate inequality in a variety of (mostly) contemporary societies, while archaeologists have employed both house sizes and burial furniture as proxies to measure inequality.

Measuring the Distribution of Wealth at Maya Sites

In archaeology, we often try to measure or evaluate social phenomena that are difficult to detect directly. Fortunately, wealth is different. Three sources of data—residential architecture, household goods, and burial practices—are commonly used by archaeologists to study wealth and stratification. In this chapter, we consider the size of residential architecture as a proxy variable for wealth because architecture "is probably the strongest and most consistent expression of wealth levels in agrarian states... Such societies exhibit a great range of variation in the size and quality of housing, and these factors related directly to the level of a household's access to goods and services..." (Smith 1987:301). We chose residential architecture as a measure of wealth because houses are common. We can estimate the sizes of many houses because we have extensive and accurate maps of Maya sites. In contrast, we have reliable samples of household artifacts for only the tiny proportion of households that have been excavated. Excavated burials also form a much smaller and biased data set. Thus, house sizes comprise the best set of data for studying the distribution of wealth. Ideally, we would develop a careful estimate of the labor investment represented by each residential building (Abrams 1994), but that would be difficult because of a lack of existing data, and so instead we have collected data on house sizes from published maps and tables.

We evaluate the distributions of house sizes for three Maya sites: Mayapan, Palenque, and Sayil. We expected that we would find: (1) that Mayapan was poorer than Palenque and Sayil; and (2) that the distribution of wealth at Mayapan was more unequal than at the other sites. The second expectation may seem contradictory, but there often is a correlation between absolute poverty and the unequal distribution of wealth. In the modern world, countries with high Gini indices (e.g., Namibia, Botswana, Haiti, Angola, Columbia, and Bolivia) also exhibit extreme, chronic, and institutionalized poverty (Central Intelligence Agency 2011; United Nations Development Programme 2009).

Mayapan

There are more than 4,000 structures within the great wall at Mayapan. Most are residential in function. We know this because the archaeologists of the Carnegie Institution of Washington identified and defined the "Mayapan house type" (Ruppert and Smith 1952, 1957; Smith 1962:217), and noted that it resembled in detail the typical house described by Landa (Tozzer 1941:180). The dwellings are rectangular, wider than they are deep, and usually rest upon a platform or substructure (Figure 12.2). In the wide, open front of the house are two or more low benches with one or more passages leading between them to the back room of the house. The long, narrow back room usually runs the full width of the building, although in some cases there is evidence of a transverse wall subdividing the room into two segments. Occasionally, the back room is a bit lower than the front room, requiring a step down into what Landa said were sleeping quarters (Tozzer 1941: 85-86). Sometimes small altars were constructed against the back wall of the rear room on the central axis of the building. There is much variation in the floor plans of dwellings, but many conform in detail to these specifications. At Mayapan, the functions of dwellings are securely supported by direct ethnohistorical evidence (Smith 1962:217). The ascription of residential function to these buildings can, therefore, be made with a level of confidence unmatched at many Classic-period sites, where "the principle of abundance" (Thompson 1892) and the presence of grinding stones and utilitarian ceramics are often used to infer structure function.

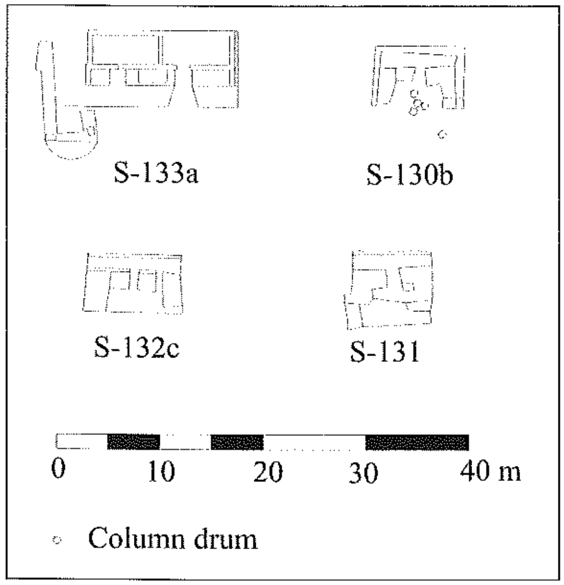

Figure 12.2. "Mayapan House Type."

