MAPPING THE SOCIAL LANDSCAPE OF AN EARLY URBAN CENTER:

SOCIO-SPATIAL VARIATION IN TEOTIHUACAN

by

Ian Gordon Robertson

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has been approved

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APPROVED:

George L. Cowgill, Chair

Barbara L. Stark

Keith W. Kintigh BS

Supervisory Committee

ACCEPTED:

John K. Chance

Department Chair

Maria T. Allen

Dean, Graduate College

ABSTRACT

This investigation provides a diachronic analysis of socio-spatial structure in Teotihuacan, the capital of a regional state that dominated much of Central Mexico during the first half-millennium AD. Spatially patterned variability in socio-economic status is a crucial feature of the social landscape of cities. It emerges from long-term processes of past social action and in turn structures and conditions future social action. It is thus an important line of evidence for investigating temporal and spatial features of urban social life.

While archaeology has the potential to bring a uniquely long-term perspective to such studies, the difficulty of obtaining detailed and extensive archaeological data means that investigations of the internal organization of ancient cities are rare. This study draws on artifacts recovered during a full-coverage survey of Teotihuacan in the 1960s that recovered around 900,000 ceramic objects from some 5,000 tracts. Quantitative and spatial statistical methods using Geographical Information Systems (GIS) and other technology form the basis for parallel analyses of ceramic remains from the temporally consecutive Miccaotli and Tlamimilolpa phases. Evidence for wealth/status variability is assembled at three levels: individual collection tracts, encompassing neighbourhoods, and still-larger districts described as 'social areas.'

These investigations demonstrate that neighbourhoods at Teotihuacan were relatively heterogenous in socio-economic terms, particularly during the earlier Miccaotli phase. The internal diversity of neighbourhoods decreased a great deal over time, with households of different wealth/status levels becoming increasingly segregated. Concomitantly, social areas grew larger and more regular in form, with more salient boundaries.

Historical and social processes that appear to relate to these changes include the rapidity of initial settlement at Teotihuacan, a probable reduction over time in the importance of kin-based relationships in structuring social life, and heightened levels of residential mobility that accompanied the adoption of apartment compounds.

Increased spatial distance and reduced rates of contact between individuals from opposite ends of the socio-economic continuum would have modified perceptions held by ancient residents of Teotihuacan about available options for social action. These changes likely intensified incipient class differences and contributed to heightened levels of social tension in the city during later stages of occupation.

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Mary Hopkins put years into processing reanalysis data before I began my work and was an equally crucial source of historical and other information on the TMP ceramic reanalysis. Over the past few years, Mary fielded hundreds of e-mails from me soliciting information and advice on coding and related procedures; I thank her for equally numerous and mostly illuminating replies. Like George Cowgill, Mary Hopkin's dedication to the TMP, and to Teotihuacan archaeology in general, is impressive and worthy of great respect.

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I have never lost sight of the fact that the artifact collections and field observations that form the backbone of this dissertation exist because of the remarkable farsightedness of René Millon, the persistence and dedication of George Cowgill, and a long fieldwork program that involved dozens of field and lab personnel. In the last group, two individuals that I want to thank by name are Don Pedro Baños and Don Ceferino Ortega, ceramic analysts at the ASU-managed research facility in San Juan Teotihuacan. I imagine that all of the artifacts that underlie this study passed through their hands at least once. Their expertise and decades-long dedication to Teotihuacan archaeology deserves to be acknowledged here.

Over the years in Arizona I have enjoyed many friendships that made doctoral study a stimulating and exciting time. It would be impossible to name all of the people I have in mind here—fellow students, faculty, staff, other friends—but I do want to acknowledge the great difference they made to my time at ASU. They are part of the reason why Arizona State University is such a great place to study anthropology.

The debt I owe to my family—William, Dorothy, Leslie and Alec Robertson—is immense. They, and above all my parents, encouraged my interest in archaeology as a young boy and have supported my endeavours ever since. My wife, Oralia Cabrera Cortés, was a more recent but no less significant source of love and support. I am grateful to all of them.

Oralia and I dedicate this study to our parents: William Alexander Robertson, Dorothy Robertson, Rubén Cabrera Castro and Mercedes Cortés Hernández.

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Chapter One

IN SEARCH OF A SOCIAL LANDSCAPE AT TEOTIHUACAN

Teotihuacan was an ancient metropolis, one of the earliest large cities in the New World. Located in the Central Mexican Highlands, near modern Mexico City (Figure 1.1), the city flourished for hundreds of years—from about 150 BC to AD 600. At its height, Teotihuacan was inhabited by a diverse population of over 100,000 people and covered around 20 square kilometers. The goal of this dissertation is to generate a deeper understanding of the social landscape of ancient Teotihuacan during the period of growth and development that characterized the first half of its existence. Patterns in the way in which different kinds of pottery were used by its prehispanic inhabitants provide a basis for exploring the nature of socio-economic variability within the city, especially as expressed spatially. The perspective that is emphasized in this work originates in the *neighbourhood*—the spatially localized subunit of a larger urban settlement that is the locus for much, perhaps most, of the day-to-day interaction that makes up city life. Grounding this study in the neighbourhoods of Teotihuacan has made it possible to characterize a social landscape for Teotihuacan that is both broad-based and fine-grained. Its results complement previous investigations that have mostly focussed on 'top-down' processes in Teotihuacan history, particularly the role played by elite administrators and centralized planning in creating the ancient city and in changing its form over time.

Neighbourhoods as Contexts of Social Action

These analyses of neighbourhood composition at Teotihuacan are motivated by two related ideas: (1) that social action is significantly conditioned by the context within which it takes place, and (2) deeper knowledge about the variable nature of the contexts of social action improves our ability to understand broad patterns of human behaviour. The detailed account of socioeconomic

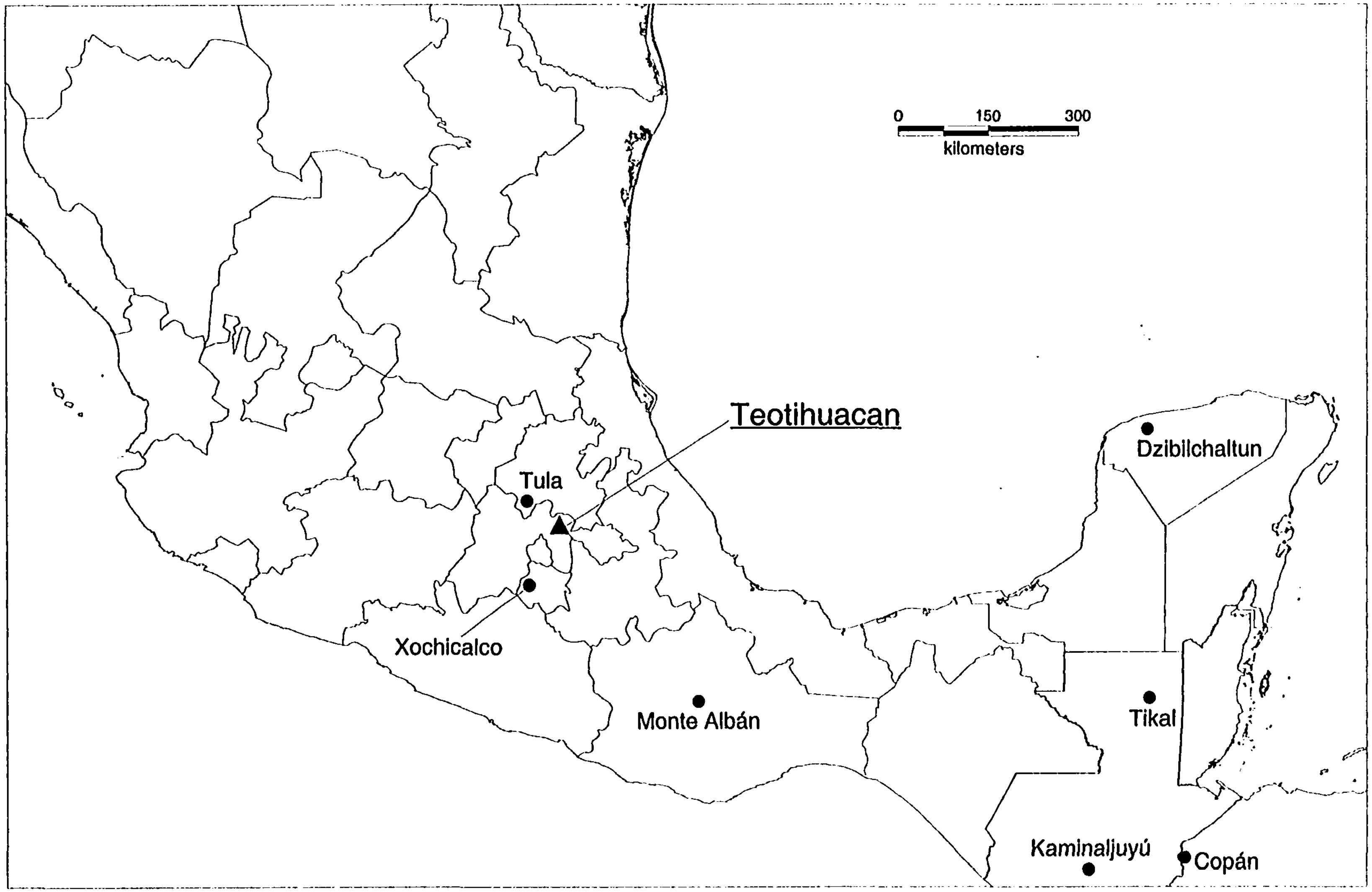

Figure 1.1: Locations of major sites referenced in the text. Lines indicate coasts and various modern political boundaries.

variability generated by this study can serve as a basis for a more informed consideration of social life at Teotihuacan, one that takes into account how contexts of social action within the city changed over time.

Included in the concept of a *context* of social action are factors that vary along both material and non-material dimensions. Spatial relations imposed by local architectural features; the symbolic content of visible material culture; and wealth, power and status differences among nearby individuals—these are only a few general examples of the myriad factors that give rise to variability in the contexts within which social interaction takes place.

Such factors are also entangled with a dimension of time. Shaped by past actions, they constitute a source of constraints and opportunities for people living in the present (Fletcher 1995). Perceptions about these constraints and opportunities lead to the decisions, and ultimately the behaviour, that partially determine the form of contexts for future social action. The essentially dialectic relationship between action and context makes it difficult to infer one from the other, particularly in archaeology—for one thing, it muddies cause and effect—but the more we know about one part of the dialectic, the better we can comprehend at least something of the whole.

Some of the ideas that I outline above are related to a broader approach in anthropology, 'agency theory,' that is becoming increasingly popular in archaeological research and literature. The concepts that have been associated with agency theory cover a great deal of intellectual ground (Dobres and Robb 2000), but most experiments in agent-based modelling share some form of interest in how knowledgeable, self-interested actors ('agents') interact with social structure and thereby effect both social reproduction and culture change. This is in marked contrast to approaches (especially associated with processual archaeology) that have placed theoretical primacy on the larger systems, institutions, and environmental contexts that encompass individuals, while according the latter little autonomy or explanatory value.

The writings of two sociologists, Anthony Giddens and Pierre Bourdieu, have been particularly influential among recent archaeological projects that purport to involve agent-based analyses (Robb 1999), and I have found certain of their ideas about social processes helpful in this research.

Giddens's concept of *structuration* (1979; 1984) is an attempt to improve how social scientists think about a fundamental problem, the relationship between individuals and higher-level social entities (Douglas 1986). One of Giddens's key insights is the idea that there is a recursive link between agency and structure. It is reasonable and important to acknowledge that the decisions, acts, and reflexive monitoring of outcomes that constitute human *agency* are generated within the context of social *structure*, a less tangible framework consisting of socio-cultural dispositions and perceptions about the options available to one's self, and other, sometimes competing, social actors. But an agent's adherence to structure is far from absolute. Structure is important because it both enables and constrains agency, but structure is in turn contested and reconstructed through social action. While formulations of structure have sometimes stressed a historical dimension—time—an important second dimension is space. Spatial variation is crucial to the construction of social worlds. The success of social actors depends significantly on their understanding of spatial relationships, and how successfully they make use of the potentialities of the built environment.

By challenging the unreasonable domination of agency by structure that is inherent in several other prominent theoretical approaches (such as functionalism and structuralism), Giddens's concept of structuration suggests ways for archaeologists to think productively about certain kinds of social issues. From a methodological perspective, it lends legitimacy to integrating an examination of small-scale behaviour into research designs. At least as importantly, it impels us to explain observations generated by our research in terms that are compatible with the idea that, whatever larger patterns they may entail, they originate in the actions of knowledgeable, self-interested individuals.

The concept of 'agency' matters in my work partly because of the explanatory emphasis that agency theorists generally place on small-scale, micro-behaviour of individuals situated at all levels of society, not just those with claims to the most overt forms of political power. If it were agreed that individuals had little explanatory importance in archaeology, we would do best to put research effort into examining high-level phenomena, the emergent expressions of the larger, systemic processes in which elite rulers appear to play the most decisive roles. In this study, however, I have focussed initial stages of analysis on relatively low-level phenomena and the finest level of archaeological provenience available.

While the resolution of the spatial units that underlie the artifact collections with which I work greatly exceeds anything that could reasonably be tied to purely individual behaviour, they are sufficiently fine-grained that much of the variability that they exhibit can reasonably be attributed to the activities of people living within single residential units, although over the course of some generations. In spite of certain methodological advantages that would accrue from aggregating these data into larger groups (most having to do with issues of sampling), I have deliberately refrained from doing this, so as to maximize the correspondence between artifact samples and small-scale behaviours.

The way in which I have characterized the relationship between agency and context (above) shares clear similarities with the 'duality' inherent in Giddens's link between agency and structure. Much of what I mean by the word *context* is in accord with ordinary archaeological usage, including, for example, material features of the built environment. On the other hand, the concept also incorporates a more social meaning that is closely intertwined with the idea of structure. In any society, the form taken by structure is strongly affected by contextual regularities. Factors that control residential choice; barriers to movement that pattern interaction between individuals bearing different social identities; cultural practices that govern symbols displayed at places of interaction—all of these are examples of elements of context that have a strong effect on how social actors perceive available options. In fact, I think it is principally because of this connection between structure and context that structure can become localized, exhibiting sufficient variation in time and space so as to cause the "rules" of social conduct to vary markedly within the same society, and become keyed to different contexts.

The importance that I attach to the examination of small-scale contexts of social action also owes something to Bourdieu's social *field*, an important element in his broader development of practice theory (Bourdieu 1977, 1989). Bourdieu's treatment of the concept of the field is unclear on several levels (Jenkins 1992:84-91), but one (possibly hybrid) characterization holds that they are social microcosms—relatively autonomous systems consisting of structured social positions that are occupied both by individuals and institutions engaged in contesting various kinds of goods including material resources, and social and cultural capital (Jenkins 1992:85). Fields are crucial building blocks in the construction of larger societies; less complex, small-scale societies subsume smaller numbers of fields than those, such as urban societies, that are highly differentiated internally. In this context, the main importance of Bourdieu's formulation of the field lies in its insistence that societies are made up of subunits for which the rules and practices of social engagement are very different.

I am not aware that Bourdieu attaches a necessarily spatial meaning to the concept of field, but it is a straightforward extension to point out that distinct fields are likely to be associated with particular parts of urban settlement systems, possibly forming distinct social areas (Timms 1976). This is similar to the concept of regionalization, which Giddens relates to the localized differentiation of social practices in time and/or space, and sees as an important response to untenable assumptions about the internal homogeneity of urban society (Giddens 1984:119-32, 365-368, 376).

Any discussion about urban neighbourhoods—localized, focussed areas within which people can be expected to gain particular expertise in social action—seems to be illuminated by a philosophical perspective in which the most localized portion of the greater environment (built, cultural, and social) has both a constraining and enabling effect on perceptions, choices, actions, and outcomes. Simply put, this is a good way to think about urban neighbourhoods. Whether 'city air' is liberating or instead serves to stifle freedom and independence depends on who you are, where you are, and what you and others think you need to do.

The Research Strategy

The foundation of this study is a large body of ceramic artifacts recovered during an extensive surface survey of Teotihuacan in the 1960s (Millon 1973b). These artifacts are organized into approximately 5,000 collections drawn from discrete tracts of land, most defined on the basis of architectural features that were in use during the latter part of the Teotihuacan Period occupation (ca. 150 BC to AD 600). The most recent full analysis of the pottery in these collections was carried out in the 1970s and 80s, based on a set of typological categories that capture important distinctions in ware, form and decoration. Many of the categories used to tabulate ceramic materials reflect broad distinctions in the kinds of activities—storage, cooking, food service, and ritual, for example—that the original vessels were used for. Most of these categories are also time-sensitive, so that diachronic studies can be carried out using subsets of categories pertaining to specific occupation periods.

In this study, methods of quantitative analysis are used to identify and describe spatial and non-spatial patterns of variability captured by the ceramic tabulations. Many of these methods are predicated on the use of a Geographical Information System (GIS), which aids in displaying the spatial parameters of basic descriptive data and visualizing the outcomes of statistical analyses, and serves as a tool for generating new information based on spatial relationships. The overall strategy is exploratory; rather than emphasizing formal tests of explicit models or hypotheses, GIS-based approaches are used to identify salient patterns in the distribution of surface pottery remains at Teotihuacan, with subsequent statistical procedures helping to elucidate and explain them.

Parallel analyses are carried out on pottery relating to two temporally sequential periods of occupation (the Miccaotli and Tlamimilolpa phases, ca. AD 150 to 350) and the presentation of analyses within each phase is organized around three stages. In the first stage, estimates of proportions of ceramic categories within each collection are subjected to a Bayesian statistical procedure designed to reduce the effect of sampling error, thus pre-treating the data used in subsequent stages of analysis. Stage-two analyses continue to focus on individual collections, using non-hierarchical cluster analysis to classify them based on compositional differences in pottery. The classes that emerge (described as 'A-clusters') are interpreted in terms of underlying dimensions of socio-economic variability and used to contrast the occupation by residential units belonging to different socio-economic levels; patterns of A-cluster distribution within the city are characterized using thematic maps and statistical measures of spatial association. The third stage of analysis places individual collection tracts in a broader spatial context using analytical neighbourhoods defined by extending the original boundary of the tract outward by 130 m. The composition of these neighbourhoods is characterized in terms of the A-cluster classification created in the second stage of analysis, and these data are used to generate a second classification that highlights socio-economic variability at the level of the neighbourhood. The classes that make up this classification ('N-clusters') delineate broadly distinct zones of occupation in Teotihuacan, social areas that can be readily contrasted in terms of form and content across both space and time.

