Figure 15.1 Reconstruction of population of the central Maya lowlands.

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Archaeology in the Maya Lowlands

Robert S. Santley

Mayanists have always been interested in population history. Maya sites, for example, were once thought to be vacant except during short, sharp episodes of occupation (e.g., 1951, 1964). This perception of Maya society had great impact on reconstructions of settlement patterns and land use, which were seen as being egalitarian, with positions of leadership and power based on descent and not on landholdings. This was viewed as being egalitarian, with positions of leadership and power based on descent and not on landholdings.
growth and decay with different demographic structures and different theoretical implications. Current methods used to reconstruct lowland Maya population history, a comparison of the methods Mayanists use with those employed in highland Mexico, and a look at the road ahead.

Like Mayanists, historical demographers have also been concerned with defining long-term population trends. Most of this research, however, has been conducted using census data from urban centers, not from rural areas where farming was the principal means of livelihood. It is precisely here where Maya archaeology has great potential to make a meaningful contribution to our knowledge about long-term patterning in regional and site demography.

**Models of Population Growth and Loss**

All populations exhibit a particular demographic structure. This structure may be described in terms of the proportion of the population in different age groups and the sex ratio of each. By and large, growing populations are bottom-heavy, with significant numbers of infants and children, a substantial proportion of whom reach reproductive age. A shrinking population, in contrast, is one in which the number of adults exceeds the number of infants who survive to reproductive age, whereas in stable populations there is a balance between the number of adults removed from the reproductive pool and the frequency of new entries into it. Although stable and shrinking populations may be bottom-heavy, younger cohorts need not constitute the majority. Demographers generally explain population change by means of the relative contributions of birth, death, and migration rates. Fertility and mortality patterns have great impact on the number of new individuals born into a population, the proportion of newborns who attain reproductive age, and the number of offspring a mating pair may have. This information, when combined with knowledge about rates of migration, provides a framework for dealing with changes in demographic structure.

The demographic history of populations varies greatly across space and through time (C. Cowgill 1975a; Hassan 1979; Spooner 1972). In some areas periods of growth are followed first by periods of population decline and then by another growth spurt, often to a higher level (S. Cook 1972; Feinman et al. 1985), whereas in other areas episodes of rapid and sustained increase precede long periods of population stability or near-zero growth (Clarkson 1971; Sanders et al. 1979; Santley and Rose 1979). In still other areas the pattern is one of growth followed by steady population decline over millennia (R. M. Adams 1981; Ammerman et al. 1976; Hollingsworth 1969).

The two simplest forms of population increase are exponential growth and logistic growth (Wilson and Bossert 1971; Whitaker 1975). Under conditions of exponential growth, the rate of reproduction per individual remains more or less constant. Populations undergoing exponential growth therefore reproduce at a uniform rate. Most populations exhibit exponential growth profiles only under special circumstances and only for comparatively short periods of time. Although the number of additional persons is not great when population size is small, any human population allowed to grow at its full exponential rate would become exceedingly large in only a few thousand years. Thus, as populations expand to their limit or carrying capacity (K), compensating factors come into play, curbing growth and sometimes bringing declines in numbers.

Logistic growth is common as populations undergoing unchecked growth approach their carrying capacity. Because population growth increases in rate early in the sequence but is always checked sooner or later, the growth curve is sigmoid in shape. Logistic growth curves may be divided into three phases. During the early phase population is little affected by external constraints and grows at a maximum rate. Phase-one logistic growth often occurs when species discover new habitats, which are subsequently colonized. In the middle phase environmental factors begin to slow growth by decreasing the birth rate, increasing the mortality rate, or both, such that growth involves the addition of a standard number of individuals per unit of time (e.g., 2000 persons/1000 years). In the third phase population approaches and finally stabilizes at carrying capacity. Often as well, populations overshoot carrying capacity and then stabilize. Sometimes there is an initial overshoot, after which the population drops back and increases again, with oscillations of increasing amplitude until stabilization is achieved at carrying capacity. In other situations the overshoot is followed by fluctuations of constant amplitude, and in others the pattern is one of boom and bust cycles, with each overshoot followed by a crash and population returning to phase-one levels before further growth occurs.