We selected a random sample of residences from the map of Mayapan and measured their areas. New field measurements might have been preferable, but recent field projects have generally found the Carnegie map to be quite accurate and complete (Brown 1999). Karl Ruppert and A. Ledyard Smith apparently made scale drawings of nearly all the structures on the Carnegie map (Smith 1962:172), but these drawings, which would be of great value, have been lost. To take the random sample, we first tabulated all of the structure numbers. We found a few structures on the map that were not numbered, and we numbered them ourselves using the Carnegie system. We used a random number generator to select our sample, and then we measured the areas of the structures using calipers on an original copy of the map. Finally, we excluded structures that did not appear to be residential. Among these are buildings that are considered to be temples, altars, *oratorios*, kitchens, terraces, and other special constructions. We also excluded structures measuring less than 20 square meters in area as non-residential. This size has been proposed as part of the definition of the "minimum residential unit" in the

Maya lowlands (Ashmore 1981:47), and its applicability to the residential architecture of Mayapan seems clear. The remaining 1,214 structures in our sample all appear to be residential.

Palenque

We wished to compare the distribution of wealth at Mayapan to that from a Classic-period site, and we chose Palenque, Chiapas, because of the availability of Edwin Barnhart's (2001) superb map and accompanying data (Figure 12.3). We extracted the dimensions of all the structures listed in Appendix A of that work, and then excluded those structures that appeared to be non-residential by taking into account his descriptions and comments in the text and their appearance on the map. Because the structures at Palenque often lack obvious surface features, such as the walls, benches, and columns that are so common at Mayapan, it was often difficult to distinguish residences from other types of buildings. The lack of surface features is probably partly attributable to the high rate of colluviation at the site, which has partially buried many of the structures. Again, we excluded structures smaller than 20 square meters in area from consideration. Our final sample consists of 1,135 structures.

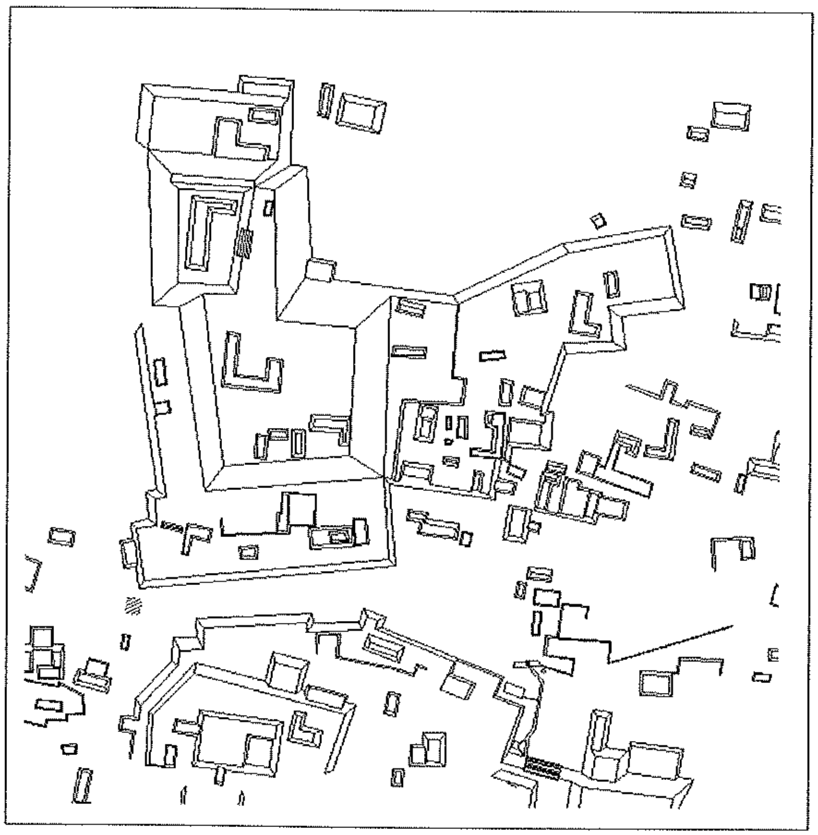

Figure 12.3. Detail of map of Palenque (Barnhart 2001).