Summary of Results

Comparing the results of parallel analyses carried out for the two consecutive occupation periods included in this study—the Miccaotli (ca. AD 150-200) and Tlamimilolpa (ca. AD 200-350) phases—highlights features of the socio-spatial landscape of Teotihuacan that persisted over significant numbers of generations, expressions of conservative settlement practices that were in some sense fundamental to the city. They also highlight diachronic patterns related to changes in the internal structure of Teotihuacan's neighbourhoods and to the new social realities that these changes represented for their inhabitants.

For both the Miccaotli and Tlamimilolpa analyses, cluster analysis was used to define four analytical classes (A-clusters) reflecting broad differences and similarities in the ceramic content of individual collection tracts. Two of the A-clusters define opposite ends of a wealth/status dimension, ceramic signatures of households and individuals possessing, respectively, relatively high and low levels of wealth, status and power. The remaining two A-clusters occupy intermediate zones along the same wealth/status dimension but are distinguished from one another by ceramic assemblages that appear to reflect differing degrees of economic and social interconnection with households of the highest wealth/status level.

The spatial distribution of A-clusters makes it clear that, during both the Miccaotli and Tlamimilolpa phases, there was a tendency for households of different socio-economic levels to be differentially distributed within the city, showing much higher levels of concentration in some areas than in others. Households tended to reside relatively near to other households of similar socio-economic levels, collectively forming neighbourhoods that were usually, to at least some degree, numerically dominated by a definable portion of the socio-economic continuum. For example, a mixture of several different A-clusters is present in most neighbourhoods, but in most cases the count of one of the A-clusters exceeds the total for the other three A-clusters combined.

Classifying Teotihuacan's neighbourhoods on the basis of variability in internal A-cluster composition and mapping the distribution of these higher-level analytical classes (N-clusters) delimits larger zones—social areas—characterized by neighbourhoods that exhibit similar mixtures of wealth/status levels. The spatial distribution of N-clusters emphasizes the fact that, for both the Miccaotli and Tlamimilolpa phases, neighbourhoods containing relatively high proportions of wealthy, high-status residents were concentrated near the core of Teotihuacan, in the vicinity of the largest, most elaborate monuments. Conversely, households from the other end of the socio-economic spectrum lived in highest densities in specific areas nearer to the city's outskirts, perhaps most notably along the northwest periphery. Many parts of the city that are vaguely intermediate, spatially between the core and periphery, were composed of neighbourhoods containing relatively high proportions of households that appear also to have occupied an intermediate part of a socio-economic scale.

It is important to emphasize that the association of the city core with households of relatively higher status, and conversely, of more peripheral areas with households of relatively lower status, are only general tendencies in a more complex empirical pattern. In neither of the phases examined was socio-spatial variation in Teotihuacan organized around regular, clearly defined, concentric rings extending outward from the city center (although there was a vague tendency toward such a pattern, at least in the Tlamimilolpa phase). Parts of Teotihuacan's periphery appear to have contained significant densities of high-status households, while some areas near to the civic-ceremonial core contained relatively high densities of low-status households.

It is also important to emphasize that, while most neighbourhoods in Miccaotli and Tlamimilolpa phase Teotihuacan were to some degree dominated by households of similar socio-economic status, most also contained households of quite different wealth/status levels, sometimes in relatively high numbers. In fact, a striking feature of many Teotihuacan neighbourhoods was their socio-economic diversity. The vast majority contained a mixture of status levels, represented in this analysis by at least three, and often four, different A-clusters.

In spite of this, levels of neighbourhood diversity dropped over time, with Tlamimilolpa neighbourhoods much more consolidated, more homogenous entities than their Miccaotli phase antecedents. The change in neighbourhood composition was most pronounced in the civic ceremonial core of the city, which, by the Tlamimilolpa phase, was a tightly integrated area overwhelmingly dominated by households of high wealth/status levels. Less striking shifts in internal diversity were evident in neighbourhoods that were characterized by high proportions of intermediate-status households. Peripheral areas occupied by high proportions of low-status households were the most conservative in terms of socio-economic diversity, and neighbourhoods that made up such areas were only slightly more homogenous in the Tlamimilolpa phase than they had been in the Miccaotli phase.

A reduction in neighbourhood diversity was not the only diachronic change revealed by this analysis. Ceramic evidence suggests that, during the Miccaotli phase, food preparation activities were relatively important within high status or wealthy households. In the Tlamimilolpa phase, such households appear to have been less intensively engaged in food preparation, with food service and consumption emphasized over cooking activities. Evidence for elevated levels of food preparation in households assigned to one of the intermediate-status A-clusters which concentrate in parts of the city adjacent to areas dominated by elite households suggests that the labour involved in preparing food for elite consumption may have become increasingly supplied by individuals outside the residential unit, and even outside the neighbourhood, in the Tlamimilolpa phase.

Changes in neighbourhood composition and the sources and organization of labour expended in food preparation relate to broader modifications in the social landscape of Teotihuacan. More specifically, I interpret both the relatively high diversity of most of Teotihuacan's neighbourhoods in the Miccaotli phase and the close proximity of households of quite different status levels as reflecting the importance of lineage or similar kin-based connections between households. The reduction of neighbourhood diversity reflected in the Tlamimilolpa phase data suggests that kin-based connections were becoming less important in Teotihuacan. The possibility that Teotihuacan's most high-status households were able to obtain cooked food from other households from which they had become spatially divorced suggests greater socio-economic differentiation and increased importance of class-based differences within Teotihuacan society, something highly characteristic of prehispanic Mesoamerican society in later stages of development.

The reduction of social diversity in Teotihuacan's neighbourhoods was likely facilitated by the Tlamimilolpa phase adoption of a distinctive type of housing complex called the apartment compound. The wholesale reorganization of the city's residential system around this new kind of structure—the razing of large numbers of existing dwellings and the construction of new ones—provided an opportunity for heightened levels of residential mobility. Households dissatisfied by their current residential locations might have moved to more desirable building sites made available by reconstruction activities and/or similar movements of others.

While households from all parts of the wealth/status continuum were involved in and affected by these sorts of residential changes, it is likely that the main impetus to movement was a desire for high-status households to reside in and around the symbolic core of Teotihuacan; low-status residential shifts were probably mostly reactive. Elites not yet living in the city core might often have claimed central building sites by displacing less-powerful families—some perhaps the low-ranking kinsmen of already established elite households—forcing them to relocate to places vacated in more peripheral zones. This would have been difficult to do without the approval and assistance of elite individuals that already dominated the city core. In fact, it is precisely these individuals that would have been best positioned to influence the socio-economic composition of their own neighbourhoods, and it is reasonable to suggest that a preference for relatively homogenous neighbourhoods was part of a more general ideological package held by the elite sector of Teotihuacan society. This ideology was presumably shared by elite administrators. A degree of top-down sanction, and even planning, may have contributed to the high levels of residential shuffling that took place.

Dissertation Outline

Chapters Two and Three develop the context for this study. Chapter Two characterizes general anthropological perspectives on cities and urbanism and summarizes some of the variety exhibited by Mesoamerican cities. A principal point that emerges from this review is that we have relatively little information about patterns of socio-spatial variation in cities associated with early states—thus, our view of urban social topography is usually unrealistically 'flat,' and there is a clear need for more detailed archaeological fieldwork and analysis. Chapter Three is a review of background archaeological data from Teotihuacan, with an emphasis on previous studies that have aimed at describing various features of spatial organization within the city.

Chapters Four and Five are concerned with methodology. A review of the empirical basis for this study, particularly the nature of provenience data assembled by the Teotihuacan Mapping Project and the typological system used to describe ceramic collections, is presented in Chapter Four. (A more detailed account of the TMP ceramic typology is provided in Appendix A.) Chapter Five describes the methods that I used to identify patterns in these data. As was described above, the general approach is an exploratory spatial analysis that proceeds at two main levels. Variability in the composition of ceramic assemblages is examined at the level of individual collections, and the individual survey tracts—which often approximate the locations of actual Teotihuacan Period structures—are classified on that basis. Collection tracts are then subjected to a second phase of classification that reflects variation both in the content of ceramic collections directly associated with them, as well as the content of ceramic collections from tracts in surrounding neighbourhoods. Spatial relationships among classes defined in both classification stages are examined in detail.

Chapter Six describes the results that emerge from the program of analysis laid out in Chapter Five. Parallel analyses are based on data from two temporally adjacent chronological phases, Miccaotli and Tlamimilolpa, that relate to a relatively early period of occupation at Teotihuacan. For each phase, the same general methods were used to classify individual collection tracts both on the basis of their own ceramic content (A-clusters) and the mixtures of different kinds of ceramic assemblage exhibited in larger, encompassing neighbourhoods (N-clusters). For the earlier Miccaotli phase, neighbourhoods are characterized as relatively heterogeneous internally, most exhibiting a fairly wide range of the ceramic assemblage types, and this is interpreted as indicating a high level of wealth/status variability. Although there are discernable tendencies for the various Miccaotli A-clusters to be more common in some parts of the city than in others, this tendency is strikingly stronger in the subsequent Tlamimilolpa phase.

During Tlamimilolpa, neighbourhoods become much less heterogeneous than their Miccaotli counterparts and more clearly dominated by single A-clusters.

Chapter Seven provides an account of the empirical patterns documented in the previous chapter in terms of social and behavioural factors. While it is highly desirable that these analyses be extended into later phases of occupation, the data examined here permit changes in the socio-economic constitution of neighbourhoods to be interpreted in light of the nature of settlement during a relatively early period of growth during the Miccaotli phase and a major reconfiguring of the Teotihuacan residential system in the following Tlamimilolpa phase. Diachronic differences in the relative heterogeneity of neighbourhoods are related to a general shift over time toward increasingly segregated social areas in Teotihuacan.

Chapter Two

ANTHROPOLOGICAL AND GEOGRAPHICAL PERSPECTIVES ON CITIES AND URBANISM

Cities are a rich and potent symbol of human culture. A fascination with and a desire to understand urban life has permeated social scientific writing for a very long time, going back at least as far as Ibn Khaldun, whose fourteenth-century writings on the history and sociology of the Maghreb made much of the distinction between urban and non-urban ways of life (Lacoste 1984:118-131).

One of the difficulties in comprehending cities has always been, on one hand, their characteristic size and internal diversity, and, on the other, the wide range of formal and functional variability exhibited by individual cases. Cities are highly complex artifacts created through long-term historical processes that emerge both from centrally directed planning and from more 'organic' forms of growth initiated and carried out by individuals or small groups (Fletcher 1995).

Simply describing salient features in the form of an urban center poses significant analytical challenges, but this is a crucial first step toward understanding the behaviour that gives rise to specific cities and drawing useful comparisons among multiple examples. Social scientists engaged in comparative urban studies face a basic need for taxonomic insights, some means of controlling at least portions of the vast range of variability exhibited by cities. Generalizing about phenomena as complex as cities seems risky, possibly because of the iteration that characterizes much social scientific research—a degree of generalizing has to be done before comparative work is really possible, while results from comparative work usually produce more useful generalizations.

In this chapter I contextualize my analysis of socio-spatial variation at Teotihuacan through a review of anthropological literature pertaining to cities in general, and to Mesoamerican cities in particular. The review is brief and selective and emphasizes studies that attempt to draw general conclusions about urban variability.

Different Kinds of Cities: Perspectives from Anthropology

In the early years of the twentieth century, anthropologists tended to focus their investigations on small-scale societies living in dispersed, rural communities or small towns—the analysis of urban life was mostly regarded as part of the research domain of sociology. As 'primitive' peoples in remote, 'exotic' parts of the world became increasingly incorporated into peasant and urban societies, the study of city life became more integrated into the broader discipline of anthropology (e.g. Warner 1963).

Richard Fox (1977) made an important attempt to bring to urban studies the insights that accrue from the comparative, holistic perspective of anthropology. Fox's contribution centers around the specification of five primary urban categories. These categories are related to a set of general functions that cities serve within broader socio-economic contexts and which in turn reflect (1) differences in the nature of state power and urban economy, and (2) the ways in which cities are molded by the ideational system of the societies within which they are embedded (Fox 1977:32-38).

According to Fox, the *regal-ritual* city fulfills a primarily ideological role and exists where state power is relatively weak and the urban economy is highly dependent on externally derived (i.e., rural) resources. The existence of such cities is closely tied to the prestige and status of the ruling elite and/or the integrative effect of state religious ideology; within a regal-ritual city, monumentality is typically expressed in the form of ostentatious palace and/or temple complexes, and these provide the main basis for large-scale spatial organization (Fox 1977:39-57).

In the Fox typology of primary urban types, *administrative* cities differ from regal-ritual cities because they are embedded in states that are directed by relatively powerful, stable bureaucracies. They tend to house denser, more diverse populations and centralize a wider range of commercial and occupational activities; their organization is thus quite different from that of the surrounding countryside. Importantly, along with increased size and specialization of the resident population appears an increasingly distinct urban class structure. The physical expression of an administrative city is similar to a regal-ritual city, and political and ritual structures often dominate the spatial layout (Fox 1977:58-91).

Like regal-ritual cities, *mercantile* cities arise when regional political control is weak. Compared to both regal-ritual and administrative urban forms, mercantile cities show greater economic autonomy from the larger societies that encompass them—an urban concentration of wealth is an important characteristic of mercantile cities but is not inherent in the control of peasant agricultural resources. Some mercantile cities become so strong politically and economically as to be completely outside the jurisdiction of any other state power and are effectively self-administered. Fox describes these independent mercantile cities as city-states (Fox 1977:92-116).

Colonial cities are similar to administrative cities in their association with strong bureaucracies and their economic dependence on a rural hinterland. Unlike administrative cities, colonial cities are a product of the industrial world; the strict control over resident populations characteristic of colonial cities is made possible by modern technologies of communication, travel, and warfare (Fox 1977:117-139).

Fox's final type, the *industrial* city, prevails in much of the world today. This urban type is associated with highly bureaucratic states that are relatively autonomous with respect to the larger societal economies, especially in the sense that wealth tends to be created within the city. Industrial cities are strikingly heterogenous—occupation, class, religion, and social life in general tend to be broken down within them in diverse and complex ways (Fox 1977:140-162).

Like any typology, Fox's primary urban types describe highly variable entities in an idealized way. In addition to the general dimensions that explicitly underlie Fox's system (state power and urban economy), real-world cities are also the product of complex historical trajectories that grow out of diverse cultural factors; this results in a range of 'secondary' variation not accounted for by the five urban types outlined above (Fox 1977:20-21). In spite of this, Fox's scheme provides a level of richness and detail that is missing in other prominent and particularly sociological formulations, including Weber's (1968 [1958]) narrowly conceived dichotomy between 'oriental' and 'occidental' forms of urbanism, and Sjoberg's (1960) distinction between 'industrial' and 'preindustrial' cities.

Intra-Urban Variability: Approaches from Economic and Urban Geography

Fox's anthropological examination focuses primarily on the variable function of cities; geographers have had much more to say to about formal aspects of urbanism. Even in fairly recent times, much geographical and sociological analysis of the form of urban settlements has been dominated by highly idealized models formulated in the first half of the twentieth century (Ayeni 1979; Murdie 1976). The most influential of these portray important socio-economic variation as structured either according to a series of nested, concentric *zones* expanding outward from around the city core, or wedge-shaped, linear *sectors* linking the core with areas closer to the city perimeter.

The zonal model, proposed by sociologist Ernest Burgess (1925) on the basis of data collected from Chicago, was conceptualized both in terms of the growth and functional zonation of cities. According to this model, urban centers, particularly the industrial cities of North America, were organized around five concentric, ring-shaped zones: a central business district, a 'transition' zone, a residential zone occupied by middle class workers, a higher class residential zone, and a 'commuter's' zone. Numerous criticisms of the Burgess model have been made, particularly that, to the degree that the zones predicted by it can be discerned in empirical cases, they are often spatially discontinuous and internally heterogenous (Murdie 1976:240). Of particular relevance to this study is the observation that non-industrial cities appear to reverse part of the zonal model with high-status households occupying the core of the city, and lower-status households at the periphery (Sjoberg 1960; Timms 1971).

The sectoral model was proposed by Homer Hoyt (1939) as an alternative to the zonal model. The main thrust of Hoyt's idea is that patterns of spatial differentiation—in his analyses, variation in socioeconomic status—near the core of a city will tend to be reproduced outward as the periphery expands. This results in the growth of sectors that, rather than forming concentric rings, extend outward from the core of the city, expanding, and sometimes shifting, toward its periphery (Marcus 1983a:200). Sector formation frequently follows transportation features such as major roads or waterways (Ayeni 1979:12-14).

The third major model that has been formulated for describing urban form augments the first two by acknowledging that urban land-use patterns do not always emerge from a single nucleus in the city core, but may instead develop around multiple nuclei, and/or grow to absorb a nearby, previously occupied, settlement or settlements (Marcus 1983a:202-206). The 'multiple-nuclei' model represents an attempt to generalize about urban form in a way that is more connected to empirical reality and less idealized than either the zonal or sectoral models. The development of distinct nuclei may stem from a variety of factors, including logistic concerns of commercial enterprises, residential locational decisions made by households differentiated on the basis of ethnicity, religion, or some other grounds (Murdie 1976:245-246), and the presence of historically antecedent nodes of settlement.

These three models are not necessarily incompatible with one another. The fact that sectors may exhibit gradational variation moving outward from the city core suggests that the zonal and sectoral models may describe different dimensions of variation that can coexist. It has been argued, for example, that sectoral variation may most often describe residential land-use patterns, especially as they relate to social rank, while the zonal model describes a wider range of phenomena, including a variety of economic and demographic factors (see Anderson and Egeland 1961; Ayeni 1979:15; Timms 1971:229-244). It has also been suggested that the multiple-nuclei model is most relevant to growth patterns that appear relatively quickly, while the other two models describe slower, more 'natural' processes of urban development (Mabogunje 1968).

In spite of recognition that more than one of these highly idealized models may have some degree of 'fit' to a real-world case, various kinds of empirical tests have been formulated to decide which of them best describes internal variation in particular cities. With respect to the zonal and sectoral models, analyses typically involve superimposing these two shapes and using them as a grid for specifying the location of often widely dispersed observations about relevant forms of social or/or economic behaviour within the city of interest (Murdie 1976:247-265). Statistical tests on these observations, such as analysis of variance, often demonstrate that most of the behaviour exhibited by urban populations is really a form of residual with respect to these two models, something not well accounted for by either, or even by interaction effects between them. Some geographers have concluded that these sorts of models are too deterministic and too abstract to provide very satisfying accounts of intra-urban variability, and that they need to incorporate a greater consideration of 'social values,' such as those invested in land before it is incorporated into an urban settlement (Murdie 1976:246-247).