Human populations differ from other biological organisms in their ability to alter food-procurement systems and hence increase the carrying capacity level (Bossert 1965; Sanders and Webster 1978; B. Turner et al. 1977). Although human populations frequently approach carrying capacity and experience declines in numbers due to crop disasters, poor nutrition, and increased disease burden, they may rebound in a few hundred years and reach even higher levels because of improvements in agricultural technology. The resulting "sawtooth" pattern consists of a series of logistic growth spurts interdigitated with periods of exponential decline (Whiteaker 1975). The demographic history of China is a case in point (Figure 16.1A). Interestingly, cycle amplitude decreases with time while cycle frequency increases, particularly in the past 500 years, implying that.
perturbations in later Chinese history were more frequent but had less severe demographic consequences (S. Cook 1972). The demographic history of Egypt is much the same; however, long-term cycles of growth also subsume shorter-term cycles of growth and decline brought about by repeated military conquest and later epidemics (Figure 16.1A) (Hollingworth 1968). Moreover, changes in the slope of both curves, when graphed logarithmically, indicate long-term shifts in rates of growth and depopulation and by implication fluctuations in fertility and mortality rates.

The demographic history of central Mexico illustrates this pattern of cyclic growth and decay (Figure 16.1B). In the Basin of Mexico, populations generally reached peak levels whenever the region was unified under a single political authority (Sanders et al. 1979). Episodes of growth also associate with developments in agricultural technology: floodwater and diversion-flow irrigation in the Terminal Formative; canal irrigation in Classic times; and drainage or chinampa agriculture in the Aztec Period. Rates of population growth, however, were the greatest very early in the sequence, and the population history varies from subregion to subregion, indicating a migration process was perhaps in operation (Sankey and Rose 1979). Local perturbations also had an impact; ethnohistoric sources suggest that several years of widespread famine preceded the demise of the Toltec Empire, and settlement data imply that the Xitle eruption at the end of the Terminal Formative had much the same effect (Davies 1980; Sanders et al. 1979). Cyclic growth and decline also characterize the demographic history of the Valley of Oaxaca (Blanton et al. 1982; Feinman et al. 1985). Except for the Conquest Period, when the valley was split into a number of competing polities, population maxima again associate with periods of political unification and changes in land-use practices. Like the Basin of Mexico, the Valley of Oaxaca has a generally up-trending population curve, with peak levels attained at the time of the Conquest.

The population history of the Maya lowlands is more variable (Figure 16.2A). Areas such as Puucrrouer Swamp and the Belize River Valley show the sawtooth pattern. A period of growth is followed by a population maximum, then decline, and finally subsequent growth to higher levels. The Late Classic collapse also appears to be more attenuated, though Belize does lose population. The pattern in the Tikal, Calakmul, and Rio Bec regions is entirely different (Figure 16.2B). Here growth is moderate but sustained until the Late Classic, after which population levels crash with only limited demographic recovery later on. Although the timing of the collapse and the ensuing episode of demographic loss varies somewhat from site to site, the pattern at most centers is much the same. Growth during the Formative Period conforms to the exponential model, not the logistic model. An exponential curve also describes the collapse, suggesting a mirror-image pattern of population growth and decay. Although the degree of fit with the exponential model is reasonably good, growth rates do vary with time (Figure 16.3). In general, crude growth rates remained relatively stable in the Preclassic but then increased dramatically, reaching a peak in the early Late Classic. Thereafter growth rates rapidly tapered off, and subsequently population levels declined, implying an overshoot phenomenon.

The growth curve for the south-central lowlands is fairly typical of population colonizing new or comparatively unsettled areas. In such settings communities are widely spaced, and the abundance of arable land permitted village fissioning. What is unusual is the dramatic increase in rates of growth in the early Late Classic, especially considering the magnitude of the populations involved. The use of major projects is not the only contributory factor here. Production levels on raised fields are two to four times the yields on dryland plots, and if cropping regimes were polycultural early in the history of late utilization, then raised-field plots would have provided Maya farmers with a mix of resources rich in more nutrients, thereby alleviating stress and reducing mortality. However, as population levels increased further still, monocultural cropping strategies would have become the norm, reducing population nutritional status and enhancing susceptibility to disease. In response to increased mortality and morbidity, Maya populations would have had greater difficulty raising children to reproductive age. If this line of reasoning is followed, population levels near the end of the Late Classic should have fluctuated widely, which would have had dramatic repercussions on the viability of the agrarian support base, dependent as it was on the application of vast amounts of labor to keep the system going. Demographic instability, then, may have sent Maya economies into a power dive, with long-term degradation of the agricultural landscape fueled by increased mortality and ultimately emigration being the result.