Sayil

Sayil is a major Puuc site in the hill country of southern Yucatan that dates to the Late and Terminal Classic periods. The site was partially mapped by Jeremy Sabloff and Gair Tourtellot (1991). To obtain our data on residence sizes, we used their map and the electronic database included on the disc distributed with the publication (Figure 12.4). We reviewed the data, which includes the inferred function of the mapped structures. As at the other sites, we excluded structures smaller than 20 square meters in area. Our sample size for Sayil is 767 domestic structures.

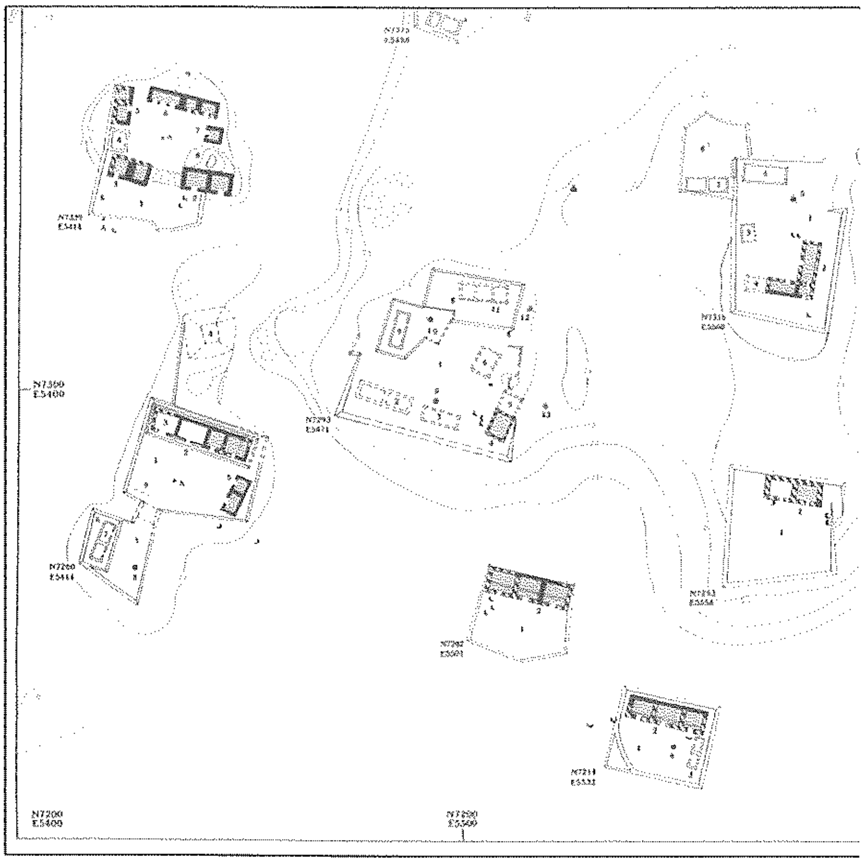

Figure 12.4. Detail of the Demetrio sheet of the map of Sayil (Sabloff and Tourtellot 1991).

Results

For each of our three data sets we: (1) calculated descriptive statistics; (2) studied the functional form of the distribution, paying particular attention to its right tail; (3) calculated the characteristic parameter of the distribution; and (4) calculated the Gini coefficient. We review the results below.

Mayapan

The distribution of residential structure sizes at Mayapan clearly shows a power-law or Pareto distribution. On a double logarithmic plot, a power-law is a straight line (Figure 12.5a). The exponent of the power law, which is the essential parameter of the distribution, is 3.02. The Gini coefficient is approximately 32, which is modest and indicates a rather low level of inequality in the distribution of wealth. This value is comparable to those of the European Union and some underdeveloped nations such as Mongolia (Central Intelligence Agency 2011). Descriptive statistics for the Mayapan sample are shown in Table 12.1. The median house size of about 48 square meters is close to Jones' (1952) estimate of the average size of the houses at Mayapan, (50 square meters), and it is even closer to the mean size (46.7 square-meters) of the 40 houses mapped by Brown (1999:131). The range (573) is, as we will see, modest compared to that at the other sites. The skew is high, as is expected for this kind of distribution.