Social Area Analysis and Factorial Ecology

A more empirical and more realistic avenue for describing patterned variability in cities is the 'factorial ecology' approach that some urban geographers have taken to the analysis of modern cities (Timms 1971). Factorial ecology grew out of 'social area analysis,' and both approaches were predicated on the assumption that urban populations can be usefully differentiated according to a number of cross-cutting characteristics, each of which may play out quite differently 'on the ground.' In social area analysis, social patterns in cities were examined by scoring census data simultaneously against composite indices that measure economic status, family status (derived from demographic information about family composition, especially as related to participation in the work force), and ethnic status (see Shevky and Bell 1955).

The adherence of social area analysis to three indexes defined on an *a priori* basis proved difficult to justify theoretically (Johnston 1976:196-202; Timms 1971:124). Factorial ecology, although similar in general aim to social area analysis, was a response to the idea that a more flexible, more inductive approach was needed to effectively explore highly variable residential practices. As its name suggests, factor analysis usually played a role in factorial ecological research, a statistical method that made it possible for researchers to relate variation in a wide range of descriptive 'indicants' gleaned from census data to a smaller and more manageable number of underlying dimensions. Variation in the dimensions that emerged from factor analysis could be usefully described and examined in its own right, but also related to observations not included in the initial analysis, including geographic location (Anderson and Egeland 1961; Johnston 1976; Timms 1971, 1976).

An interesting generalization to emerge from factorial ecology is that, at least in many Western industrial cities, a relatively high proportion of the variation exhibited by urban populations can be related to three or four basic dimensions having to do, respectively, with socio-economic status, family composition, ethnicity, and mobility (Timms 1971:36-84, 85). How variation along these dimensions patterns spatially, however, is less clear. In accord with observations made earlier, there is often a tendency for socio-economic status to vary primarily according to a zonal pattern and other dimensions primarily to reflect sectoral differences, but neither model provides a very satisfactory framework for detailed description or comparison (Timms 1971:229-249).

What makes factorial ecology 'ecological' are theoretical perspectives drawn from analogies with biology, in particular the use of the concept of 'impersonal competition' as a means of explaining patterns of variation observed in cities. While it is difficult to object to the general idea that competition is an important feature of urban landscapes, factorial ecologists have been criticized for reifying the biological analogy, adopting unrealistically simple, deterministic views of cultural behaviour (Timms 1971:91-95). Nevertheless, factorial ecology is important for its flexible approach to urban analysis, particularly the way in which it seeks to describe the major lines of structure in a dataset without imposing preconceived ideas as to the form that structure might take. As will become clear in Chapter Five, the general methodology of factorial ecology shares broad similarities to the research strategy that I have developed in this study.

Variability in Prehispanic Mesoamerican Cities

Marcus (1983a) provides a useful synthesis of much of what is known about prehispanic Mesoamerican cities. Most of Marcus's discussion is organized around a set of three general themes that address (1) the general form of prehispanic cities, (2) the functions that they served, and (3) emic perspectives on the classification of urban and rural landscapes.

Urban Form

Marcus notes that many different schemes for characterizing urban form have been proposed, many based on variation in some measure of size, such as area, population count, or population density. The size of Mesoamerican cities varied widely. Near the high end of most such scales is Teotihuacan, with a maximum population that may have exceeded 150,000 (Millon 1976:212), and density estimates that range from 70 (Sanders and Santley 1983:257) to over 150 persons/ha (Hirth 2000a:139) for different parts of the city. At the other end of the scale are many Maya cities, which, while often very extensive, housed much more dispersed populations. An example is Dzibilchaltun, which had an estimated population of 42,000 at around AD 900, living in an area of 19 square kilometers (Marcus 1983a)—a density of roughly 20 persons/ha. Similarly dispersed populations lived in Tikal (Chase et al. 1990; Puleston 1983) and Copán (Sanders and Santley 1983; Webster 1999).

The form of cities can also be contrasted in terms of the degree of planning that they exhibit. At one end of an idealized continuum are cities constructed around a rectangular grid plan, perhaps composed of repetitive, regular units; at the other end are more 'natural' cities that show little or no evidence of formal planning and develop irregular residential patterns. In the real world, including many Mesoamerican examples, cities often show a combination of both characteristics, which may be expressed differentially in different parts of the city (Marcus 1983a:196-197). As will be discussed in somewhat more detail in the next chapter, Teotihuacan appears to have been like this. Its geographic core shows a good deal of evidence for planning, including the organization of the city core around cruciform access corridors (Millon 1973b) and the spacing of major monuments in conformity to a microcosmic plan (Sugiyama 1993). Much less control is apparent in peripheral parts of the city. Away from the ceremonial core, structures are united by a common orientation, but often appear to be arranged haphazardly, forming an irregular, 'patchy' pattern. In contrast, Maya cities usually lack regular or rectilinear layouts, even in central zones where elaborate architectural remains tend to be clustered. While most of Dzibilchaltun, for example, consists of nested rings that are distinguished by a decrease in the density of vaulted architectural remains away from the center's core (Kurjack 1974), these rings do not appear to be the result of growth that was directed by a centralized authority (Marcus 1983a:197). On the other hand, the spatial arrangements of monuments in the center of some Maya settlements may have been subject to at least some top-down planning. Ashmore (1989), for example, has argued that the internal layouts of a number of lowland Maya sites incorporate a cosmologic symbolism similar to what Sugiyama has argued existed at Teotihuacan. The patterns identified by Ashmore, however, are based on fairly subtle details of architectural form, function, and iconography that suggest vague associations between buildings and spaces and different parts of the Maya cosmos, and are not unequivocal. If the patterns do exist, they could be as plausibly related to after-the-fact additions as to initial planning.

Marcus's review also considers the degree to which Mesoamerican cities conform to the formal models of sociologists and urban geographers. As previously noted for Dzibilchaltun, many Mesoamerican cities appear to be reasonably compatible with some form of zonal model based on an inner core of monumental structures, surrounded by loosely defined rings of increasingly less impressive architectural remains (Kurjack 1974; Marcus 1983a:199-200). In particular, concentric zonation has been claimed for a number of large Maya centers, notably Cobá (Folan et al. 1979; Folan et al. 1983:50-54), Lubaantun (Hammond 1972a, 1972b, 1975), and Tikal (Puleston 1983). Whether or not internal settlement patterns at the site of Tikal actually conform to a concentric pattern has been debated in some detail. Arnold and Ford's (1980; 1982) attempt to rank residential units from Tikal on the basis of labour investment and distance from the city core failed to reveal any systematic relationship between the two variables. The analysis that led to this conclusion—that Tikal exhibits no evidence for concentric zonation—has been criticized for excluding the largest structures located at the heart of Tikal, examining too small a portion of the rest of the settlement, and failing to distinguish between vaulted and unvaulted structures (Folan et al. 1982; Haviland 1982).

Marcus suggests that the sector model is compatible with Teotihuacan, Monte Albán, Xochicalco, Tenochtitlan, and possibly Tula—interestingly, all settlements outside of the Maya zone, and mostly from Central Mexico. 'Fit' between the form of Teotihuacan and a sectoral model is attributed by Marcus [citing Millon (1976)] to the existence of residential wards of craftsmen and the concentration of high-status residences along the Street of the Dead. The latter observation supports Marcus's position only if the Street of the Dead is regarded principally as an access corridor leading into the center of the city, rather than as an elongated nucleus (a view that I find more persuasive). Monte Albán is said to fit the sectoral model because of its putative division into more than a dozen residential wards in Period IIIb. Although citing no details with respect to Xochicalco, Marcus likely has in mind the residential wards recently described by Hirth (2000a) and discussed in more detail below; it is worth noting that Hirth actually characterizes Xochicalco in terms of a five-ring zonal model in which three residential tiers surround two central tiers of elite and civic-ceremonial areas (Hirth 2000a:227-229). It is unclear why Marcus regards Tula as sectoral—possibly because during its period of maximal growth (the Tollan phase) it appears to have incorporated occupational zones that had been spatially isolated during earlier phases (see below, and Healan et al. 1989:244; Healan and Stoutamire 1989:234-235). This sort of growth pattern seems more compatible with a multiple-nuclei than with a sectoral model, and in either case it is not clear that these zones retained distinct social or economic identities after becoming part of the larger city at Tula.

Urban Function

Drawing in part on Richard Fox's work, Marcus (1983a) contrasts different functions served by Mesoamerican cities, especially as they relate to positions in a broader hierarchy. Marcus notes that such hierarchies can be based on various criteria, including political, economic, and ritual status. It is rare for a city to occupy a top position in all three realms, and examples where this seems to have been the case, such as Teotihuacan, are unusual in Mesoamerica. Monte Albán, for example, was at the top of the political hierarchy in the Valley of Oaxaca, but it may have been essentially detached from a regional economic system built on secondary and tertiary centers (Blanton et al. 1999:62-66; Blanton et al. 1982; Blanton et al. 1993:69-72; Kowalewski et al. 1989). In Fox's terms, Monte Albán was a regal-ritual (or possibly administrative) city, where political and religious functions were more important than economic functions (Marcus 1983a:208-211).

Marcus compares Monte Albán, Teotihuacan, and Tikal in terms of (1) access networks, (2) craft specialization, (3) fortifications, and (4) ritual structures in an attempt to assess the relative importance of administrative, religious, and commercial functions within each of the cities. An emphasis on religious functions is fundamental to all three cities, although temple platforms may be more common at Teotihuacan than at Monte Albán or Tikal. Monte Albán and Tikal differ from Teotihuacan in emphasizing religious and administrative over commercial roles. Monte Albán appears to have isolated most residents from administrative loci. In contrast, Marcus believes that administrative buildings were more easily accessible in Teotihuacan, as was the city's major economic facility, i.e., the possible market in the Great Compound. The commercial focus at Teotihuacan is reflected in its numerous craft production workshops, while occupational specialists are much less evident at either of the other two cities (Marcus 1983a:211-223).

Emic Perspectives

In addition to considering different etic approaches to the description of urban form and function, Marcus uses sixteenth-century ethnohistoric sources in an attempt to characterize emic perspectives. Nahuatl, Mixtec, Zapotec and Yucatec Maya terms for nucleated settlements appear to have meanings that extend beyond what westerners tend to mean by 'city' or 'town', encompassing inhabitants and rulers, as well as the outlying countryside under a ruler's governance. Our relatively crisp distinction between rural and urban forms of settlement may be appropriate for certain kinds of analysis, but it possibly also reifies a settlement boundary that meant relatively little to indigenous peoples (Marcus 1983a:206-208). This perspective on the issue is interesting and probably useful for researchers working on the last few centuries of prehispanic settlement history. It is not clear, however, that Marcus's conclusions apply as broadly in Mesoamerican time and space as she implies. The nature of emic perspectives about very early and very large settlements like Teotihuacan, and their relationship to a rural hinterland, remains a very open question.

Neighbourhoods, Enclaves and Internal Factions: Parts of the Urban Whole

The phenomenon of the city is intertwined historically and conceptually with the administrative apparatus called the state. Recently, archaeological literature exploring the nature of early states has emphasized the varied and sometimes opposing interests of the individuals, and groups of individuals, of which they are composed; this is in marked contrast to perspectives that have attempted to account for states as coherent, well integrated systems that exist primarily to serve larger societal interests (see Brumfiel 1983, 1992).

Although they are a different kind of entity, cities mirror some of the organizational complexity of states. Like states, cities are made up of self-interested individuals that are connected, more or less loosely, with larger collectivities based on differences in kinship or association, ethnicity, religion, and occupation. Urban residents may be recruited into political factions, and they may be assigned to administrative units by civic authorities. Individuals may become affiliated with numerous higher-level interest groups. Multiple memberships may sometimes 'map out' in relatively straightforward ways—they may be discrete or they may be nested, for example—but they may also be complex and crosscutting. Much of the dynamism of urban life lies in the nature of interaction among interest groups, and an important factor in this is how individual actors negotiate and manipulate relevant affiliations in specific situations.

Sometimes urban collectivities take on a spatial expression, becoming associated with particular parts of the city and forming distinct neighbourhoods or enclaves. Such spatial differences may be aimed at creating distinct residential areas, the result of deliberate collective action instigated either by urban administrators, or at a more local level by residents of a particular part of the city. Such action may become materially expressed in physical barriers to movement, or in breaks in the distribution of residential or other structures. On the other hand, even slight preferences at the household level about immediate neighbours, coupled with sufficient levels of residential mobility, can result over time in the emergence of 'social areas' with distinctive characteristics and clearly defined borders (Schelling 1978). Of course, in an archaeological context, understanding the processes that gave rise to such patterning may be very difficult; although generated by 'microbehaviour,' this kind of social area may well be attributed to a higher level of planning than was directly involved.

In spite of the theoretical importance of considering internal divisions and internal variability in cities, there are few archaeological case studies that examine the related issue of internal spatial divisions in ancient cities (but see Stone 1987; Stone and Zimansky 1992), and this is as true for Mesoamerica as anywhere else. In Mesoamerica, important exceptions mostly come from Teotihuacan (Altschul 1981; Cowgill et al. 1984; Sload 1982). Some information on internal divisions is also available for Monte Albán, Xochicalco, and to a lesser extent, Tula, as summarized in the next three sections. Studies at Teotihuacan are discussed in the next chapter.

Monte Albán

Monte Albán was built on the top and sides of several large hills located in the central area of the Valley of Oaxaca, in the Southern Highlands of Mexico. Potsherds attributed to the Monte Albán Early I Period, the founding phase at Monte Albán (ca. 500-300 BC), form three separate, dense concentrations around the Main Plaza, the ceremonial core of the city. Richard Blanton has suggested that this indicates community partition, with early residential areas organized into three barrios. Conceivably, the origin of this pattern may lie in the migration of households from each of the main arms of the Valley of Oaxaca, events that integrated what were previously three different polities (Blanton 1978:37-40; Blanton et al. 1999:61).

The division of Monte Albán into barrios may have continued into later periods. Parts of the city away from the Main Plaza contain clusters of mound groups that appear to be more or less evenly spaced from one another and surrounded by groups of residential terraces. Blanton argues that these mound clusters may have been residences and administrative structures occupied by elite leaders of corporate groups, with households of lower-ranking members residing on nearby terraces. Fifteen such clusters were identified; Thiessen polygons were used to center these clusters in analytical subdivisions, some of which may approximate original barrios. In a few cases, polygon boundaries map quite closely onto both natural and man-made barriers. Some examples of ceramic and other artifactual differences appear to be consistent with the hypothesis that at least some of the proposed subdivisions reflect socio-economic distinctions at Monte Albán (Blanton 1978:66-93).

Blanton attributes these divisions to the Monte Albán IIIb phase (ca. AD 500-700), perhaps a millennium later than the founding of the city. Construction dates for the mound-group clusters that these divisions are based upon are mostly unknown, so it is difficult to assess how the much larger number of Late Classic barrios might relate to the hypothesized original set of three barrios (Blanton 1978:44-46).

Xochicalco

A somewhat similar approach has been taken by Kenneth Hirth to describing internal divisions at the Epiclassic (AD 650-900) hilltop center of Xochicalco, Morelos (Hirth 2000a:234-243). Instead of defining Thiessen polygons, Hirth used roads and moats that cross-cut terraces built around the sides of Cerro Xochicalco to divide the settlement into fourteen units. The meaning of these subdivisions is unclear, but they may represent a form of urban ward. Civic-ceremonial and elite residential structures appear to be fairly evenly distributed among these units. Hirth describes some evidence for internal social stratification and argues that a specific kind of platform structure may have served corporate social functions within that part of the settlement. The relatively small internal populations estimated for these divisions appear to be compatible with an administrative unit of the size of a small *calpulli*, a highly variable form of socio-political and residential unit that was important in Central Mexico at the time of the Spanish conquest (see Hicks 1982; Lockhart 1992:16-19; Sanders et al. 1979:159-160). Interestingly, most of the structures interpreted as serving civic-ceremonial functions occur not at the center of ward divisions, but rather near their boundaries, so that the latter could not have been reproduced using Thiessen polygons (Hirth 2000a:236-237).

Tula

The Epiclassic and Early Postclassic city of Tula was constructed approximately 65 km northwest of Teotihuacan, at the confluence of two rivers in the modern state of Hidalgo. Although the subject of a large-scale survey and excavation project (Healan 1989; Mastache de Escobar et al. 1982; Matos Moctezuma 1974, 1976), considerably less detail is available about internal divisions in Tula compared to either Monte Albán or Xochicalco. Its contribution to the present discussion is mainly as a Mesoamerican example of urban growth absorbing initially separate nodes of settlement.

The earliest large-scale occupation of the urban zone of Tula (ca. AD 700-800) was concentrated in a slightly elevated area of 3 to 5 square kilometers, centered around a small ceremonial mound/plaza complex known as "Tula Chico." A early and distinctive pottery complex with cultural ties to the Bajío region northwest of Tula is largely confined to the immediate vicinity of this early ceremonial core, and it has been suggested that the first rulers of the city may have been immigrants among a largely indigenous population (Cobean and Mastache 1989:37-38, 40-42; Healan et al. 1989:241-243). A similar distinction between an elite and perhaps foreign pottery complex associated with the city core, and non-elite forms of pottery elsewhere, has not been reported for later phases of occupation; it is likely that the original rulers of Tula were eventually assimilated into a broader cultural tradition.

Tula grew considerably over time, eventually reaching a maximum extent of about 13 square kilometers during the Tollan phase (ca. AD 950-1200). An occupation approximately 3 km to the south of Tula Chico, initially an outlier community, was eventually absorbed into the city, and the ceremonial core of Tula was shifted about one kilometer southwest, to a locality known as "Tula Grande." The earliest obsidian workshops were also located somewhat outside of Tula, and these too eventually became incorporated into the city. Later obsidian workshops appear to have been widespread in Tula, but probably concentrated around a few principal zones of production (Cobean and Mastache 1989:38-39, 44; Healan et al. 1989:244-247).

Summary – Socio-spatial Variation

Largely due to the difficulty and expense of collecting relevant data, we know relatively little about the social landscape of ancient cities, particularly small-scale socio-economic variation and the different kinds of larger socio-spatial patterns that may emerge from it. As will be shown in the next two chapters, Teotihuacan is one of the few early cities that have been subjected to the kind of field investigations that have the potential to inform us about this kind of variability, and significant progress has already been made in analyzing relevant data. Adding to current knowledge about and understanding of spatially patterned socio-economic variation is the main contribution made by my research.