Skeletal data from several lowland sites do indicate marked changes in the paleodemographic status of Maya populations through time. Although information on the status of Preclassic populations is still forthcoming, it appears that stress levels increased dramatically in Classic times. At Tikal there was a marked reduction in nonelite adult male stature during the Late Classic (Havliland 1967) in comparison to earlier time periods, a pattern that also occurs at Altar de Sacrificios (Saul 1973), Barton Ramie (Willey et al. 1965), and perhaps Copan (Longyear 1952). At Tikal mortality was particularly high for infants and females entering childbearing age (Havliland 1972a), which also seems to have been the case at Copan in the Late Classic (Sanders, personal communication 1985). At Altar de Sacrificios (Saul 1973) and Copan (Storey, personal communication 1985) the incidence of porotic hyperostosis also increased markedly in Late Classic times. Porotic hyperostosis, most authorities now agree, occurs in populations suffering from chronic anemias that are often caused by inadequate.
amounts of iron intake, although prolonged breastfeeding, diarrheal infections, and parasitic disease infestations due to population aggregation may also have played a role (Gent 1986; Walker 1985). Moreover, iron and zinc deficiencies should have become more severe if the diet became increasingly maize-dependent as population levels rose throughout the Classic (Santley et al. 1986). In addition, the incidence of linear dental enamel hypoplasia is fairly high for all time periods at Altar and Seibal, indicating that short-term developmental arrests from disease and/or inadequate nutrition were also a common problem (Saul 1975).

Some Maya growth curves are therefore exponential-like, whereas others illustrate a pattern of cyclic growth and decay. The sawtooth pattern characterizes growth profiles in areas where raised-field agriculture was practiced or Maya populations had access to riverine habitats. Exponential-like profiles, in contrast, occur in areas that are landlocked and where agriculture involved a substantial dryland component. Paleodemographic data from certain sites in landlocked areas indicate declines in health and nutritional status in the Late Classic, suggesting that interrelationships among demographic status, nutrition and disease, and preventing modes of land use may be the key to explaining variability in population histories. The abandonment of the south-central lowlands in Terminal Classic times appears to be related to both increased mortality and emigration to neighboring areas, which may have been brought about by degradation of the agricultural landscape.

**Methods of Population Estimation in the Maya Region**

Archaeologists reconstruct the population history of a site or region by devising methods to measure properties of the archaeological record said to be responsive to the number of occupants. All the chapters in this volume deal with archaeodemography, the systematic study of estimating the number of people who lived in a structure, at a site, or in a region at one or more points in time in the past. The method Maya archaeodemographers employ to estimate past population size has three steps. First, time is compartmentalized into a series of discrete phases encompassing several hundred years of occupation, generally based on qualitative or quantitative changes in ceramics. Counts are then obtained for elements of the archaeological record assumed to be demographically sensitive, such as room number, platform size, or density of remains. These figures are subsequently multiplied by some estimate of modal population per entity or area per site to compute phase-specific population estimates. This operation is repeated for all phases represented in the sequence to produce a reconstruction of site or regional demographic history.

This method has some obvious shortcomings. One problem is the number of occupants per room, structure, or platform and the number of such features per unit area. Although much research relies heavily on a figure of 3.6 persons/residence, derived from ethnohistoric documents, studies in this volume demonstrate considerable variability, depending on the case example and the archaeologist’s use of the documentary record, with the modal estimate per house often being much higher (Tingle and co-authors: this volume, MacNeish: this volume). Another problem is the number of mounds that physically function as habitation structures. Work at Copan (Webster and Freter: this volume), Sayil (McAnany: this volume), and in the Peten (Ford 1986) implies that a much lower frequency of mounds were habitation structures than previously expected. This research suggests that at least 40 to 50% of all structures had functions other than residence and that population estimates based purely on house-mound counts ought to be decreased accordingly.