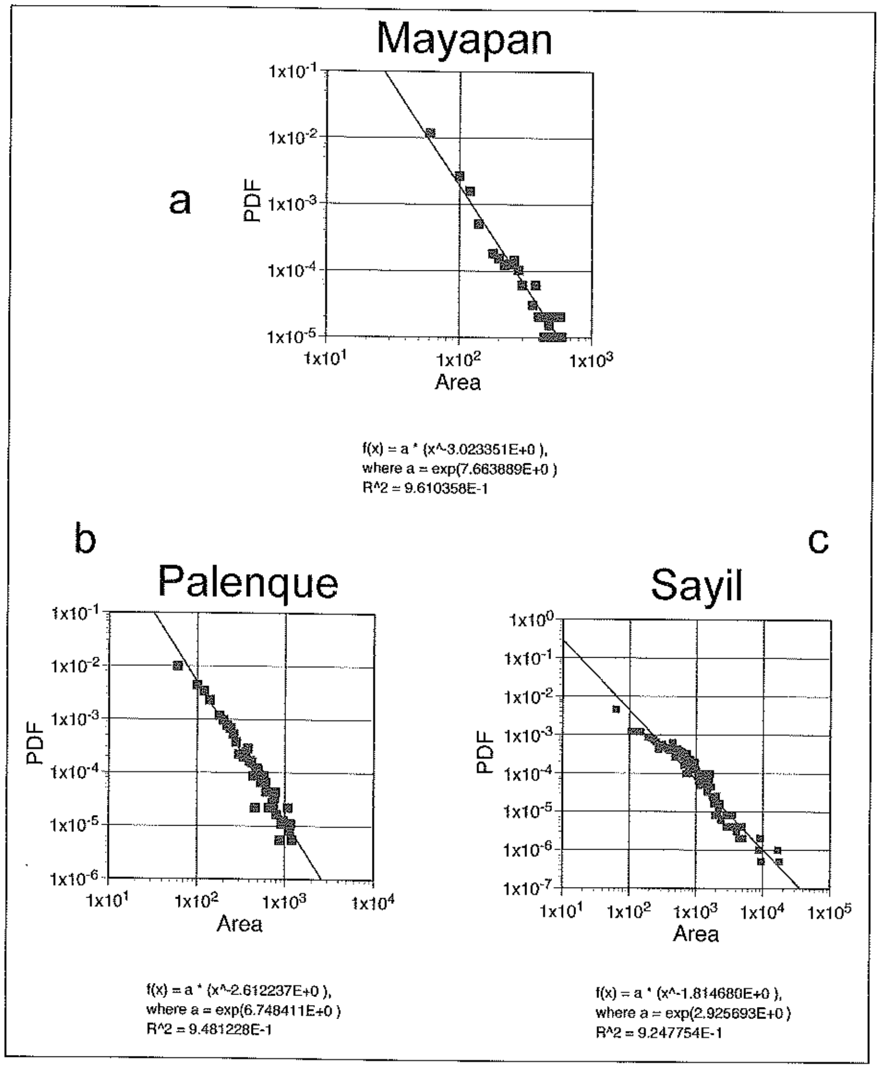

Figure 12.5. Pareto distribution of house sizes at: (a) Mayapan; (b) Palenque; and (c) Sayil.

Palenque

The Palenque data reveal a distribution similar in functional form to that of Mayapan and modern examples (Figure 12.5b). The distribution is a power law with an exponent of approximately 2.61. The Gini coefficient for this data set is approximately 44, which indicates greater inequality than we saw at Mayapan and on par with the United States in 2007 (Central Intelligence Agency 2011). The descriptive statistics for the Palenque house sizes are summarized in Table 12.1. The median house size, 70 square-meters, is much larger than at Mayapan by almost 47 percent. The range at Palenque is also larger, by 93 percent, all of which represents an increase in the top brackets because in both cases the lower end of the distribution began at 20 square-meters.

Table 12.1. Descriptive statistics for houses at Mayapan, Palenque, and Sayil.