Chapter Three

TEOTIHUACAN: AN EARLY EXPERIMENT IN URBAN LIFE

Antecedent Studies

At the time of the Spanish conquest, the word *Teotihuacan* was used by Nahuatl-speaking peoples in Central Mexico to describe a locality in the northeastern part of the Basic of Mexico, near modern Mexico City. Although a settlement of some significance at the time of the Spanish conquest (Garraty 2000; Hodge 1984), Teotihuacan was most famous for its massive ruins—the remains of an ancient city that predated the Aztecs by centuries and which was regarded by them largely in mythic terms. Teotihuacan means 'the place where divinity comes into being,' a clear reflection of its importance in the cosmology of later peoples.[1]

Archaeological research has been carried out at Teotihuacan for more than a hundred years. Not surprizingly, early investigations concentrated on the most obvious and spectacular religious monuments in the city core (Gamboa Cabezas 1997). Evidence for the residential use of what we now know to have been outlying parts of the settlement is much less obvious and was greatly under-appreciated until recent times. As late as the 1950s, it was still possible to argue that Teotihuacan was simply a ceremonial center, lacking a large, permanent population (Millon 1992:344).

The Teotihuacan Mapping Project

The urban status of Teotihuacan was firmly established in the 1960s, when the archaeological site was subjected to an extensive, systematic survey. The Teotihuacan Mapping Project (TMP), directed by René Millon of the University of Rochester, was a massive project inspired by ambitious ideas and goals (Altschul 1997:643-645; Millon 1973b). The TMP began by searching for the city's margins, mapping the fall-off in archaeological materials that signals the edges of dense urban settlement at Teotihuacan. The zone so delimited was then subjected to a systematic, full-coverage survey. During the survey, the remains of thousands of architectural features visible on the surface of the site were individually described and mapped. These, as well as features of modern land use such as fields and roadways, formed the main units of observation for the TMP and the organizational basis for a surface collection program that resulted in the systematic recovery of around one million artifacts. Much less extensively, test excavations were carried out at various locations, strategically selected in order to obtain chronological and typological information from stratigraphically controlled contexts, data that could then be applied in lab analyses of surface collections, and other kinds of studies (Millon 1964; 1973b; 1974).

The TMP produced a record of an archaeological urban center that may well be unrivalled for its level of comprehensive detail (Altschul 1997:644-645), and of all the research projects that have been carried out at Teotihuacan, the TMP has probably had the greatest overall influence on how we currently understand the ancient city. The project gave us our first sense of Teotihuacan as a major pre-industrial metropolis—a settlement of an almost staggering size inhabited by a large, diverse population varying widely in terms of social status, occupation, and ethnicity.

One of the most important, long-lasting contributions of the TMP comes directly from the realization of its main goal, i.e., a highly detailed map that accurately records topography, conditions of modern land-use, and most importantly, interpretations of ancient architectural features (Millon et al. 1973). This map has played a fundamental role in much of the scholarly discussion about Teotihuacan that has taken place since the Mapping Project. Among other things, it established the sheer size of the city, the density of its residential zones, and its internal division by massive walls and long avenues. A version of the TMP map is reproduced in Figure 3.1.

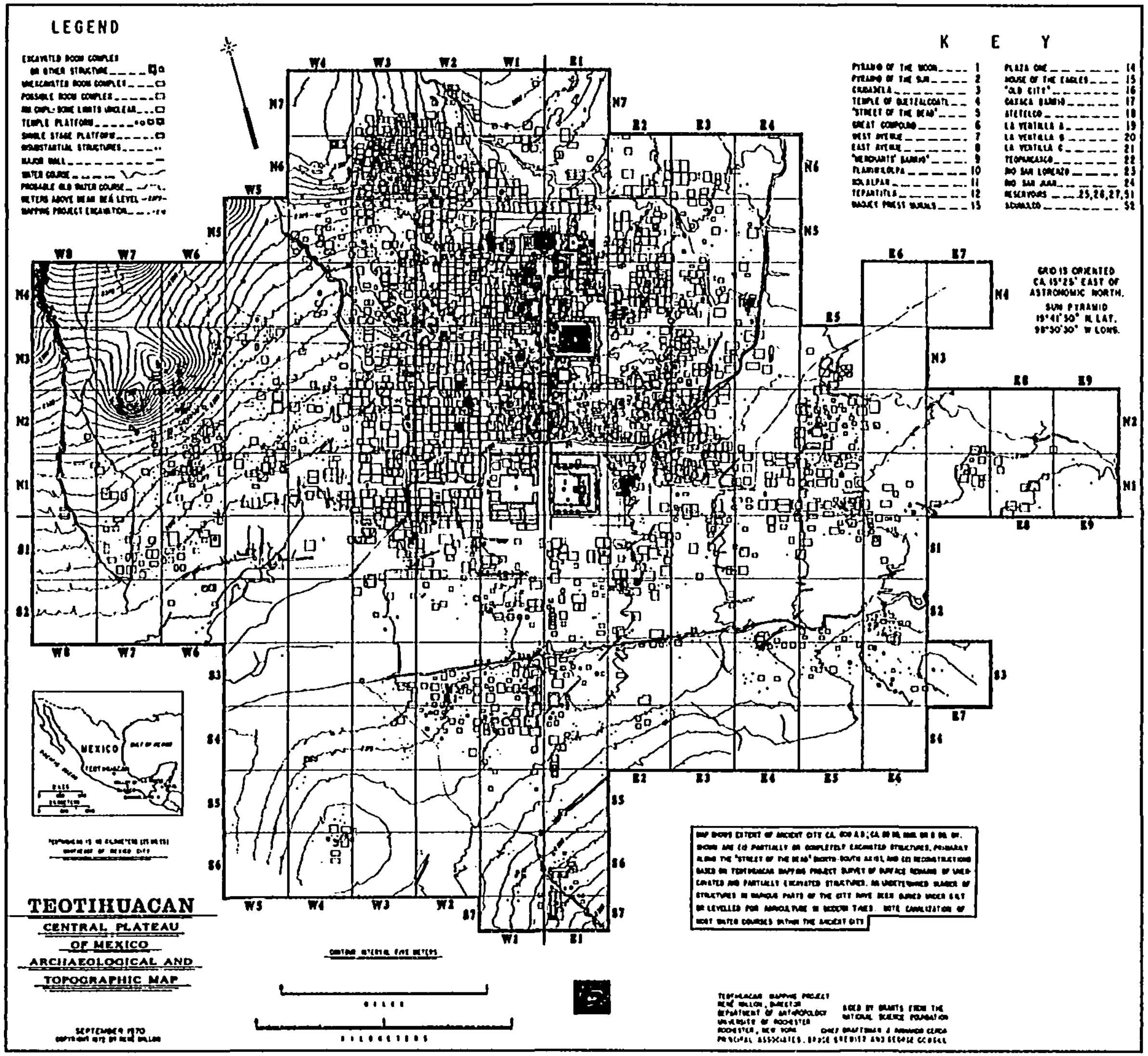

Figure 3.1: Teotihuacan, based on the 1:40,000 scale TMP map published in Millon 1973 (Map 1).

George Cowgill began digitizing the main TMP records in 1965; among the significant products to have emerged from the project are electronic datafiles that combine standardized observations made by field personnel with the results of artifact analyses carried out in the TMP laboratory. Many versions of this database have been created over the years, mostly on mainframe computer platforms that are no longer in common use. Analyses of information contained within these files have continued since the late 1960s, often involving innovative applications of computer-based quantitative methods to important theoretical issues (Cowgill 1968; 1974, 1987; Cowgill et al. 1984). More details about the nature of the TMP electronic files will be provided in Chapter Four.

Another crucial type of information to emerge from the TMP has to do with demography. A combination of architectural and ceramic data collected by the TMP has made it possible to estimate population levels during different occupation phases which roughly track the city's growth and eventual decline. By estimating the amount of sleeping space available in residential structures that the survey identified as having been occupied between about AD 350 and 500 (the Xolalpan phase, see below), Millon was able to suggest a minimum population of 75,000 for this period, with 125,000 a more probable figure (Millon 1970; 1973b:44-45). Because comparable architectural data for other phases was lacking, Cowgill used the ratio of these estimates to the total count of Xolalpan ceramics to project Millon's population estimates into both earlier and later periods (Cowgill 1974:370-373). Cowgill's phase-specific population estimates and the demographic growth curve they suggest for Teotihuacan must be regarded as rough approximations, resting as they do on necessary but insufficiently tested assumptions about the per-capita production of potsherds, the duration of different occupation phases, and the relative surface visibility of pottery from different phases.

A number of other field projects have been carried out at Teotihuacan since the TMP was initiated, mostly excavations focussed on single architectural complexes. The detailed information generated by such studies often complements the more extensive, more general data provided by survey records of the TMP. Unfortunately, too much work proceeds without sufficient control over stratigraphy or artifact collection methods, and many excavation studies remain unpublished. Examples of careful and systematic excavations in residential contexts include those carried out by Sanders (1994), Storey and Widmer (Storey and Widmer 1989; Widmer 1987; 1991), Spence (1992), Manzanilla (1993) and Rattray (1987a). A useful summary of much of this research is presented in Millon (1992).

Culture History

While the site of Teotihuacan has been occupied more or less continuously for over two millennia, the centuries of most relevance to this study fall between about 150 BC and AD 600,[2] within the Terminal Preclassic and Early Classic Periods of the conventional archaeological chronology for Mesoamerica (Blanton et al. 1993). During these years, more conveniently described simply as the Teotihuacan Period, the distinctive way of life that we associate with the city came into existence, developed, and eventually declined. The Teotihuacan Period is divided into a number of archaeological phases, based largely on changes in ceramic materials. These phases are plotted against a time scale in Figure 3.2, with divisions between phases de-emphasized to reflect the lack of certainty about their precise chronology. Absolute dates are not well established for any of the Teotihuacan Period phases, partly because relatively few radiocarbon samples from Teotihuacan have been processed, and partly because divisions between phases are somewhat arbitrary and sometimes based on subtle distinctions. Much of the pottery that was used at Teotihuacan can be attributed with fair confidence to one or more of these phases, but much cannot. The stylistic changes that have been used to define divisions were

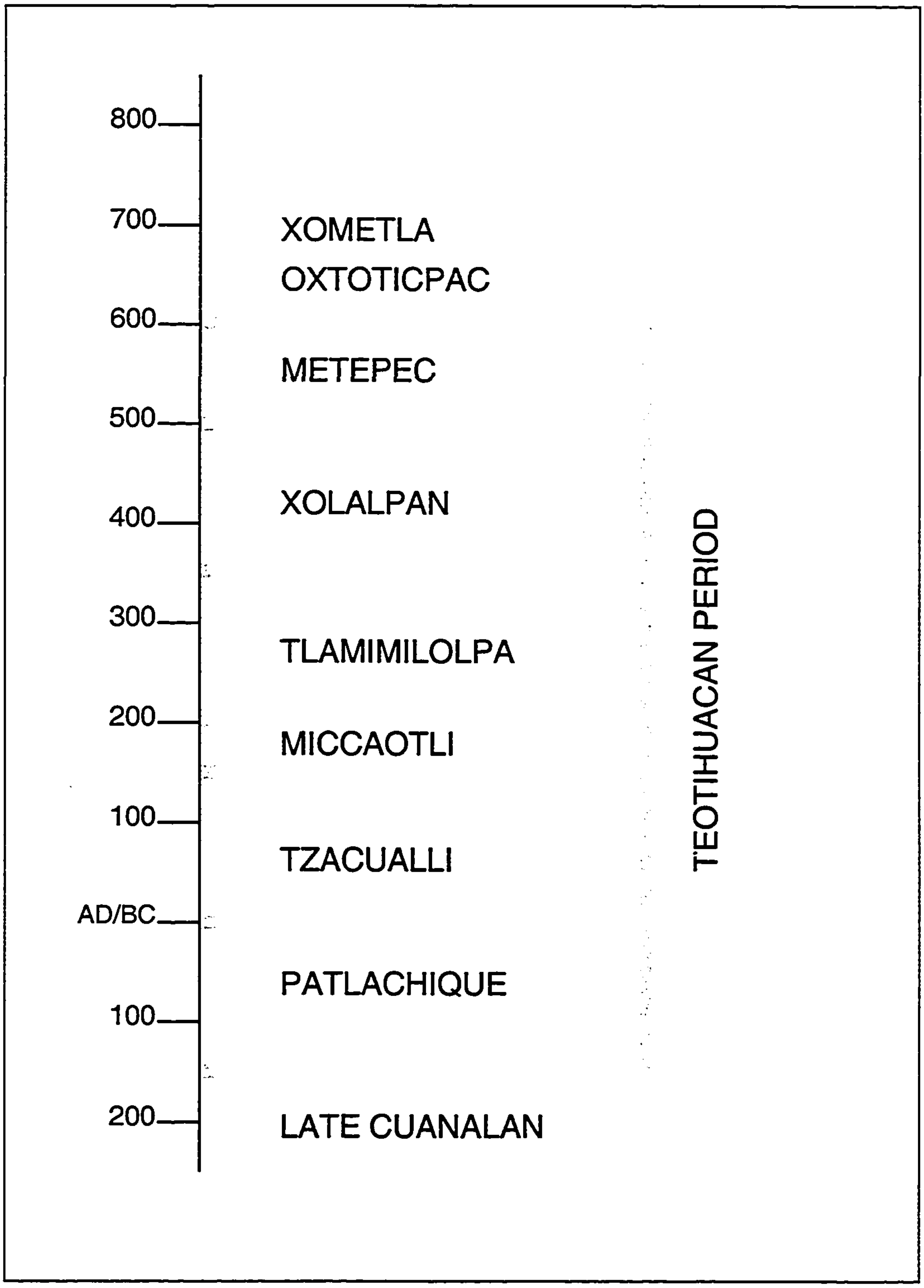

Figure 3.2: A chronology for the Teotihuacan Valley. Lines between phases have been de-emphasized to reflect current uncertainty about the dating of phase boundaries.

seldom abrupt, and important ceramic shifts also occurred within phases (Rattray 1991, 1998a).

Cuanalan Phase

The Cuanalan phase (the local variant of the Ticomán phase elsewhere in the Basin of Mexico) falls between about 500 and 150 BC. During this period, the Teotihuacan area was inhabited by a few thousand people organized in several small villages, the largest situated near springs located in what would later become the southwestern periphery of the urban center (Cowgill 1992b:Figure 5.1). Compared to other parts of the Basin of Mexico, the Valley of Teotihuacan was a demographic backwater for much of this time, with farming populations concentrated in larger numbers in more productive regions further south (Blanton et al. 1993:Figure 4.4; Sanders et al. 1979:97-102).

Some of the settlements in the southern basin grew large during this phase and made significant investments in civic-ceremonial architecture. Cuicuilco, in the southwest corner of the basin, may have been inhabited by as many as 10,000 people toward the end of the Ticoman phase, and boasted a number of large ceremonial platforms, including a circular pyramid 20 m in height. Although other, smaller centers coexisted, Cuicuilco was evidently the most powerful regional center in the southern basin.

Patlachique Phase

Sometime after about 150 BC, the settlement at Teotihuacan both shifted in location and began to increase rapidly in size, implying population numbers and densities that signal a completely new kind of settlement for the Basin of Mexico—the full-blown city. Ceramic data from the Patlachique phase (150-1 BC) are consistent with 20,000 to 40,000 individuals living in an area of about 8 square kilometers (Cowgill 1974:381-383; 1992b:94). Populations in other parts of the Basin of Mexico may have declined at around the same time (Blanton 1972; Blanton et al. 1993:122; Sanders et al. 1979:106), and immigrants from these areas may have been an important source of new residents for Teotihuacan (Cowgill 1992b:94-95). Teotihuacan was probably a significant rival to Cuicuilco, although the two centers may have enjoyed about equal influence in the Basin of Mexico for much of this time (Sanders et al. 1979:99).

Unfortunately, we have almost no details about architectural practices from this period, as most relevant data are thoroughly obscured by later building activities at Teotihuacan (but see Blucher 1971). The distribution of pottery, however, does give some hints about the distribution of structures: settlement was the most dense to the northwest of the future city core and no longer clustered around the springs; at least some low-density concentrations existed around what would later become the ceremonial core of Teotihuacan (the Street of the Dead, Figure 3.3), and large-scale religious architecture probably existed in several areas (Cowgill 1992b:91-96).

It is very likely that the enhancement of irrigation systems played a significant role in sustaining the burgeoning population of Teotihuacan. Remnants of raised agricultural fields may exist today in the vicinity of the ancient springs; it is possible that they extend back to this early period, although direct evidence is lacking (Gamboa Cabezas 1999, 2000; Millon 1957). Remains of canals have been identified in several areas (Nichols 1987; Nichols et al. 1991). Although the relative importance of the obsidian industry in early phases is difficult to judge (Spence 1984, 1987), proximity to obsidian sources in the Teotihuacan Valley and the Pachuca area further north may also have been a factor. Nevertheless, models based on narrowly conceived environmental factors are unlikely to fully explain the founding and growth of Teotihuacan, which must have had as much to do with promoting specific social and political ideas and objectives as with harnessing new economic opportunities (Cowgill 1992b:95-96; Millon 1973b:47-49).