An even more serious problem is the distorting effect that differential phase duration has on the quality of archaeological remains produced (Culbert 1988; Culbert et al., this volume). Basically, it is argued that the longer a site is occupied, the greater the number of house mounds or platforms there will be, especially in areas such as the Maya lowlands, where settlement patterns are dispersed and there is sufficient room to move residential structures as conditions dictate. According to Culbert (1988), a better way to compare phases of dramatically different length is to adjust the counts to a standard unit of time, for example, 100 years. Length of mound occupancy, then, is assumed to be constant from one phase to the next. Only unobtrusive house mounds and small platforms are standardized in this fashion, since larger structures show multiple renovations and a labor investment that indicates occupancy for longer periods of time. The effects of this adjustment on phase-specific house-mound counts are sometimes enormous (cf. Willey 1977 and Culbert 1988).

The work of Culbert et al. (this volume) raises an even more significant point: that of the episodic contemporaneity of remains, an issue also considered by other authors in this volume without much consensus other than to assume occupancy duration as a constant. For most archaeologists, contemporaneity refers to the occurrence of objects and elements. Materials found together in the archaeological record are used as a basis for making statements about properties of past systems. Archaeological context, however, is not the same as systemic context, which (following Schiffer (1972, 1976)) can produce serious errors in the magnitude of the population estimates so derived. A closer examination of the procedures Mesoamericanists employ and the assumptions commonly made illustrates how such a situation can come about.

As we have seen, population estimation in the Maya region involves the use of the three-step procedure described above. This method assumes
that the number of entities in the universe under study is complete or that an adequate or representative sample of those entities has been obtained, a requirement that has been brought into question by recent work at Nohmul (Pyburn, this volume) and Pulltress Swamp. The net effect of this “invisible universe,” as Harrison (personal communication 1987) terms it, is to increase the number of structures expected. It seems clear that the population estimates for Maya sites will most certainly also rise, an observation that dovetails nicely with the evidence for intensive land use.

More structures, unfortunately, do not always mean more population. Although there is a general positive relationship between structure density and population density, the relationship may exhibit different slopes and need not necessarily be linear in form. Many archaeologists working in Mesoamerica consider that sites with residential architecture (house mounds) and associated features such as hearths, storage pits, and refuse dumps were sedentary communities occupied on a year-round basis, often throughout all of the seasons in question or throughout a constant fraction of it. Mayanists making this assumption ignore the fact that the mobility structure of human groups has obvious implications not only for the number of sites formed but also for the scale of the population estimates derived. Empirical studies have made clear that mobility is a property of human behavior on all levels of sociocultural integration. Two kinds of mobility options are important in this regard: site reoccupation and site reuse.

Reoccupation refers to the redundant use of space without spatial congruence in the location of residential sites (Brooks and Yellen 1987). Particular localities are frequently used for different purposes at different times, a pattern of differential serial use that should be reflected in the character of the assemblages of artifacts and features left at Maya sites and their spatial patterning. Reuse, on the other hand, occurs in situations “in which space is organized and used in a pattern which is spatially congruent with previous occupations of the same space” (Brooks and Yellen 1987:69). Often the pattern of reuse involves mobility systems that are residually constrained or entrenched (M. Graham and Roberts 1986). Entrenched mobility is found in settlement systems in which residential moves are scheduled from point to point over a restricted land area during a seasonal round, with this pattern being repeated year after year (M. Graham 1986). Entrenchment may also take place in longer cycles, with localities occupied as residential sites for a generation or two and then abandoned for a decade or so. Populations return to residential sites because they have invested in facilities and technology left at that site in anticipation of future use.

Prevailing archaeological opinion holds that Classic Period Maya settlement patterns were dispersed, with land-use strategies involving the application of vast amounts of labor to maintain the food-production system, which apparently required that peasants live near agricultural holdings (Ashmore, ed., 1981). Dispersed occupation, however, is not the only settlement-subsistence arrangement in the humid tropics, nor is agriculture the only variable that determines settlement patterns. Residentially entrenched settlement patterns typically occur when there are incoherences in the factors determining residence. Different variables exerting effects on the farmer’s behavior at different times and in different places require that he maintain structures at several locations. High-density zones in such systems would represent foci of settlement where elites, their immediate dependents, and craftworkers resided permanently but where farmers lived for only part of the year. Structures would also be erected near agricultural resources, would be used by the farmer and his family during the growing season or when agricultural activities were labor-intensive or required a large labor force, and then would be abandoned. Moreover, individual sites might be deserted on the death of the extended family head, a Postclassic Maya custom, or when insect infestations or other pests became particularly bothersome. Thus, it is quite conceivable that within an archaeological phase of 200 years a total of 10 to 15 structures might have been used and abandoned by the same consedical group. Conventional survey techniques might show all these structures as “house mounds.”