House Area (m^2)	*Mayapan*	*Palenque*	*Sayil*
Mean	57	104	291
Standard Error	1	3	28
Median	48	70	65
Mode	38	60	20
Standard Deviation	45	113	777
Sample Variance	2030	12850	604305
Kurtosis	40	22	207
Skew	5.0	4.0	12.1
Range	573	1108	15377
Minimum	20	20	20
Maximum	593	1128	15397
Sum	69070	118090	223234
Count	1214	1135	767

Sayil

As at the other two sites, the distribution of house sizes, and presumably wealth, is a power-law (Figure 12.5c). In this case, the exponent is 1.81, lower than either Mayapan or Palenque. The Gini coefficient for the same data set is 71, much higher than at either of the other sites and comparable in the modern world only with Namibia (Central Intelligence Agency 2011). The descriptive statistics are presented in Table 12.1. At Sayil, the median house size is 65 square meters, slightly lower than at Palenque and significantly higher than at Mayapan. The range in sizes is far greater than even at Palenque, exceeding that of Mayapan by an order of magnitude.

Distribution of Wealth and Poverty at Mayapan, Palenque, and Sayil

First and most fundamentally, it is very interesting that the house sizes at all three sites are distributed approximately as power laws. If we use these dwelling sizes as a proxy for wealth, then all the sites exhibit distributions of wealth that are mathematically similar to those from modern societies; that is, they are modeled by the Pareto distribution. The exponents of the power laws decrease dramatically from Mayapan to Palenque to Sayil, indicating progressively greater inequality The Gini coefficients are in agreement with the power law exponents. The coefficients indicate that the distribution of wealth was more equal at Mayapan, less so at Palenque, and extremely unequal at Sayil. Nevertheless, Mayapan was clearly the poorest site. The descriptive statistics show that houses at Mayapan were smaller with a much lower median area. The difference is statistically significant. Comparing the house sizes at Mayapan and Palenque using a Mann-Whitney U test yields a probability value that is extremely small, meaning that the difference between medians of the two data sets is highly significant and not due to chance alone. In addition, given the more expedient masonry, lower substructure platforms, and other architectural features, the Mayapan houses probably represent a lower investment of labor per square meter than those at Palenque. The same is true when comparing the Mayapan houses to those at Sayil. Therefore, we conclude that poverty was more severe at Mayapan, which helps explain the expedient nature of the material culture there.

It is reasonable to ask if factors other than wealth might account for the differing house sizes at these sites. They are, after all, found in different environments. Mayapan is a fortress city whose battlements look out on a hot, dry plain. Palenque occupies a narrow mountain shelf that overlooks the alluvial plains of Tabasco in one of the wettest parts of the Maya lowlands. Sayil fills the center of a valley in the low karst hills of the Puuc region, an area much drier than Palenque but a little wetter than Mayapan. The architecture, engineering, and masonry of the buildings at all three sites also differ, but those differences do not seem to correlate well with environmental or topographical variables. For example, settlement within the great wall at Mayapan is much denser than at most Classic-period sites, but in fact the area within the wall is not filled. The northern half of the site and especially the northeast corner are sparsely settled. It therefore seems unlikely that lack of space within the defenses drove people to build smaller houses.

Mayapan, with its Mediterranean climate, is friendly to outdoor activities. Palenque, in contrast, with all its rain, may have demanded more roofed area in households. Roofing, whether vaulted or thatched, is expensive, and the houses of Palenque *should be* smaller in area as a result. They are also densely packed, filling the mountain bench where the site is located. Nevertheless, the median house size at Palenque is the largest of all three sites. Sayil, although circumscribed by hills, does not fill its valley. It seems unlikely that house sizes there were inhibited by the topography or climate. Therefore, we believe that the variation in house sizes that we have documented is attributable primarily to economic and cultural forces, rather than to differences in geography and weather patterns.

Conclusion

The discovery of Pareto distributions of wealth at ancient Maya cities is significant. The Pareto distributions are important because they share a generic form, a particular type of mathematical function called a power law, which describes a surprising number of phenomena. Pareto distributions of wealth have been documented in modern nations around the world for over a century, in ancient Egypt (Abul-Magd 2002), and now in both Classic and Postclassic Maya cities. Although their changing parameters are historically interesting in the Maya case, what is arguably more important is their widespread presence in remarkably different societies. The economies of these diverse societies could not possibly be very similar. Therefore, the distribution of wealth has a certain general pattern despite significant differences in underlying economic systems. In physics, categories of dynamic systems that exhibit generic behavior despite differences in their details are called "universality classes," and their universality is often described by power-law relations (Kadanoff 1971; see Deift [2007] for a broader definition). The most plausible explanation for the existence of Pareto distributions of wealth in ancient Maya society is that the dynamics of the economies of complex societies must share certain fundamental properties despite their many differences.