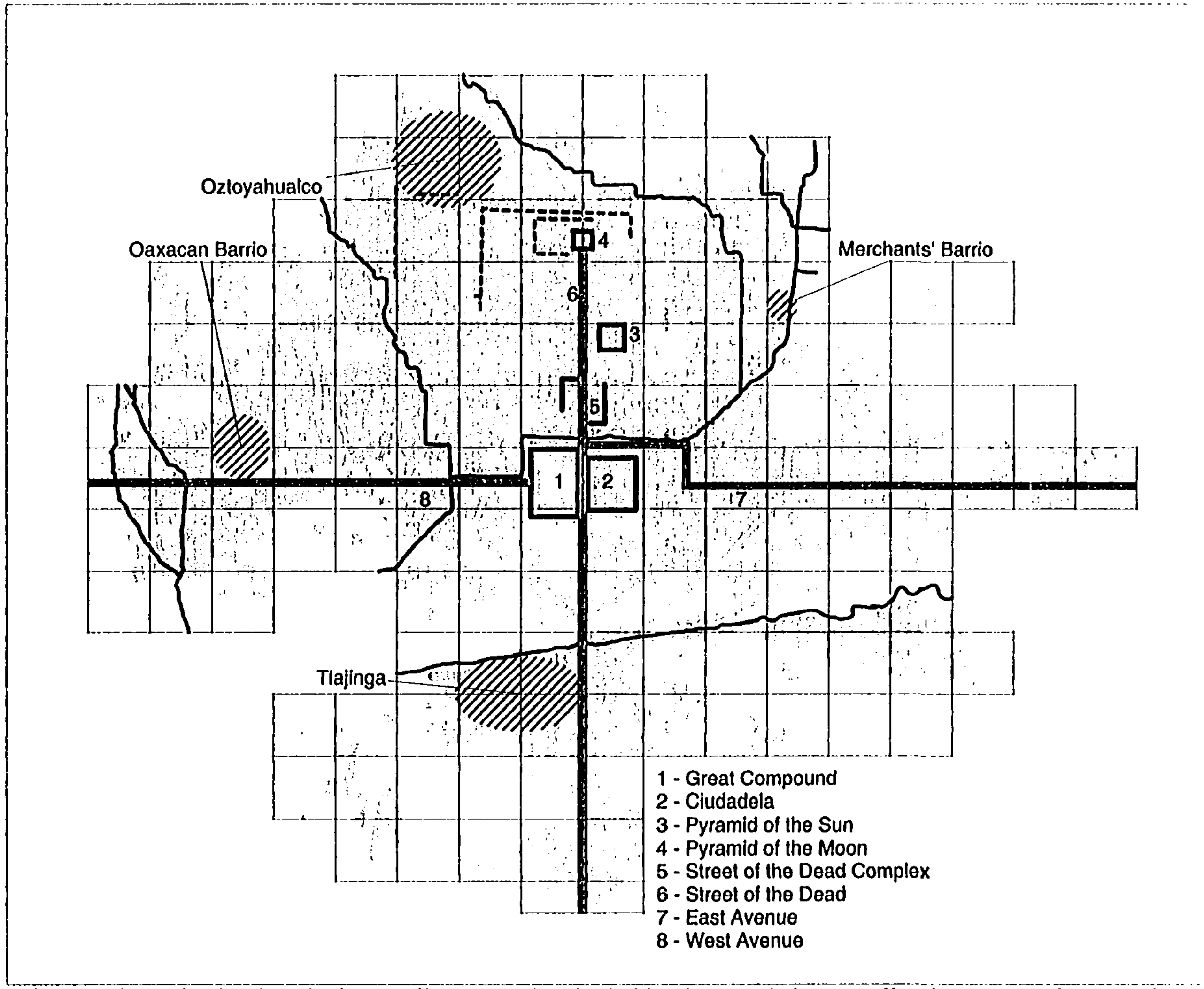

Figure 3.3: Major landmarks in Teotihuacan. The shaded background shows collection tracts where total Miccaotli-Tlamimilolpa sherd counts exceed four. Prominent examples of free-standing walls are indicated by dashed lines, watercourses by solid lines.

Tzacualli Phase

It once appeared that the balance of power between Cuicuilco and Teotihuacan was upset by the eruption of a nearby volcano in the Ajusco Range, perhaps sometime during the Patlachique phase. It is evident that lava and ash deposits from a volcano called Xictli did at some point in time destroy most of the agricultural land around Cuicuilco, perhaps somewhat later covering the settlement itself. However, several different kinds of evidence, above all recent radiocarbon dates, show that the Xictli eruptions were relatively late (ca. AD 300) and probably occurred after Cuicuilco had already declined as a political power (Cordova F. de A. et al. 1994; Siebe 2000). Siebe (2000:61) argues that an earlier, cataclysmic eruption of the volcano Popocatépetl, at around 200-0 BC, would have led to a general reduction of the population living in the southern Basin of Mexico, and perhaps played a key role in the nucleation of population at Teotihuacan. The effect that this would have had on Cuicuilco, some 70 km to the northwest of Popocatépetl, is unclear, and it may be that competition with Teotihuacan was the main reason for Cuicuilco's loss of power.

Whatever causal roles volcanic activity and/or the demise of Cuicuilco may have played, Cowgill (1974:385-388; 1992b:96) suggests that the size of Teotihuacan roughly doubled during the subsequent Tzacualli phase (ca. 1 BC-AD 150) to perhaps 60,000-80,000 inhabitants occupying a space of over 20 square kilometers. This implies a level of in-migration even greater than during the Patlachique phase, and it is estimated that as much as 90% of the total population of the Basin of Mexico was now living in the city (Sanders et al. 1979). Many of the new residents must have vacated lands that were not impacted by ash deposits and of a quality unlikely to be matched in the ever more crowded vicinity of Teotihuacan. Nevertheless, the relative roles of naked force, more subtle forms of coercion, and free-will that underlay this major reorganization of regional demography remain a topic for conjecture.

Archaeological remains from the Tzacualli phase cover all of the terrain that would be occupied during later phases, with the notable addition of a large 'tail' of occupation running into more elevated lands to the northwest of the Miccaotli-to-Metepec phase city. This zone was also occupied in Patlachique times but largely abandoned after Tzacualli; unfortunately, it has not yet been fully mapped or documented. The most densely-settled part of Teotihuacan was to the northwest of what would later become the geographical center of the city, roughly in the same location as the densest Patlachique occupation.

During the Tzacualli phase, Teotihuacan's most massive monuments began to be constructed, likely arranged, at least in part, according to a plan or plans that incorporated important cosmic ideals (Cowgill 1997:154; Sugiyama 1993). The Pyramid of the Sun (Figure 3.3), a colossal mound of earth and rubble faced with stone and concrete, was largely completed during this phase (Millon et al. 1965) as were early stages of more than twenty other substantial pyramid complexes (Millon 1981), although construction on many may have begun during Patlachique times (Cowgill 1992b:93-94, 97). Pottery samples recovered by Cabrera and Sugiyama's recent excavations into the core of the Pyramid of the Moon (Cabrera Castro and Sugiyama 1999), at the northern terminus of the Street of the Dead, suggest that this massive construction may have Patlachique antecedents, although the latest major construction phase is probably Early Tlamimilolpa (George Cowgill, personal communication 2000). Much of the Street of the Dead may have already been laid out and built during this time (Millon 1973b:42; 1981:note 11). The ability of Teotihuacan's rulers to undertake these massive projects reflects strong political power at this early period, although the sheer mass immigration into the city is equally good evidence. The two sets of phenomena—rapid immigration and monumental construction efforts—may be closely related.

Miccaotli Phase

Evidence from the TMP ceramic collections indicate that most of the terrain occupied during Tzacualli was still in use during the subsequent Miccaotli phase (ca. AD 150-200). The 'center of gravity' of the city, however, had shifted; there was a retraction from the north and west, a notable increase in settlement southeast of the Tzacualli 'core,' and the densest occupation located around the Street of the Dead (Cowgill 1974:388). Cowgill (1974) notes that a large north-south running wall near the eastern edge of map square N5W4 approximates the western limit of heavy Miccaotli sherd cover and may therefore have existed at this time. The rate of population growth had probably slowed by Miccaotli times (Cowgill 1992b:102). Although Miccaotli sherd counts are compatible with a population that was somewhat less than that estimated for the Xolalpan phase, likely the phase in which population levels peaked (Cowgill 1974:389), Teotihuacan may conceivably have reached its maximum population by the end of the Miccaotli phase (Cowgill 1997:133).

At least some further construction on the two largest pyramids was carried out during the Miccaotli phase. The "Ciudadela" was a completely new project, a massive, enclosed-plaza complex adjacent to and on the east side of the Street of the Dead, just under a kilometer south of the Pyramid of the Sun. Apartments within the Ciudadela probably served as residences and administrative offices for Teotihuacan's most elevated rulers, which Cowgill feels may have previously been located in the vicinity of the Pyramid of the Sun. Although these apartments may not have been constructed much before the early years of the Tlamimilolpa phase, the building of the Ciudadela may itself signal a reorientation of high-level political life at Teotihuacan, a reflection of new ideologies and structures associated with rulership (Cowgill 1983; 1992b:108). Relevant evidence includes the Feathered Serpent Pyramid, a huge monument that was built near the center of the Ciudadela and decorated with an elaborate facade of religious symbols that (among other things) appear to sanctify rulership (López Austin et al. 1991; Sugiyama 1992). Either during the Miccaotli phase or very early in Tlamimilolpa, foundation ceremonies for the construction of the Feathered Serpent Pyramid involved the sacrifice of around 200 individuals, most of whom were adult males buried with an impressive assortment of military symbols and regalia (Sugiyama 1995). Although prehispanic looting within the pyramid destroyed important evidence, they may have been retainers interred around the body of an important ruler. They may also have been residents of Teotihuacan, although stable oxygen isotope and other compositional analyses of bone and teeth samples suggest that most had lived at least parts of their lives elsewhere (Stuart-Williams et al. 1996; White et al. 2001). Whether they were long-term residents or newcomers, their sacrifice is a good indication of the power that the ruler or rulers of Teotihuacan at this time held over the city's inhabitants, and/or neighbouring regions.

Tlamimilolpa Phase

If the building of the Ciudadela reflected important changes in political policy during Miccaotli, certain alterations carried out during the Tlamimilolpa phase (ca. AD 200-350) may signal their reversal, conceivably a reaction against the political forces responsible for the Feathered Serpent Pyramid and its sacrificial victims. Perhaps as much as a century or two after it was constructed, late in the Tlamimilolpa phase (Cowgill 1992b:108), an intense fire was built against the base of the stairway leading up the west face of the Feathered Serpent Pyramid, presumably as a form of ritual destruction. A large platform was then built directly over this same surface, obscuring most of the western facade of the pyramid from view. It has been suggested that these events mark a break with a period of tyrannical rule (Millon 1988b; Pasztory 1988), the start of a trend that is expressed in later times by artistic styles that downplay individuality, overt power relations, and human sacrifice, while favouring values that are "impersonal, corporate, and communal" (Millon 1981:212-214; Pasztory 1988:50; see also Pasztory 1997). Sometime during

Tlamimilolpa, the focus of construction work presumably sponsored by central authorities shifted away from the Ciudadela toward the Street of the Dead, most notably the Calle de los Muertos Complex (Figure 3.3), located along the Street of the Dead between the Río San Juan and the Pyramid of the Sun (Morelos García 1993; Wallrath 1966). This area may have become the new focus of administrative activity at this time (Cowgill 1983).

While the most monumental of Teotihuacan's civic-ceremonial structures were largely complete by this time, the Tlamimilolpa phase was witness to a major construction project of a very different and more extensive kind. During this period, early and essentially undocumented residential structures began to be systematically razed and replaced by a new and highly distinctive building type that has come to be known as an apartment compound. These were large, fortress-like structures, delimited externally by thick rubble and concrete walls arranged typically into a simple rectangle or square, with sides often around 60 m in length (Millon 1981:203-210). Perhaps quite standardized in outer appearance, they are highly variable in how individual room groups and patios are arranged within them.

The number of occupants of these compounds varied widely. Some of the apartment compounds that have been excavated contained crowded clusters of small rooms, while others were clearly much more spacious (Hopkins 1987a; Millon 1981:Figure 7-4, 7-5). Millon made 'conservative' population estimates for individual compounds of either 12, 30, or 60 individuals, depending on their general size (1970:1079-1080). A less conservative, but perhaps more realistic, estimate of an average population is closer to 100 individuals (Millon 1976:216). Details aside, it is clear that these buildings usually must have housed a residential unit larger than that of the extended family. There is some evidence that these units were often corporate groups related by descent and marriage, although occupational specialization was also a factor in defining residential groups (Spence 1974). Craft production activities, although present from at least

Tzacualli, had become a very important feature of the Teotihuacan economy by the Tlamimilolpa phase (Millon 1981:225), and many apartment compounds served as workshops for part-time or full-time manufacture of pottery, obsidian tools, lapidary materials, and other goods.

Eventually, more than 2000 apartment compounds were built, and from at least the Xolalpan phase onward, almost everyone in Teotihuacan lived in them. This huge investment in construction suggests a sponsoring role for the central authorities of Teotihuacan—if nothing else, in obtaining costly raw materials such as quicklime for concrete. The Teotihuacan apartment compound is a unique dwelling type in the Mesoamerican archaeological and ethnographic record, an innovation that was probably adopted to fulfill specific needs or purposes. Whether or not the adoption of this structure was a response to some prior reorientation of social relations, they codified a particular kind of social group based on residence, and apartment compounds must have had a pervasive effect on Teotihuacan society from this time on.

Cowgill suggests that population growth ceased by Tlamimilolpa times, with little or no subsequent over-all growth. Occupation density was increasing around the Great Compound, however, and in the vicinity of the Ciudadela, eastward along the East Avenue (Cowgill 1974:389).

Xolalpan Phase

During the Xolalpan phase (ca. AD 350-500), Teotihuacan was at the height of its visibility and influence in greater Mesoamerica (Millon 1988a:114-136). Millon has estimated the Xolalpan phase population at 75,000 to 125,000 and regards figures at the upper end of the range as more likely than those at the lower end (Millon 1976:212).

Materials and symbols related to Teotihuacan culture are widely spread during this period, found in archaeological sites in regions as distant as the Gulf Lowlands, the Valley of Oaxaca, and the Maya Highlands and Lowlands, including Kaminaljuyú, Tikal, and Copán (see Coggins 1979; Kidder et al. 1946; Marcus 1983b; Sanders and Michels 1977; Santley 1989; Santley et al. 1987; Schele and Freidel 1990:147, 159-164). Opinions have varied widely over the behavioural implications of evidence for interaction between Teotihuacan and far-flung polities and regions. Obtaining exotic raw materials was clearly important to its various craft production industries (Cabrera Cortés 1995; Charlton 1977; Kolb 1987; 1987; Turner 1988), but the portrayal of Teotihuacan as the hub of an expansive trading empire (Santley 1983) has fallen into disfavour. Most researchers have taken conservative positions in which direct political and economic control much beyond the Basin of Mexico is regarded as unlikely (Clark 1986; Cowgill 1997:134-135; Drennan et al. 1990; Stark et al. 1992), and widespread dissemination of ideas and items from Teotihuacan is attributed to elite emulation (Demarest and Foias 1993) and gift exchange (Spence 1996). In any case, Teotihuacan's reputation and prestige clearly did loom large in very distant places, and the case for direct and even aggressive intervention in the politics of certain Maya cities by individuals somehow related to Teotihuacan, if not necessarily the Teotihuacan state, may be stronger than was once thought (Cowgill 2002; Fash and Fash 2000; Stuart 2000).

Closer to home, Teotihuacan appears to have enjoyed direct political control over several regions adjacent to the Basin of Mexico. There was a major Teotihuacan outpost at Chingú (Díaz Oyarzábal 1980, 1981) some 60 km to the northwest of Teotihuacan, in the Tula Valley of Hidalgo; the surrounding region may have been important for obtaining the quick-lime that was so extensively used in construction at Teotihuacan itself. Settlement patterns in eastern Morelos are strongly suggestive of Teotihuacan invention and control, and it has been suggested that cotton for textile production may have been an important resource obtained from this region (Cabrera Cortés 1999; Hirth 1978, 1980; Hirth and Angulo Villaseñor 1981). The Toluca Valley, a region roughly 25 km to the west of the Basin of Mexico, may also have been controlled by Teotihuacan (González de la Vara 1999).

There is some evidence that, toward the end of the Xolalpan phase, various kinds of socio-economic problems may have been affecting the ability of Teotihuacan's rulers to control its local population and perhaps its external affairs. The population of the city may have declined somewhat, and, compared to earlier and later phases, relatively few construction projects appear to have been initiated (Millon 1988a:142-144). Mortuary offerings hint at a broadening of socio-economic inequality among different residential groups (Sempowski 1987; 1992; 1994). Increased 'regionalization' of certain areas in Teotihuacan's 'outer hinterland' may reflect a weakening of control over long-distance exchange systems (Millon 1988a:141-142).

Metepec Phase

Socio-political and economic problems experienced by the Late Xolalpan residents of Teotihuacan may have contributed to a loss of administrative power and centralized control during Metepec (ca. AD 500-600), the final phase of the Teotihuacan Period.

The major episode in the latter years of Teotihuacan history was the deliberate, cataclysmic destruction of major civic-ceremonial structures, carried out sometime between about AD 550 and 650. Once thought to have pervaded the city, the conflagrations involved in effecting this destruction were focussed on buildings in the core of the city, mostly religious and elite residential structures on or near the Street of the Dead. Millon argues that the destructive activities, while almost certainly reflecting high levels of purposeful fury, had a significant symbolic/ritual component. Millon also believes that the burning of Teotihuacan was most likely carried out by the city's residents rather than by outsiders, perhaps in reaction to the policies or actions of their own civic leaders (Millon 1988a:149-158). In fact, what little evidence bears on this is ambiguous; whoever was responsible for this destruction, it is good evidence for a serious decline in a social and political system that had worked well at Teotihuacan for a period of centuries (Cowgill 2000:289-290).

While the burning of Teotihuacan is conventionally associated with the end of both the Teotihuacan Period and the Metepec phase, Teotihuacan was abandoned only briefly or not at all. Although the former core of the city was never again a focus of occupation, post-Metepec populations appear small only in comparison to earlier times. There may have been 30,000 to 40,000 people present during the succeeding Coyotlatelco phase (ca. AD 600-800). In Cowgill's opinion, many, perhaps all, of these people may have been newcomers (George Cowgill, personal communication 2001).

Socio-Spatial Organization

As far as we know, cities have never been 'flat', homogeneous monoliths; economic, social and political diversity is fundamental to the way in which urbanism has been conceived by social scientists. Most of these various dimensions of diversity have spatial components that give rise to the larger-scale patterns that give a city socio-spatial texture. In this section I move beyond the rather general culture-historical characterization presented above. Drawing on results of previous research I begin to characterize Teotihuacan as a socio-political landscape—a palimpsest of spatial subunits of different sizes and shapes, reflecting variable effects of different kinds of motives and actions.

Because the Mapping Project succeeded in surveying almost all of the area that was densely occupied during the Miccaotli to Metepec phases, the TMP data files have been particularly useful for answering questions about the spatial organization of Teotihuacan, including the spatial expression of socio-economic variability. An immediate result of the project was to show that the field data recovered from Teotihuacan contained evidence for different kinds of internal differentiation. Revealed through the combined effect of patterned formal and spatial differences in material remains, expressions of internal variability appeared to exist at different scales, perhaps reflecting different levels of organization. Various parts of the city exhibited characteristics that distinguished them from other areas, with smaller units sometimes subsumed by larger ones.

Variability at the Level of Individual Structures

In living populations, it is often possible to examine variability at the level of individual households and even at the level of individual people. While the resolution of archaeological data seldom permits such detailed inquiry, the site of Teotihuacan offers the opportunity to examine urban socio-economic variability at a relatively fine-grained scale.

For much of Teotihuacan's history, most of the city's inhabitants lived in multi-household residential structures known as apartment compounds. Although some degree of corporate and/or kin-based relationship is thought often to have linked together many of the households that shared these multi-roomed buildings (Millon 1976:221-224; Spence 1974; Widmer and Storey 1993), our still meagre sample of excavated apartment compounds indicates that such households were not necessarily of equivalent social or economic status. Differences in space allocation (Hopkins 1987a; 1987b), degree of architectural elaboration and decoration (Séjourné 1966b), and investment in mortuary offerings (Sempowski 1987; 1992) suggest that certain individuals and households sometimes had significantly greater access to wealth than others living in the same apartment compounds.