Work at Copan implies that some Maya settlement systems may have been organized in just this fashion (Webster and Freter, this volume). Rural settlement in the area around the main nucleus of occupation at Copan fits the pattern common in other parts of the southern lowlands: house mounds occur almost everywhere, although densities are the greatest on bottomlands along stream tracts and especially near the main ceremonial center. The excavation of a set of house-mound clusters in the vicinity of the main acropolis indicates that they were occupied by family groups of different ranks, all kinds of domestic refuse are present, as well as great numbers of burials. The assemblages associated with structures in rural settings look quite different. Here domestic refuse is much less abundant and burials are not present, implying a categorically different kind of occupation. According to Sanders (personal communication 1988), many of these structures may have only been seasonally occupied by male cultivators who maintained residences within a few kilometers of the main acropolis. Late Classic Maya settlement in the Copan Valley consequently may have a densely settled core, the urban center per se, surrounded by a large rural hinterland that was occupied on a much more impermanent basis. I am not suggesting that all Maya settlement systems were organized in this fashion, only that we do not know that they were not.

The grossly inflationary effects of entrenchment and reoccupation on Maya house-mound counts should be obvious. If habitation structures went through an occupation/abandonment cycle but were consistently...
reused at the end of each cycle, house-mound counts would have to be reduced by a factor of 90% to estimate the number of buildings simultaneously occupied by families. Total counts might have to be reduced by a factor of 75 to 90% if structure use-life was short (e.g., 25 years) but the reuse cycle was comparatively long (e.g., 100-125 years). Entrapment, with each coreidential group maintaining one or more field houses, would require a further 50 to 75% reduction to estimate the number of structures inhabited by families groups on a contemporaneous basis. Finer periodizations will not allow resolution of these problems, as most structure-occupation/abandonment cycles are probably well within the limits of the finest chronologies. Neither will the blanket application of a correction figure help us much, for the mobility requirements of a population are likely to change from one time period to the next if demographic growth occurs and subsistence strategies change.

Clearly, what is needed are investigations of the range of mobility options manifest in different systemic contexts, the conditions under which groups maintain or change their mobility strategies, the interrelationships between mobility patterns and agricultural land-use strategies, and the archaeological consequences of different mixes of mobility strategies in different settings, both urban and rural. Midrange research of this type has the potential of producing powerful methods for assigning meaning to the archaeological record. Only then can we have any confidence, even in a relative sense, in house-mound counts as a source of demographic information.

Methods of Population Estimation in Highland Mexico

Research on population history has a much longer history in highland Mesoamerica, particularly in the Basin of Mexico (Blanton 1972; Parsons 1971; Parsons et al. 1982; Sanders et al. 1979) and the Valley of Oaxaca (Blanton 1978; Blanton et al. 1982; Feinman et al. 1985). Much of this research has employed occupational density as a measure of the number of persons inhabiting sites. Archaeodemographers who use this method assume that the amount of refuse discarded at a settlement varies in direct relation to site population. Twice as many persons deposit twice as much garbage, and if population density is twice as high, the density of surface remains, mainly pottery, is likely to be twice as high also. Variation in occupational density, which can be empirically measured in the field, is thus assumed to be primarily a function of variation in the density of population. Multicomponent sites must be dealt with separately. Here, phase-specific densities must be compared and the absolute densities ad-

justed based on the frequency of materials from different periods. The area over which different occupation densities are distributed is then calculated and population estimates derived.

Use of this method requires some assumptions about past systemic contexts and the character of the archaeological record in each. First, all time periods from which the materials derive must be of equal duration so that phase length has little impact on the amount of refuse discarded. Second, the method assumes little change in the generic composition of the ceramic assemblage from one time period to the next. In addition, postdepositional processes should not obscure surface deposits, causing underestimation, and specialized activities such as craft production should have little effect on the amount of refuse discarded.