The fact that ancient and modern economies share important characteristics does not mean that the formalist, neoclassical model of economics is true and that the substantivists are wrong. It says nothing, for example, about the ubiquity of rational or maximizing economic behavior. In fact, take it to be self-evident that each economy is embedded in its culture. But this does not mean that specific kinds of economies cannot share significant traits. As Stuart Plattner remarked, "*All* generalizations across different societies cannot be invalid" (1989:13, emphasis in original). Our finding is only one of a number of structural similarities that have been detected between ancient state economies and modern capitalist ones. These discoveries do, however, contradict the primitivist belief that ancient economies are categorically and inevitably different from modern ones (Smith 2004:74-76). Our task now is to identify the specific dynamic processes of economies that generate Pareto distributions of wealth in ancient societies. This will be more difficult than it may sound because economists do not agree on the causes of Pareto distributions.

In recent years, econophysicists have explained Pareto distributions of wealth primarily in terms of exchange processes (e.g., Bagrow et al. 2008; Ispolatov et al. 1998), although factors such as inheritance are also relevant (Smith et al. 2010; Stiglitz 1969). One of the best-known dynamic models is Bouchaud and Mézard's (2000) model of wealth condensation, which predicts that exchange tends to reduce inequality. An agent-based archaeological version of this model has been elaborated by Bentley et al. (2005), who found the same effect. Initially trade produces extreme inequalities in wealth in the form of a power-law distribution, but beyond a certain threshold, further increases in trade tend to reduce inequality. The pattern documented in the present study matches that evolutionary pattern. The intensive trade of the Late Postclassic period may have induced greater equality at Mayapan than that seen at the earlier Classic-period sites.

A different theory for the development of Pareto distributions of wealth has been proffered by Manus Midlarsky, a well-known political scientist. In his book *The Evolution of Inequality* (1999), he argues that the scarcity of land in agricultural societies can lead, by several mechanisms, to a Pareto distribution of wealth. This argument is relevant to our case because Midlarsky (1999:49) asserts that: (1) growing populations increase the scarcity of a finite resource such as land, thus creating greater inequality; and (2) population loss can have an ameliorating effect on inequality. This was the case in the Maya lowlands. Numerous archaeological surveys (e.g., Culbert and Rice 1990) have shown that during the Late Classic period, populations—including those in rural areas—reached peak densities that were surprisingly high and probably unsustainable. The succeeding catastrophic decline in population is called the "Classic Maya Collapse."

In the Puuc region, where Sayil is located, maximum population density was reached during the Terminal Classic period (Dunning 1992). In the Mayapan region of central Yucatan, we have surprisingly few data concerning the distribution of Late Postclassic population outside of the city itself. What information we have, however, indicates that people were scattered in small, nucleated rural settlements, and that the total population was much less and lower in density than during the Late Classic period (Brown et al. 2006). In fact, we argue that population density in the Mayapan region was much lower during the Late Postclassic period than in the Puuc during the Terminal Classic period or in the Palenque region during the Late Classic period. According to Midlarksy's scenario, the decline in population during the Postclassic period could account for the greater equality seen at Mayapan than at earlier Classic-period Palenque and Sayil.

The research reported in this chapter can be expanded. The distribution of wealth at other sites can be explored. The use of labor investment for the construction of houses would be an improvement over the use of house size. It is not difficult to estimate labor investment, but collecting the necessary data in the field would itself be labor intensive. One could also use household goods and grave lots to produce an alternative estimate of wealth. We are particularly interested in the evolution of the Pareto distribution of wealth from a different kind of distribution that seems to have reigned in earlier societies, a change that seems to be associated with the transition to state-level society. More generally, we advocate the use of approaches derived from econophysics and complex systems. We find them fruitful, as we hope our chapter illustrates.

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