While experiments conducted by Jeffrey Altschul have shown that small-scale surface artifact collections are potentially informative about socio-economic variability within individual apartment compounds (Altschul 1981:194-257), for reasons of practicality the TMP used single apartment compounds as the basic provenience units for investigating residential zones of the city. This does not mean that the TMP collection procedures systematically failed to obtain or eliminated evidence for socio-economic variability. It is clear, for example, that many of the apartment compounds for which we have relevant information can be usefully characterized *as a whole* according to some scale of wealth or status, and so compared to other architectural units (Millon 1976:226-228; Sempowski and Spence 1994:262; Widmer and Storey 1993:87-88). For the purpose of this summary, therefore, I begin by focussing largely on the apartment compound, the basic residential unit during the Xolalpan and Metepec phases and probably much of the Tlamimilolpa phase. Relevant information about other kinds of structures will also be considered, including 'room groups' and 'insubstantial structures.' *Room group* designates a set of rooms, typically on a platform adjacent or very close to a pyramid (Sload 1982:23). *Insubstantial structure* refers to a concentration of artifactual debris that suggests at least the possibility of residential activities, but without evidence for substantial architectural remains—at least some of these concentrations may be the remains of adobe or other kinds of perishable structures (Cowgill et al. 1984:159, 174; Millon 1973b:23-24). Others may be trash dumps.

It is certain that there was much variability in the status and power held by individuals within Teotihuacan society, but what are most clear in the available data are differences in architectural features and mortuary behaviour (Millon 1976; Sempowski 1987; 1992). These probably relate most directly to wealth-based variation but probably also correlate in more complex ways with differences in status and/or power (Cowgill 1992a).

Millon (1976), focussing mostly on features revealed during the excavation of apartment compounds (size and number of rooms, decoration, construction methods, associated burials), has argued that Teotihuacan society had at least six status levels. The highest was occupied by the rulers of Teotihuacan and the lowest by residents of compounds exemplified by La Ventilla B and

Tlamimilolpa (Millon 1976:227; 1981:214). Individuals living in 'insubstantial' adobe houses, rather than apartment compounds, may have constituted a still lower level. While it is apparent that residential structures reveal at least a gradient of wealth and undoubtedly status differences as well, the small number of apartment compounds that have been excavated makes it difficult to evaluate the degree to which status levels were discrete, or well-bounded.

Localities near to the center of the city *tended* to be occupied by relatively greater proportions of high status individuals (Cowgill 1992a:215-216), but Millon points out that the variability exhibited by excavated apartment compounds suggests a mosaic pattern, not a linear status-gradient running from the city core to its outskirts (Millon 1976:220). In at least some instances, adjacent apartment compounds appear to reflect markedly different overall status levels. Millon notes this pattern for two apartment compounds (Zacuala Palace and Zacuala Patios) excavated in square N2W2 (Millon 1976:227; 1981:211). A similar situation has been reported for two adjacent apartment compounds recently excavated in squares S1W2 and N1W2, within the La Ventilla district of Teotihuacan (Cabrera Castro 1996, 1998a; Gómez Chávez 1996, 2000).

Although surface observations of architectural data collected by TMP field workers lack the detail and resolution associated with excavation data, they have been used by Cowgill et al. (1984:173) to tentatively classify residential structures based on a less elaborate, 3-tiered scale of social status. Insubstantial structures (as defined above) constitute the lowest level. Apartment compounds and room groups that were identified by field workers as 'high-status' (largely on the basis of unusually high quality building materials, and/or proximity to the Street of the Dead) occupy the highest tier. The remaining apartment compounds and room groups (i.e., those not identified as 'high-status') were lumped into a broad, intermediate level category that probably masks a great deal of socio-economic variability.

A more systematic, fine-grained examination of socio-economic variability was undertaken as dissertation research by Rebecca Sload (1982) and summarized in Cowgill et al. (1984:176-182). Sload used a series of discriminant analyses to assess the degree to which data in the TMP surface collections might corroborate, modify, or otherwise illuminate the 3-tiered system based on the high, intermediate, and low-status categories described above.

In Sload's study, two architectural sub-groups of the high-status category were distinguished: apartment compounds and room groups. In an effort to isolate a set of structures most likely to have served similar functions, only room groups within 250 m of the Street of the Dead were included in the analysis. The low status group composed of insubstantial structures was subdivided on the basis of distance to the nearest apartment compound, with 'close insubstantial structures' (closer than 25 m from an apartment compound) forming one input group and 'distant insubstantial structures' (more than 60 m from an apartment compound) forming another input group. This was done to distinguish between localities that were likely to have been actual dwellings (the 'distant group') from those that may often have been outbuildings or dumps associated with apartment compounds (the 'close' group).

Counts for thirteen artifact categories pertaining to the Xolalpan-Metepec phases (all but one pottery or figurine categories) were standardized as percents within each collection, using the total artifact count within these thirteen categories ('rawcount') as the denominator. The percent-standardized counts were combined with the unstandardized 'rawcount' value in a discriminant function analysis aimed at characterizing differences among the five input groups described above.

Among other things, Sload's study showed that the input groups could be differentiated from one another by three linear functions that also suggested positive and negative associations with specific artifact categories. For example, a distinctive, locally-made ware (San Martín Orange) used for cooking and storage was positively associated with 'high-status' apartment compounds, as were several other vessels that represent a mixture of ritual and domestic activities. 'Intermediate-status' apartment compounds also showed a positive association with artifacts that served both domestic and ritual functions, although the specific categories involved were different (Cowgill et al. 1984:178). A functional distinction between 'high-status' apartment compounds and 'high-status' room groups was supported, with apartment compounds showing a "wider and more intense use of categories associated with domestic activities" (Cowgill et al. 1984:181). The location of 'high-status' room groups (i.e., close proximity to pyramids) and the suites of artifacts found on them are consistent with the idea that these rooms served a relatively limited range of purposes, and were likely used by priests for some combination of residential, ritual and administrative activities.

Intermediate Level Constructs – Enclaves and Barrios

Foreign Enclaves

As the TMP survey of Teotihuacan began in the 1960s, it became quickly apparent to fieldworkers that parts of the ancient city were characterized by architectural remains and by suites of artifact types that set them apart from other such areas.

TMP surface collections concentrating in an area near the western periphery of Teotihuacan (principally in squares N1W6, N2W6 and N2W5) contained low but significant proportions of ceramic wares that had clear stylistic connections with pottery made by prehispanic peoples living in the Valley of Oaxaca, about 300 kilometers to the southeast (Millon 1973b:41-42). Subsequent excavations recovered both fine and utilitarian pottery of Oaxacan style, and iconographic and mortuary evidence verifying that people of Oaxacan ethnic origins lived in this part of Teotihuacan, now known variously as the Oaxaca barrio or enclave, the Zapotec barrio, and 'Tlailotlacan' (Gómez Chávez 1998; Rattray 1993; Spence 1992). The settlement of this part of Teotihuacan by what may have been recent immigrants from Oaxaca occurred during the early part of the Tlamimilolpa phase, perhaps around AD 200, and their occupation persisted into the Metepec phase (Rattray 1993:7-15). During this time, they lived in buildings that do not appear to have differed significantly from the typical Teotihuacan-style apartment compound; material expressions of ethnicity were primarily manifested in mortuary and other kinds of ritual contexts, and in the manufacture and use of certain distinctive kinds of pottery—behaviours that would have been visible to community insiders, but not necessarily to the wider population of Teotihuacan. Rattray estimates that the 'Oaxaca barrio' may have housed as many as 500 individuals (Rattray 1993:6). It is unclear what role these people played in the local economy, but there is weak evidence for involvement in the importation of lime and green obsidian, both materials that were brought to Teotihuacan from locations in the modern state of Hidalgo to the north. At least two other sites combining significant quantities of Oaxacan-style and Teotihuacan pottery have been identified in the vicinity of Tula, Hidalgo, some 50 kilometers northwest of Teotihuacan (Crespo Oviedo and Mastache de Escobar 1981; Díaz Oyarzábal 1980).

There is at least one other well-documented 'foreign' enclave in Teotihuacan, also located well away from the city's core, but on the eastern rather than the western periphery (squares N4E4 and N3E4). This enclave, usually described as the 'Merchants' Barrio,' had cultural connections with the Gulf Lowlands of Mexico and may have been involved in long-distance trade involving the Gulf Lowlands, the Maya Area, and Teotihuacan. Surface collections from tracts in this area contain modest but significant percentages of pottery imported from the Gulf Lowlands; a lower percentage of sherds are from the Maya area. Unlike the inhabitants of the Oaxacan enclave, these individuals lived at least partially in highly distinctive, circular, residential structures. Rattray regards these as stylistically similar to houses used in the Gulf

Lowlands during this period (Rattray 1987b); they would have been visibly 'foreign' in Teotihuacan, a striking contrast to the larger, rectilinear apartment compounds inhabited by most residents.

Evidence for the multi-ethnic character of Teotihuacan has been reinforced by more recent excavations (in square N1W5) slightly to the east of the area thought to have been the primary focus of Oaxacan settlement. Only partially analyzed and published, these excavations included the investigation of a kind of mortuary facility that is described as similar to the highly distinctive shaft-tombs typical of certain prehispanic cultures in West Mexico (Gómez Chávez 1998:1476-1485). Artifacts recovered from this work, notably figurines, are related stylistically to Classic Period materials found in the modern state of Michoacán (Cabrera Castro 1998b), and it is likely that individuals living in the associated compound had cultural connections with that part of Mesoamerica. A West-Mexican ethnicity was not shared by everyone living in this compound and other residents appeared to hold the Oaxacan identity more clearly characteristic of the area immediately to the west (Gómez Chávez 1998:1476).

Karl Taube (2002) and others (e.g., Millon 1973a) have identified iconographic elements in mural paintings in the excavated apartment compound known as Tetitla that are clearly based on artistic and iconographic conventions from the Maya area, as well as examples of what is almost surely Maya writing. It is likely that ethnic Maya lived in this compound, although probably not to the exclusion of ethnic Teotihuacanos, since Teotihuacan-style mural art is also very prominent among the Tetitla murals.

Barrios

While the so-called 'foreign' enclaves have captured the most attention, many other, and presumably other *kinds* of, intermediate-level spatial subdivisions have been tentatively identified in the TMP data and are usually described as barrios or neighbourhoods. These entities are still understood largely in terms of their physical and artifactual manifestations, and, unlike the foreign enclaves, we seldom have any clear idea of the socio-economic behaviour that gave rise to them.

Spatial clusters of architectural structures revealed by the TMP map—groups of buildings that appear to be delimited by relatively unoccupied terrain, and/or by natural or artificial inhibitors to movement—appear to provide good *a priori* evidence for some sort of special identity or status. An example of this type of phenomenon is the well-defined block of residential buildings in the northeast corner of square N4E2. Only a handful of other cases are so clear, however, and most appear as *possible* spatial clusters with vague or ambiguous limits (Cowgill 1997:138).

Another type of spatial sub-division was revealed by patterns in the distribution of specific kinds of surface remains, especially the artifacts collected during the surface survey. The two cases of 'foreign enclaves' described above are notable examples, but artifact collections identifying areas where people engaged in similar economic pursuits are more common. Multiple examples of localities in Teotihuacan where obsidian workers (Spence 1986), potters (Krotser and Rattray 1980; Krotser 1987), and lapidary workers (Turner 1987) were concentrated have been tentatively identified. The individual residential units that were located in such areas may have been connected by a form of corporate organization (Millon 1973b:40-41; 1976:225).

René Millon (1981:211) prepared a map of possible barrios at Teotihuacan, based on the general kinds of information discussed above: patterned variability in surface artifact samples and observations about architectural remains; evidence for clustered workshops; discontinuities in the spatial arrangement of residential and other structures. His map shows 157 barrios that vary widely in size, shape and composition. Neither the map nor detailed arguments for barrio definition have been published. Millon's barrios should be regarded as a series of hypotheses for future testing, rather than as a basis for discussing urban regionalization at Teotihuacan.

As part of a broader study, Jeffrey Altschul (1981) undertook a detailed analysis of barrios at Teotihuacan, using electronic data files of the TMP in an attempt to evaluate the more informal observations of Millon by identifying material correlates for barrios in the surface artifact collections. Recognizing that a variety of different kinds of barrio-like structures likely existed, Altschul focussed his examination of the TMP data sets on evidence for *homogenous organizations.* These were modelled as entities in which members would share both residential location and enough salient behavioural characteristics that within-group variability would be small relative to outside-group variability (Altschul 1981:99-101). While other kinds of organizations (i.e., *heterogenous organizations*) were acknowledged as likely to have existed in many parts of the city, the material correlates associated with them presumably were thought to be patterned in ways that would hinder recognition, making a search for them unprofitable.

With the implied assumption that some of the distinctive behaviours thought to characterize homogenous organizations would involve the use of distinctive assemblages of ceramic vessels, Altschul looked for spatial patterns in the surface pottery collections of the TMP. Focussing on several spatial sub-samples of the Mapping Project data files and 25 ceramic categories that were used during the last centuries of Teotihuacan Period occupation (Xolalpan and Metepec phases), Altschul used hierarchical cluster analysis to classify collections on the basis of their ceramic profiles. Where possible, resulting clusters were interpreted on the basis of positive and negative associations of ceramic types, and cluster memberships were mapped to determine if groups of contiguous collection tracts belonging to the same cluster—the anticipated archaeological signature of homogenous organizations—were present.

Altschul's results produced relatively little evidence that homogenous spatial units were characteristic features of the Teotihuacan urban landscape. Most of the areas he examined showed complex mixtures of cluster memberships that argued against a model in which spatial units exhibited limited internal variability (Altschul 1993).

High Level Patterns – Urban Planning and Emergent Social Districts

Just as it is possible to group individual buildings into neighbourhood-like entities or barrios, it has sometimes been possible to identify higher-level entities that encompass multiple barrios, as well as structures that do not appear to be part of barrios.

For example, Teotihuacan appears to have been divided into quadrants by a pair of nearly perpendicular avenues (i.e., the Street of the Dead and the East and West Avenues) that intersect at a major architectural complex in the heart of the city. These features do not appear to have had an obvious impact on intrasite settlement variation, although they do delimit zones in which settlement density differs substantially. Construction around cruciform axes probably had less influence on city administration at Teotihuacan than at Tenochtitlan (Calnek 1974; Hassig 1982), for example; their emic importance appears to lie mostly in the symbolic realm, and their etic importance in what they appear to say about early, centralized planning.

The degree to which the layout and construction of Teotihuacan were subject to centralized planning has important implications for our assessment of political organization, especially the amount of control and power available to Teotihuacan's early rulers. René Millon (1973b:42-43) asserts that the map of Teotihuacan shows evidence for a 'great deal of planning,' although not necessarily for early and sustained adherence to a master plan. He suggests that the axes of movement that give Teotihuacan its fundamentally quadripartite organization were established early, perhaps around 1 BC. The orientation of one of these—the Street of the Dead, at about

15.5° east of true north—was closely followed by almost all other structures to be built at Teotihuacan during the Teotihuacan Period (Drewitt 1967, 1987).

Saburo Sugiyama (1993), also drawing on spatial arrangements revealed by the TMP map, has identified stronger evidence for a master plan, one that may have governed the location of major civic-ceremonial monuments in the city core. Based on a standard measurement unit posited at around 83 cm, Sugiyama showed that linear dimensions of and (more importantly) *between* major monuments incorporate numbers with religious and/or calendrical significance. This suggests that an integrated plan governing the spatial relationships of many of these structures was formulated early in the city's history, although their actual construction appears to have unfolded over the course of generations (Cowgill 1997:154; Millon 1992:382-397).

On the other hand, much of the construction that was carried at a smaller scales must have been the result of local decisions; sometimes structures may appear to conform to a larger plan simply because they were fitted around the basic cruciform plan and follow the standard orientation of "Teotihuacan north" (Millon 1973b:36, 42-44). It is important to recognize the possibility of *emergent* patterns that originate in low-level decisions, but that collectively form larger, perhaps highly patterned entities. For example, many of the spatial phenomena revealed by factorial ecological studies in modern cities (Chapter Two) are this type of entity—social areas that develop largely because of residential location choices made at the level of households.

This may be the sort of spatial entity that René Millon (1973b:43) had in mind when he suggested that the residents of Teotihuacan might have made a conceptual distinction between 'inner' and 'outer' zones of the city, the former being the relatively dense, compact zone comprised largely of high-status residential and civic-ceremonial structures clustering along the Street of the Dead and around adjacent areas further west. The idea of an 'outer city' was suggested by the more dispersed settlement of areas nearer the outskirts, perhaps largely residential areas mostly housing individuals of relatively low status and notably containing both of the foreign enclaves described above.

The rather vague distinction between an 'inner city' and the rest of Teotihuacan is probably most compatible with relatively low-level, local decision making, but there is some evidence that top-down planning may also have been involved to some extent. Certain architectural features and arrangements—buildings situated directly on the East and West Avenues, for example, in squares N1E6 and N1W5—may have signaled intended limits to the city (Millon 1973b:43-44; 1976:212); if so, they bolster the idea of a division between inner and outer zones, although the evidence is far from clear. More telling are the remains of long and perhaps once high walls that subdivided certain parts of the city, especially in the northwest quadrant. Prominent examples can be seen in the vicinity of the Moon Pyramid, and in squares N5W2 and N4W2, N5W4 and N6W3 (Millon 1973b:39-40). One wall was found to have been ca. 5 m in height where it abuts the Pyramid of the Moon (Teotihuacan Mapping Project Test Excavation 5, George Cowgill, personal communication 2001). These and other remains of walls are shown in Figure 3.3.

Notes for Chapter Three:

[1] Various meanings for *teotihuacan* have been suggested, including 'place of worship', 'abode of the Gods', 'the place where men became Gods, and the 'place of those who have the road of the Gods' (see Millon 1992:359). In fact, none of these translations are compatible with the morphology of the word, which is clearly composed of the elements: teoti <denominal verb "to become divine">; -hua <impersonal suffix>; and -can <locative noun "place where">. A fairly literal, if inelegant, translation is 'place where there is becoming of divinity.'

[2] These and other dates are in calendar years unless otherwise indicated.

Chapter Four

EMPIRICAL FOUNDATIONS FOR EXPLORATORY SPATIAL ANALYSIS

This chapter describes the various lines of empirical evidence on which this study is based and how the organization, format, and content of background data affect our ability to use them to answer relevant anthropological questions. A general theme concerns the use of surface survey data as a basis for reconstructing prehistoric spatial organization. More specific issues include the provenience units that were used to organize TMP field data and the artifact typologies that underlie the main TMP databases.