Finally, garbage disposal must involve discard near residences. Refuse disposal, however, varies greatly from one situation to another. In general, the lower the population density, the greater the likelihood that there will be vacant space available for trash midden near the residence and the greater the probability that locations of tool use and refuse discard will spatially coincide (J. Clark 1986; Hayden and Canyon 1986; Schiffer 1975, 1977). This seems to be the case on the Gulf Coast (Killion 1987; Santley et al. 1987) and in the Maya lowlands (Chamber, ed. 1981; McNamara 1986), two regions where a dispersed settlement pattern prevails. Where there should be little spatial congruity between location of use and location of discard are sites such as Tazumal, where structures were built directly adjacent to one another, with little intervening space (Gunnerson 1973; Niemczewski 1977). Consequently, until the interrelationships between type of occupation and refuse densities are worked out in more detail, it seems best to restrict application of this method to cases in which occupation is single-phase, short-term, and not deflated and there are independent archaeological and/or ethnohistoric controls on refuse disposal, specialized ceramic production, and population. In the Basin of Mexico these conditions are met only during the Late Aztec Period.

Roofed-over space is another variable that has been applied to measure population. Methods that use roofed-over space assume that changes in the size of a structure are primarily a function of variation in population size. The first study employing roofed-over space as an indicator of number of occupants was conducted by Naroll (1962), who concluded, after sampling largest settlements in 18 societies, that the population of a structure or site can be predicted as roughly one-tenth of the roofed-over space in square meters. Although this rule of thumb has been widely applied by archaeologists, subsequent research has demonstrated that it works best in egalitarian agricultural societies in which structures are occupied by single family units, where there is little intrahouse storage of goods and raw materials, and where most of the family's domestic activities occur.
outside the dwelling. In societies in which buildings are not divided into rooms but are occupied by multifamily units, the amount of roofed-over space averages about 6 m²/person (Cassellberry 1974), whereas in contexts where there is a substantial amount of storage within buildings, including the penning of domestic animals overnight, the amount of per capita floor space varies from 8 to more than 24 m², and the standard deviations between family units are large (LeBlanc 1971). Settlements containing structures that share partition walls (e.g., room blocks in Southwest pueblos) support even larger numbers of persons per unit area (Hill 1970; Longacre 1976).

Differences in household status present additional variability. Archaeologists have long recognized the fact that elites living in large masonry structures probably had more space per capita than peasants occupying pole-and-thatch huts, but mode of house construction may not always be a useful indicator of household status. For example, at Loma Torrecusa, a late Formative village in the Basin of Mexico, all houses were constructed of wattle and daub, with crushed tepetate floors (Sankey 1977). Although dwelling size averaged about 35 m², some structures were much larger, implying a greater number of occupants. Since disposal of the dead involved interment under house floors or in the adjacent patios and all house compounds were occupied for more or less the same length of time (ca. 100 years), differences in the number of burials present might be used as a relative indicator of differences in the average number of inhabitants. Interestingly, the number of burials found in different house compounds was about the same, but the average area of floored-over space varied considerably, which indicated that differences in structure size could be attributed to status differentials, a conclusion supported by other lines of evidence. Larger structure size was also linked to a series of specialized activities such as centralization of storage, group ritual, and obsidian working, which took place in different areas (rooms) within the house.

It should be apparent that the relationships among the variables affecting structure size and refuse density still remain largely undefined. We need to know how other independent variables—for example, household activity structure or family status—condition the amount of roofed-over space required. I am in no way suggesting that Mesoamericanists should not worry about archaeodemography, but I do believe that the methods that archaeodemographers currently have at their disposal do not always produce very robust results. This inadequacy requires that archaeologists, Mayanists included, engage in research aimed at understanding the relationships among population, subsistence, mobility, and economic structure, and the kinds of archaeological residues generated in different socioeconomic contexts under different density regimes. As the chapters in this volume illustrate, Mayanists are beginning to make some strides in these directions, but there is still much to do.

The Road Ahead

What should the road ahead look like? Two research directions show great promise.

First, there should be more research on paleodemography: the study of human skeletal remains as a tool for deriving inferences about prehistoric demographic structure and the factors that influence or condition that structure. Demographers commonly use vital rates of birth and death as measures of the quality of life in contemporary societies. To describe the structure of a human population, demographers construct a life table, an analytic model that generates summary population statistics such as life expectancy, survivorship, and mortality rates (Andrews and Neel 1970; Weiss 1973). Life tables may also be constructed using archaeological skeletal series, provided that burial patterns can be defined, members of both sexes and all age groups are represented, and the samples derive from short time periods (Angel 1971; Buikstra 1976; M. N. Cohen and Armelagos 1984; Sattenspiel and Harpending 1983; Uphaler 1974).