Surface Artifact Collections as Archaeological Data

This research project relies almost exclusively on artifact samples that were collected from the modern surface of Teotihuacan, using them to assess the relative importance of different kinds of domestic, ritual, and other activities in different parts of the city. The rationale for this is straightforward. Although data recovered from excavation tends to have greater time-space resolution than data recovered through surface survey, the percentage of ancient Teotihuacan that has been systematically investigated though any form of subsurface procedure is very low. Much of the city, particularly that falling outside the official Archaeological Zone of Teotihuacan and the protection of the Instituto Nacional de Antropología e Historia (INAH) of Mexico, continues to disappear under urban sprawl; given the labour and other costs of excavation, it is unlikely that a high proportion of what remains will ever be excavated. In spite of the undoubted value of carefully controlled excavation for addressing archaeological problems (Gómez Chávez 1996:33), for purely practical reasons any gains that we hope to make in understanding the *large-scale* organization of the ancient city will—at least for the foreseeable future—necessarily rely on the extensive surface collection made by the Teotihuacan Mapping Project.

A wide range of natural and cultural processes can distort the relationship between any class of archaeological remains and the questions that anthropologists would like to ask of them (Schiffer 1987), and it is important to consider the pitfalls that may be confronted in identifying and interpreting patterns in surface data. In the case of the TMP data, there are three main areas of concern: artifacts relating to early occupation may have been systematically masked by later human and natural deposits; artifacts may have been frequently subjected to secondary disposal and/or lateral recycling practices that displaced them from localities in which they were actually used; and the recovery of the sometimes small number of artifacts visible on the surface may fail to represent adequately larger populations of interest.

Given the natural and cultural processes of deposition that operate in densely occupied, long-lived settlements, one might reasonably expect that artifacts pertaining to early periods of occupation will have a low degree of archaeological visibility, either under-represented on, or simply absent from, the modern surface of sites like Teotihuacan. In fact, there are reasons to be cautiously optimistic. As Cowgill (1974:367) has noted, many parts of Teotihuacan that were densely occupied in later phases show abundant surface remains from earlier periods as well. This is due to the fact that the sediments at Teotihuacan are generally not very deep, rarely more than a few meters, and often less than a meter or two. The degree of ancient digging associated with architectural construction and repair work seems usually to have vertically mixed deposits to the extent that both early and later materials are well represented on the surface and thus available for sampling. If Teotihuacan were anything like one of the deeply stratified *tells* of the Near East, the situation we face would be very different.

The possibility that artifacts were systematically displaced from locations of primary discard, either as the result of construction work or refuse disposal practices, is of greater concern, and Santley and Kneebone provide useful cautions to that effect (1993). It is certain, in fact, that such processes occurred, and in some localities traces of behavioural patterns that are of great inherent interest must have been distorted or even eradicated. A necessary assumption of this study, however, is that lateral displacement of archaeological remains mostly occurred over relatively short distances and at scales that did not seriously homogenize artifact collections over horizontal space. Given the overall size of Teotihuacan (ca. 7,000 m along its major axes) and typical sizes of TMP collection tracts (the median size is approximately 60 by 60 m), the degree of spatial dispersion that would seriously compromise the recognition of spatial patterns at smaller sites would have only a moderate blurring effect at Teotihuacan. Supporting this contention is the fact that abrupt changes in the frequency of artifact types in collections from adjacent structures are common at Teotihuacan. Jeffrey Altschul (1981:194-257) found evidence that, in at least some cases, the location of surface artifacts may even be informative about patterned spatial differences *inside* apartment compounds, although this relates to a more finely-grained analysis than is undertaken here. Also, 'hazardous' waste products such as obsidian would have been more subject to deliberate locational displacement than benign materials such as broken pottery, the empirical basis for this analysis.

While (often fairly minor) discrepancies between architectural reconstructions based on the TMP surface survey (Millon et al. 1973) and details revealed by excavation have been noted (Cabrera Castro 1982; see also Hendon 1992), clear correspondences between TMP surface artifact collections and subsurface materials have been demonstrated on numerous occasions (Cowgill 1974:368; Rattray 1990a; Sanders 1993; Spence 1992:59; Turner 1992:92). For example, the presence of workshops and the existence of workshop sub-specializations were suggested by surface remains in the Tlajinga district and confirmed by subsequent subsurface testing (Sanders 1993:278-279). There are relatively few good examples of the contrary situation—where excavation revealed materials completely unanticipated in surface remains—but the discovery of a censer adorno workshop in a precinct just north of the Ciudadela (Múnera Bermúdez 1985) serves as a reminder that they will occasionally occur.

Finally, appropriate statistical procedures can help control the effects of sampling error in small artifact samples. This matter is taken up in Chapter Five, which describes the use of Bayesian estimation as a means of improving the characterization of small artifact collections.

The TMP Datafiles

The main empirical resources used in this dissertation are the spatial information contained in published and unpublished versions of the TMP map of Teotihuacan and computer files describing individual spatial units and the results of typological analyses carried out on surface artifact collections.

Fairly early in the TMP research program, Cowgill and associates began to assemble an electronic database for managing descriptive information generated in the field and laboratory. A number of versions of the database were created, the earliest incomplete and used mostly for testing, later versions incorporating more data and various kinds of changes and improvements (Cowgill 1993). The most recent database, DF8 (for Data File 8) was completed between about 1975 and 1977 and, in the early 1990s, converted from a mainframe VAX version into various PC-based database formats, notably Paradox (Borland International 1995). DF8 contains information on 5,046 cases, each case normally corresponding to one of the spatial tracts defined during the field survey for organizing artifact collections and feature descriptions. There are approximately 300 data fields in DF8. Some contain basic administrative and locational data while others provide more strictly descriptive information that includes the nature of preserved architectural remains, land-use and vegetative cover at the time of the survey, and local patterns of sediment erosion and deposition. Roughly half of the fields record artifact tabulations that were generated from typological analyses of the approximately one million artifacts in the TMP collections.

Initial tabulations of ceramic materials (a total of around 900,000 rim and feature sherds) were carried out simultaneously with or soon after the field survey activities of the 1960s; the results of most of this work are recorded in 111 fields in DF8. A substantial amount of analysis has been based on these data (e.g. Altschul 1981; Cowgill et al. 1984; Sload 1982), but the typology on which they were based incorporates significant problems and limitations. Even before the first analysis was completed, plans were laid for a complete retabulation of the TMP ceramic collection; the result of this ambitious project was the REANS database. Further detail on both DF8 and REANS is provided below.

The map of Teotihuacan created by the TMP was published in 1973 in the form of 147 map sheets, drafted at a scale of 1:2,000 (Millon et al. 1973). Information provided by this map includes topographic and hydrologic details; modern architectural and transportation features; outlines of archaeological mounds, visible traces of ancient walls, floors and other features; and the borders between the collection tracts that encompass individual "sites." A transparent plastic overlay for each map sheet indicates outlines of ancient structures, using excavation data where available, but otherwise based on the interpretations of Millon and other TMP field personnel.

In preparation for the present project, the collection tract boundaries published on this map were digitized as polygons in a MapInfo-format map (MapInfo Corporation 1997) and used to create a layer in a GIS system that integrates observations recorded in the two main databases, DF8 and REANS, while providing both with underlying locational information. The current version of the digital map of Teotihuacan (designated MF2, or Map File 2) still needs a certain amount of editing. Because each of the original map sheets was digitized separately, common boundaries of collection tracts recorded on different sheets are usually not an exact match. For the purpose of analyses carried out in this study, however, this is simply a cosmetic concern that does not affect results.

A more important issue has to do with matching sites/collection tracts recorded on the Millon et al. map (1973) with records in the electronic databases (a procedure known as "geocoding" in GIS analysis). There are a number of locational and identification discrepancies between cases recorded in DF8 and REANS, and because of this, the older DF8 file was used as the basis for geocoding MF2. The correspondence between database records in DF8 and polygon records in MF2 was usually straightforward, and much of the matching could be done in a fairly automatic way, exploiting fields in DF8 that record the spatial coordinates of collection tract centroids. In a significant number of instances, however, DF8 records were found to correspond to more than one record, or collection tract, on the Millon et al. (1973) map. This situation almost always involved artifact collections recovered from areas that were originally mapped as separate proveniences but merged during analysis; this could usually be remedied simply by combining the appropriate records in MF2. In a smaller number of cases, the reverse situation was encountered, with multiple cases in DF8 corresponding to a single collection tract on the Millon et al. map. Sometimes it was possible to find evidence on the site-recording forms used by TMP fieldworkers indicating how to subdivide the appropriate polygon object in MF2, but some divisions were made simply on the basis of reasonable guesses. A small number of cases in DF8 were never matched with cases in MF2, and are therefore excluded from analyses in which MF2 plays a basic role. In all, 5,013 of the 5,046 cases in DF8 were matched to polygon objects in MF2.

Units of TMP Provenience

The collections and records of the TMP are organized around the more than 5,000 tracts of land that fieldworkers described, sometimes confusingly, as "sites." In this study, I usually refer to these sites as "collection tracts," in recognition of the role that they play in the organization of artifact collections and analyses based on them. For the most part, collection tracts were defined on the basis of architectural features and/or artifact concentrations that could be viewed on the modern surface of Teotihuacan. This was especially so in the vicinity of the city core; collection tracts show a greater tendency to map onto modern field boundaries near the periphery of the ancient settlement.

Even when collection tracts are based on ancient architectural remains, it is important to recognize that they may subsume large numbers of sub-features. More than 2,000 tracts, for example, were defined on the basis of traces of collapsed walls and/or floors of residential apartment compounds; within these structures are large numbers of rooms and patios (mostly invisible without excavation) that played no part in defining the boundaries of collection tracts. Similar observations would hold for the other main categories of architectural features—particularly room groups and platforms—that were used to define collection tracts during the TMP survey. As I have noted elsewhere, architectural variation subsumed by collection tracts is thought to be matched in some cases by significant levels of socio-economic variation. Such variation pertains to a higher level of analytical resolution than exists in the TMP datafiles. This study necessarily rests on an examination of the main unit of provenience utilized by the TMP, the collection tract.

It is also important to emphasize that the correspondence between TMP collection tracts and architectural remains is very uncertain for early phases of occupation at Teotihuacan. Architectural remains visible on the surface at Teotihuacan reflect most directly the state of the built environment as it was during the last few centuries of the Teotihuacan Period. Many of these structures would not have existed during the two phases (Miccaotli and Tlamimilolpa) addressed by this dissertation. As was noted in Chapter Three, an important and very common category of architectural feature, the apartment compound, probably did not exist until the Tlamimilolpa phase.

Particularly for the Miccaotli phase, it is not at all clear what kinds of architectural features stood in the locations eventually occupied by apartment compounds (except that they were probably mostly residential structures) or whether the boundaries between apartment compounds reproduced divisions that were meaningful at earlier times. In an unknown and possibly large number of cases, collection tracts based on visible architectural remains may correspond closely to those from earlier phases, including Miccaotli. This cannot be assumed, however, and the conservative view is to regard collection tracts, even those based on quite clear architectural remains (but particularly apartment compounds) as essentially arbitrary units for sampling surface pottery from the Miccaotli and Tlamimilolpa phases.

Given this fact, it may seem surprizing that this study was based on a comparison of ceramic materials from the Miccaotli and Tlamimilolpa phases, rather than from later phases such as Xolalpan and Metepec. The main justification for focussing on the two earlier phases lies in the opportunity that they provide for evaluating the effect on socio-spatial relations at Teotihuacan of a major reconfiguration of the residential system—changes that came with the widespread adoption of the apartment compound (see previous chapter). Constraints on time and space preclude extending the present analysis into periods of occupation much after this change, but it is important that this be done in the future.

Ceramic Variability at Teotihuacan

Like many sedentary, pre-industrial peoples, the inhabitants of Teotihuacan made extensive use of fired clay in creating their distinctive material culture. Most of the tools they made of ceramics were containers—for cooking and serving food; for storing water and other liquids including pulque, and dried goods; and for transporting all of these materials to and from the city and between locations within it. Pottery played a vital role in the household economies of both producers and consumers. Vast quantities of pottery were consumed in daily tasks. Ceramic needs were mostly satisfied by local production, but surprizingly-large quantities of a few types of pottery were imported to the city from other regions.

As is common in most pre-industrial societies, Teotihuacan's utilitarian pottery tends to be rather plain and sparingly decorated. Some vessel forms, however, are quite elaborate, decorated in ways that must sometimes have contributed significantly to the energy and labour costs of production, and subsequently to the costs at which they would have been made available to consumers (Feinman et al. 1981). Because of the prestige associated with finer, more costly ceramics and cultural information inherent in certain associated decorations and form, some of the types of pottery used at Teotihuacan played important symbolic roles, signaling differences in wealth and social status, conveying sacred offerings to gods and ancestors, and serving as mortuary gifts in interments. A household's need for such pots and the economic means to acquire them relates to both wealth and status levels (Smith 1987a), but not in clear and straightforward ways (Cowgill 1992a). Nevertheless, the relative proportions of different kinds of pottery—some forms more highly decorated, some forms more symbolically charged than others—is used in this dissertation as an important, if rudimentary, measure of how wealth and status differences vary over space and time.

In the remaining sections of this chapter, and in more detail in Appendix A, I review the major kinds of pottery used by the ancient residents of Teotihuacan and a typological system that has been employed to describe the fragments that make up the ceramic collections of the Teotihuacan Mapping Project. My goal is not to provide a detailed or exhaustive treatment, but rather to provide the basic framework needed to contextualize my analyses and make sense of the results. Major published and unpublished sources about Teotihuacan ceramics include Rattray (1981b)[1], Hopkins (1996), Sanders (1995), Sheehy (1992), Bennyhoff and Millon (n.d.), Smith (1987b), and Müller (1978).

Ceramic Tabulation Data – DF8 and REANS

The database known to TMP researchers as DF8 has already been described as one of the main research tools to emerge from the Teotihuacan Mapping Project. A large proportion of the data contained in the DF8 is concerned with ceramic variability and reflects a ceramic typology that was developed and put into use while the Mapping Project survey was still underway (Bennyhoff 1967). Much of the initial pottery tabulation based on this system was done in the field by some members of the team of field personnel who made the collection. Most collections were re-examined under lab conditions by a smaller set of individuals with greater expertise in ceramic analysis.

As valuable as DF8 was and still is, the value of its ceramic content is reduced by the relatively limited knowledge of formal and chronological variability in Teotihuacan ceramics that was available when the typological criteria were first formulated in the 1960s, as well as by some problems in communication between the ceramic analysts and Cowgill, whose knowledge of Teotihuacan pottery was also limited at the time (George Cowgill, personal communication 2001). The ceramic analysis itself, as well as other research activities running parallel to it, soon made it clear that criteria used to assign pottery to specific phases were sometimes based on mistaken ideas, while other categories failed to capture important formal distinctions. A good example of the latter kind of problem is San Martin Orange, a ceramic ware captured by a single category in DF8, but known to occur as craters, amphorae, and scraped basins—three distinct forms that were probably used for different purposes. A number of potential categories based on combinations of formal differences (especially different bowl forms and jars) and decorative modes (polishing, painting, incision) were similarly left out of the DF8 typology.

In an attempt to generate more accurate and detailed information about the use of pottery at Teotihuacan, a project was undertaken to reanalyze of all of the TMP collections using a more detailed and more refined typological system. The laboratory work of the "ceramic reanalysis project" was mostly carried out in the decade between 1973 and 1983, under the general direction of Cowgill, with sorting activities supervised by Evelyn Rattray. The results of artifact sorting in the lab were recorded on specially designed and printed, oversized, tabulation forms. Tallies from the tabulation form were then transferred to set of coding sheets designed to facilitate computer entry. For various reasons, migrating data generated by the reanalysis into an electronic format appropriate for research purposes was a difficult and time-consuming process that suffered from long delays. The first electronic database that incorporates a large proportion of the reanalysis results (designated REANS) was prepared as background work for this dissertation. This is the first study to make more than sparing, experimental use of reanalysis data.

The typological criteria used in reanalyzing the pottery collections, largely developed and implemented by Evelyn Rattray, were mostly improvements over those previously employed by the TMP, and in most ways REANS supersedes the DF8 ceramic data. Apparent inconsistencies and errors in the REANS data are quite numerous, however, and often difficult to correct or account for. Beyond the many thousands of tabulation and coding forms that were used, relatively little documentation exists for the reanalysis project. Not all of the procedures that were used are now well remembered or understood. Nevertheless, some procedures did have had a significant effect on the quality of the data that currently exist in REANS, and these need to be outlined in general terms.

One of the more serious issues concerns the state of the TMP collections at the time that the reanalysis was carried out. Both during and after fieldwork, other, more specific research interests led to a number of special purpose collections that were formed by physically removing artifacts from individual collections, sometimes in fairly large numbers. This went on both before and during the reanalysis, and it is difficult to know if any specific collection was intact at the time of the reanalysis, or what procedure (or combination of procedures) was followed if lab workers recognized that artifacts were absent. If a collection happened to contain a note indicating that artifacts from the original collection were missing, sometimes some or all of the artifacts were located and reanalyzed. If a note specified in detail which artifacts had been removed, an attempt was sometimes made to include them in the reanalysis tabulations without physically examining them. Perhaps most often, nothing specific was done to deal with the problem of missing artifacts, and lab workers were probably often unaware of their absence.

Eventually, most of the artifacts that had been transferred to one of the various “specials collections” were subjected to a streamlined version of the reanalysis procedures. The resulting tabulations were later transferred by Mary R. Hopkins to around 3,700 filecards—a record for each of about three-quarters of all collections. Integrating the filecard data with reanalysis tabulations that were obtained from parent collections (sometimes many years earlier) is extremely problematic, however, and this as-yet-incomplete task has greatly delayed the preparation of an electronic database summarizing reanalysis results. For any given case, a great deal of guesswork is involved in determining what portion, if any, of the artifacts represented in the filecard records might already be present in the reanalysis records for the larger collection. While a great deal of time and care has gone into merging the filecard and reanalysis records, it must be recognized that the REANS records reflect only approximately the state of collections originally recovered from the field, or recorded in DF8. In any given collection, counts for some of the artifact classes may be deflated by a failure to add "specials" counts for artifacts that were absent during the reanalysis, or inflated by additions that duplicate counts already present. Nevertheless, it is important not to exaggerate the effect of filecard additions. I estimate that around 30,000 artifacts were involved in the "specials" collections, and only about 26,000 of these belong to categories that were counted in reanalysis procedures. This is about three percent of the almost 800,000 sherds that make up the total number of sherds in the current version of REANS; the mean proportion of "specials" counts within individual collections is also only around three percent. Of course, because not all artifact categories were equally involved in the analyses that gave rise to "specials" collections, the uncertainty involved in restoring information from the reanalysis of these collections is not evenly distributed among categories. Fortunately, most of the ceramic categories that play an important role in the present study are not among those that figure most prominently in the "specials" collections, such as the various Thin Orange categories, for example.