Paleodemographic methods work best in situations in which the deceased was buried under or around the residential structure. Then the paleodemography of different residential groups can be defined in some detail and estimates of the average number of persons who lived in the structure derived (Sanders et al. 1979; Sankey 1977). Population estimates for different residential groups cannot be computed using the life-table method of estimation in situations in which preservation or postcultural processes skew the sample and in which interment was in cemeteries, though in the latter case computations for sites might be obtained.

The skeletal remains can also supply useful information on paleoethnobotany and paleonutritional status, which have important implications for paleodemographic structure. The incidence and severity of paleopathologies such as transverse lines, dental hypoplasia, Wilson bands, dental attrition, and such lesions as porotic hyperostosis and metacarpal notching allow definition of the amount of nutritional stress experienced by infants, children, and adolescents (El Nahas et al. 1976; Martin et al. 1985; Steinbock 1976). In adults nutritional stress affects stature, the frequency of dental caries and periodontal disease, calcifications, bone texture and curvature, as well as other traits, which when taken together with those pathologies affecting younger cohorts, can provide a powerful explanatory framework accounting for variation in population structure and consequently group size (Buikstra and Ubelaker 1985; M. N. Cohen and Armelagos 1984; Rose et al. 1985).

Skeletal tissues also provide a record of general dietary history. Carbon isotope analysis can be used to establish various plant diets (Wing and Brown 1979). Photosynthesis in plants follows two main biochemical path-
cultural complexity. As a result, it is difficult to have any confidence in theories of state development employing population pressure as a causal agent, because there is no theoretical calculus specifying the conditions that select for complexity given agricultural intensification, the dynamic linkages between variables assigned explanatory import, and the form emergent complex systems take.

Where do we go from here? Two areas of inquiry deserve more attention before there will be much progress in theory-building. First, we have virtually no information on village subsistence organization. Most of the literature on subsistence economies in Mesoamerica consists of descriptions of techniques of land use (Kirch 1972; Sanders et al. 1979; Stedman 1940; Steggerda 1941). It is still unclear how farmers organize their subsistence behavior when they have access to different types of land, the array and proportion of different cultivars planted when different land-use strategies are applied, the kinds of storage procedures implemented by individual cultivators and more inclusive village groupings, and the conditions responsible for each. For example, some systems, like the Inca, emphasized the control of large corvee labor forces that cultivated state lands and worked in industries producing goods used for sustaining and enhancing elite power and for redistribution to the populace at large in times of need (Conrad 1981). Other systems, like the Aztec, were supported primarily by tribute in luxury and subsistence goods (Berdan 1982; Hassan 1985). These differences in elite and state power bases probably had major impact on systems economic organization. Research investigating the role of storage facilities at Maya sites is planned for the Puuc region (Tourtellot et al., this volume), but except for McNamn’s recent work at Sayil (this volume), Mayanists have yet to address this question adequately as well as define its implications.

Another potentially productive line of research concerns the organization of human groups in aggregated environments. Most recent work on the development of complex society has adopted a regional approach emphasizing articulations between communities, but largely unrecognized is a rather substantial literature that suggests that the social dynamics responsible for increasing complexity occur within communities. In other words, larger-scale sociopolitical (and presumably economic) complexity is an emergent property of permanent aggregation at one place (Barth 1978; Carneiro 1967; Rapoport 1976; Specht 1979). According to Leesson (1984), the population threshold for complexity within a single settlement is surprisingly low: about 2500 people, based on modern cross-cultural research. If the patterning detected by Leesson is indeed a genuine response to aggregation, then it is likely that other properties of complexity represent an ordered adjustment to living at particular settlements. More work at the community level should allow us to evaluate the degree to which increasing complexity is a function of changing modes of local ver-
sus intercommunity articulation. Specification of how households, local kin groups or cooperatives, and villages structure their subsistence organization should give us a better understanding of the interrelationships among mode of production, population distribution, and sociocultural complexity.

Figure 16.1 Demographic history of China, Egypt, and highland Mexico.
A. MAYA REGIONS

B. TIKAL CURVE FITTING

Figure 16.3 Crude growth rates for the south-central Maya lowlands.

Figure 16.2 Demographic history of various Maya sites.