Although a fairly small number of personnel were directly involved, it is probable that the criteria used to sort potsherds "drifted" somewhat over the decade that the tabulation work of the reanalysis project took place. For at least a few of the ceramic categories, however, definitional criteria were changed suddenly and deliberately. To my knowledge, no explicit records of these sorts of procedural changes were made; they constitute part of the TMP "folk knowledge," and/or are revealed by patterns in the reanalysis recording sheets. The "red-rimmed olla" categories provide one illustration. Although red-rimmed ollas were recognized as an olla variant at least as early as the time of the TMP survey (George Cowgill, personal communication 2000), they were not recorded in DF8, and were not coded under ceramic reanalysis procedures until about 1977, roughly four years after the beginning of the analysis. Initially, Tlamimilolpa, Xolalpan, and Metepec phase variants of red-rimmed ollas were recorded. At some later point in time, Rattray decided that only the Xolalpan and Metepec phase-variants were to be recognized, and sherds that previously would have been attributed to Tlamimilolpa mostly began to be recorded as Xolalpan. Red-rimmed ollas that had already been coded as Tlamimilolpa are not recorded in the electronic version of the reanalysis tabulations (REANS), since "Tlamimilolpa red-rimmed olla" was not a recognized category at the time that fields for REANS were defined. Fortunately, similar sorts of changes were probably not very common, and most examples of which I am aware have to do with the phasing of specific categories. A rigorous assessment of these and similar problems has only started.

The various data sources that have been generated by the TMP constitute a uniquely valuable resource for research, and the archaeologists who contributed to them over the years deserve a great deal of credit for their efforts. Their analytical potential, however, has to be weighed against internal errors and inconsistencies, and limited documentation. Both the unusual scope and longevity of the project mean that no single individual fully understands the basis for all of the observations recorded either in the field and the lab, and there are some that are no longer understood by anyone. While a project has been initiated to create and archive metadata documentation for the TMP data to the fullest extent possible, in their current form they have to be used cautiously. Some fields have to be approached in a way that is almost experimental, with research necessarily involving elements of archaeological detective work. In spite of these concerns, the files contain a great deal of useful, reliable information.

The Ceramic Reanalysis - Terminology

The artifact tabulation work carried out under the ceramic reanalysis project employed a typology that drew heavily on the earlier, more basic system that underlies ceramic descriptions in DF8. Not all of the categories that underlie reanalysis procedures were conceived of in very similar or systematic ways, but most can be characterized according to three main domains of variability. Two of these have to do with physical characteristics of the artifacts and are related hierarchically: *ware* usually refers to a class of pottery defined according to type of paste or general mode of finishing or firing behaviour; I use the term *form* to refer to more specific differences in vessel shape or decorative treatment that are subsumed by the various wares. A third domain of variability may be regarded as crosscutting the previous two and relates to chronologically sensitive differences that I describe as *phase-variants*.

In reanalysis tabulations and REANS, sherd counts are based on the *category*, often the point of articulation between ware, form, and phase-variant. An example of a fully-designated category is "Miccaotli Burnished Comal"; comal refers to a specific form of vessel that, along with several other forms, belongs to Burnished Ware; an artifact assigned to this specific category also has characteristics that identify it as belonging to the phase-variant Miccaotli. Because the comal form is not recognized for wares other than "Burnished," the category can be more conveniently and succinctly described as "Miccaotli Comal."

A number of categories have no recognized phase variants, and/or are defined as wares, without formal subcategories. "Dense Ware," for example, is a rather scarce category which subsumes both bowls and jars, and is not broken down by phase.

Some reanalysis categories are based on what are better described as *modes* rather than wares. Modes encompass variation, such as that based on decorative and vessel support styles, that builds on, and may crosscut, more fundamental groupings in the ceramic repertoire. A good example is the "nubbin," a vessel support mode with recognized phase-variants. Categories based on modes are not generally mutually exclusive to other kinds of categories, and it is possible for the same sherd to generate a count in one or more mode-based categories, as well as in another non-mode-based category. In order to make it possible to calculate phase and collection totals, brackets were used on reanalysis tabulation sheets to mark counts that were derived from sherds that had already been recorded elsewhere on the form. For example, a sherd marked as '1' under "Xolalpan Polished Vase" might also be recorded as '(1)' under "Xolalpan Nubbin" if it showed evidence of that particular kind of support. This notational distinction between bracketed and unbracketed counts does not exist in the REANS database. Because of this fact, some sherds are unavoidably subject to multiple-counting in analyses based on REANS data, including those that underlie this study. The effect that this has had on its substantive results is probably very minor, however.

Miccaotli and Tlamimilolpa Ceramic Categories – Summary

The analyses of ceramic variability during the Miccaotli and Tlamimilolpa phase occupations at Teotihuacan (described in Chapter Six) are based exclusively on ceramic categories drawn from the REANS database. While analyses involving later phases of the Teotihuacan Period (Xolalpan and Metepec) might well incorporate categories from DF8 (to obtain candelero counts, for example), it has not been necessary in this study to make use of any of the ceramic data contained within the DF8 files.

As will be discussed more fully in Chapter Six, a total of 23 categories from REANS were selected for analysis in this study, eleven pertaining to the Miccaotli phase, twelve to Tlamimilolpa. Eighteen of these categories are Miccaotli and Tlamimilolpa phase-variants of what are essentially the same nine typological entities. The other five categories are specific to one of the two phases (Miccaotli and Tlamimilolpa), either because the other phase-variant does not exist in REANS, or because it was excluded because of uncertainty about its phase-affiliation (see below, Chapter Six).

The remainder of this chapter consists of a highly abbreviated description of these 23 categories; significantly more detail can be found in Appendix A, which also provides information on ceramic reanalysis categories pertaining to phases other than Miccaotli and Tlamimilolpa. The 23 categories used in this study are listed in the first two columns of Table 4.1, along with the codes assigned to them in REANS (e.g. R453 for "Miccaotli olla"). This table also provides information on the ware, form, and mode variations that underlie these categories. Broad functional differences are shown in the last column, based on the crude, tripartite division between vessels and vessel attributes associated principally with *cooking and storage*, *food service* and *ritual*. Outline drawings of the main vessel forms exhibited by these categories are included in Figure 4.1.

Table 4.1: Miccaotli and Tlamimilolpa ceramic categories included in analyses. Miccaotli jars and Tlamimilolpa comales were excluded because of probable systematic phasing problems. Tlamimilolpa "Polished Black" counts were excluded because of their rarity.

categories				wares	forms / modes		function
Miccaotli phase-variants		Tlamimilolpa phase-variants					
R453:	olla	R454:	olla	burnished	(forms)	olla	cooking/ storage
		R474:	jar			jar	
R483:	comal					comal	
R503:	cazuela/crater	R504:	cazuela/crater			cazuela/crater	
R683:	censer	R684:	censer	matte		censer	ritual
		R584:	red-on-natural bowl	painted		bowl	service
		R614:	red-on-natural vase			vase	
R923:	outcurving bowl	R924:	outcurving bowl	polished		outcurving bowl	
R943:	polished bowl	R944:	polished bowl			bowl	
R913:	polished vase	R914:	polished vase			vase	
R733:	polished black			—	(modes)	polished black	
R743:	pattern polished	R744:	pattern polished			pattern polished	
—	incised	—	incised			incised	
R873:	nubbin	R874:	nubbin			nubbin supports	

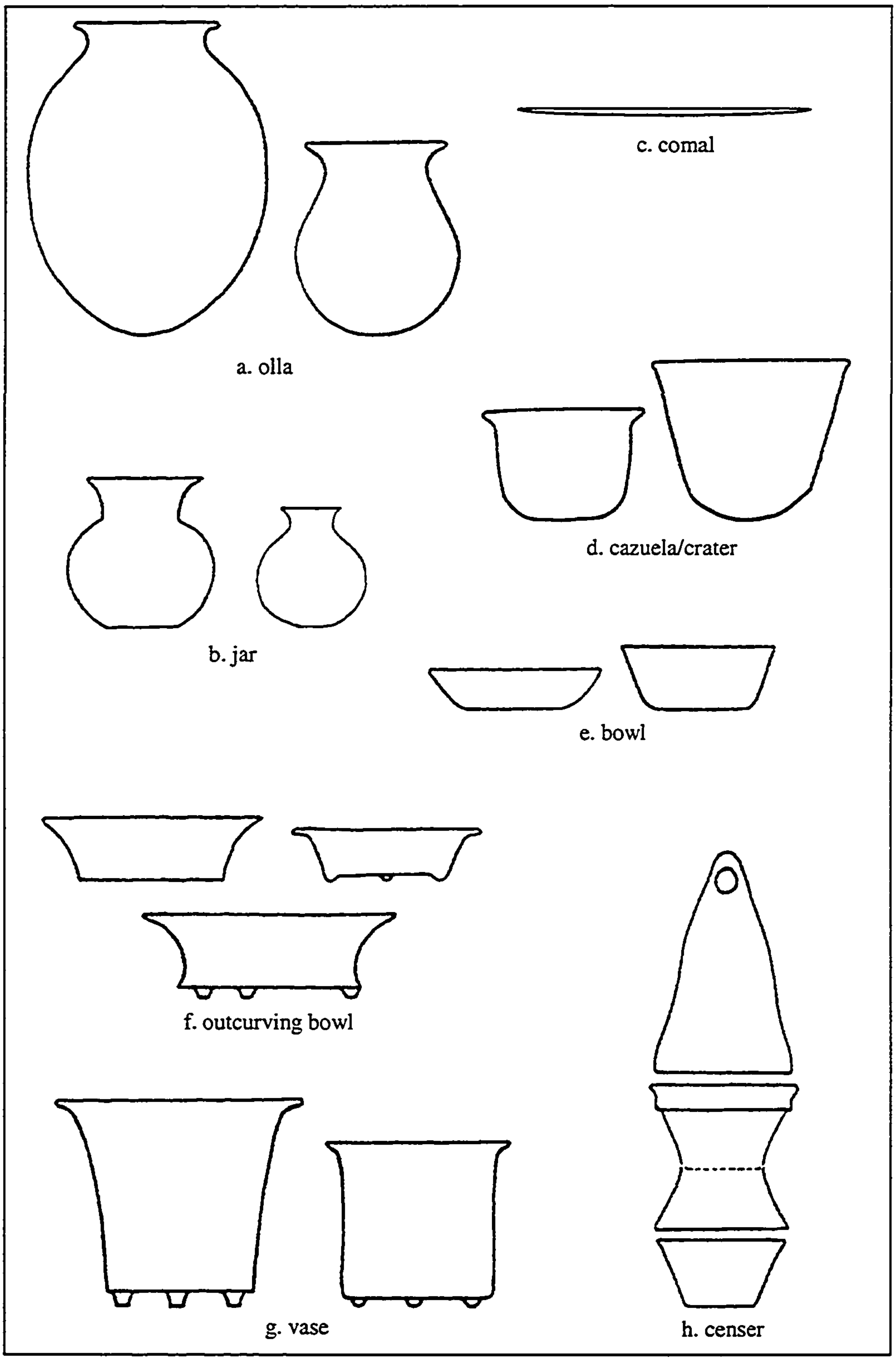

Figure 4.1: Major vessel forms used in Miccaotli and Tlamimilolpa ceramic categories. All vessel profiles (except 'c. comal') are based on Rattray (1981b:Fig. 2B). Not to scale.

Contributing to several of the categories included in this study are four vessel forms—ollas, jars, comales, and cazuela/craters—that belong to Burnished Ware. Surfaces of most Burnished Ware vessels are characterized by a finish produced by smoothing and rubbing the exterior surface with a hard object before the clay was completely dry. Vessels exhibiting this rather simple type of finish were generally used for utilitarian, domestic tasks. Ollas are fairly large, globular vessels that were used principally for cooking and storage (Hopkins 1996:131). The "burnished jar" category probably applies to a vessel form that was similar to an olla (cf. Rattray 1981b:185), used for similar purposes, but smaller in size. Comales are flat or slightly-dished ceramic griddles on which maize tortillas and other non-liquid food stuffs were toasted. The cazuela/crater category encompasses two quite similar types of open, bowl-shaped vessel that, like ollas, were used for a variety of cooking and storage tasks (Hopkins 1996).

Vessels belonging to Matte Ware have surfaces that were smoothed but not burnished (Rattray 1981b:92-93). Censers are the only type of Matte Ware vessel included in this study, and phase-varieties exist for both Miccaotli and Tlamimilolpa. Used at Teotihuacan as containers for the ritual burning of incense, the simplest censers are shaped like a modern terra-cotta flower pot (Rattray 1981b:158, 182). More complex censers were formed by stacking two such pots in the form of an hourglass. Lids of varying degrees of elaboration were often used with censers; an example of a censer with a cone-shaped lid is depicted in Figure 4.1.

A variety of Teotihuacan vessel types were decorated with paint, and under ceramic reanalysis procedures fragments of such vessels were assigned to various Painted Ware categories. Two Painted Ware categories—the Tlamimilolpa Red-on-Natural bowls and Tlamimilolpa Red-on-Natural vases—are included in this analysis; no comparable Miccaotli phase-variants exist in REANS. Both Red-on-Natural bowls and Red-on-Natural vases can probably be regarded as painted variants of Polished Ware forms (below). Like comparable Polished Ware categories, they were probably most often used to serve cooked food.

Polished Ware categories included in this study include the Miccaotli and Tlamimilolpa phase-variants of Polished Outcurving Bowls, Polished Bowls and Polished Vases. Although sharing several of the same forms, Polished Ware is distinguished from Burnished Ware by its more meticulous surface finish. Polished Ware vessels were presumably more costly for potters to manufacture and non-potters to acquire. While the various forms that were made of Polished Ware could have served a variety of purposes, it is probable that they were most often used as service vessels.

Seven categories (four Miccaotli and three Tlamimilolpa phase-variants) derived from four modes (Polished Black, Pattern Polished, Incised, and Nubbin Support) were included in this analysis. "Polished Black" is a somewhat enigmatic designation that was likely used to describe examples of a particularly fine, black finish on various Polished Ware vessels, including bowls, outcurving bowls, and vases. Observations of Polished Black are relatively rare in the REANS files, and almost entirely confined to the Miccaotli phase (see Appendix A); the Tlamimilolpa phase-variant of the Polished Black mode was excluded from this study because of its rarity. The "Pattern Polish" categories describe surface decoration that was produced by polishing discrete zones of a vessel, leaving the original matte surface on intervening areas. This was often used to create standardized geometric and naturalistic designs (Rattray 1981b:337). Pottery at Teotihuacan was frequently decorated by various forms of incision, five varieties of which were recorded under ceramic reanalysis procedures. Because tallies for the individual "Incised" categories are relatively low, particularly for the Miccaotli phase (see Appendix A, Table A.10), several different types of incision were aggregated into composite categories for both Miccaotli and Tlamimilolpa (see Chapter Six). The last of the mode-based categories are the Miccaotli and

Tlamimilolpa phase-variants of the "nubbin support." Nubbins are small, roughly conical lumps of clay attached in groups of three around the base of flat-bottomed vessels to serve as a tripod support. They were most commonly used on outcurving bowls and vases.

Notes for Chapter Four:

[1] An updated version of Rattray's (1981b) manuscript on Teotihuacan ceramics was published in the summer of 2001. Rattray (2001) was not available for consultation at the time of writing, but is an important addition to this list of sources.

Chapter Five

ANALYTICAL METHODS

This study makes use of a variety of analytic procedures. The main purpose of this chapter is to describe these procedures in general terms, especially the rationale for their use and the ways in which they are integrated with one another. This will facilitate the presentation of material in the next chapter, which deals directly with the new information that has been generated by their use.

A fundamental methodological challenge faced by this research project is describing spatial parameters of ceramic distribution at Teotihuacan in ways that allow them to be plausibly related to dimensions of socio-economic variation. As described in Chapter Four, the raw data available for this work consists of ceramics collected from ca. 5,000 discrete localities within the city, tabulated across a broad set of typological categories. As will be seen in the next chapter, these tabulations show that collections vary considerably in content, and a comparison of any two collections, drawn at random, is likely to reveal striking differences. This level of variation—that associated with individual collections from very small parts of the city—is important for what it can reveal about socio-spatial differences at a fine-grained, localized scale. In an archaeological study that seeks to take into account the role of individuals in the creation of social worlds, it is clearly desirable that analyses be grounded in variation exhibited by individual collection tracts, the most basic unit of provenience for TMP data, and the one offering the finest possible level of spatial resolution.

Nevertheless it is also important to engage in analyses that lead to higher, more general levels of spatial abstraction. One reason for this is the difficulty of comprehending, and conveying to others, information drawn from large numbers of observations based on large numbers of cases. To deal effectively and systematically with complex, highly detailed data, the human brain must be assisted by tools that summarize variability at higher levels. This is true during the research process, as raw data are converted into meaningful information, and also as the results of research are communicated to others.

One might argue that focussing investigations on a number of spatial samples—examining, for example, cases that make up a few relatively small neighbourhoods in different parts of the city—would make it possible to avoid overwhelming detail, while retaining the full richness and detail of a tract-by-tract analysis. This would raise other problems, however. In Chapter Four, I claimed that natural and cultural transformation processes and sampling error do not seriously limit our ability to draw anthropologically meaningful information from the TMP surface collections. This argument, however, is most defensible in the context of large, rather than small, scales of analysis. To the extent that transformational and other kinds of factors do conspire to obscure behavioural patterns of interest, such distortion can be minimized by taking advantage of the very large number of cases available in the complete TMP database and by directing much of the analysis toward the recognition and interpretation of relatively broad patterns that exist at spatial scales well above that of individual collection tracts. This is not to suggest, however, that *none* of the variability that can be observed at the scale of individual structures is informative about behavioural reality—if this were so, broader patterns would be equally meaningless. In the case of any *specific* structure, however, there is no ready way to judge the distorting effect that cultural and natural transformation processes may have had on relevant behavioural remains. In general, "big picture" conclusions will be more stable and durable than fine-grained conclusions drawn from small subsets of cases; insights based on patterns observed at a very localized scale are convincing to the extent that they are observed to recur in multiple, separate instances, thus constituting still larger patterns.

There are also more theoretical reasons to seek to identify and understand spatial patterns that exist at higher levels than that of the individual structure, and this has to do with the kind of social realities that are represented by such patterns. While the most fundamental kinds of action engaged in by an urban population are overwhelmingly expressed at quite local levels, such habitual, routinized behaviour gives rise to larger socio-spatial entities that form crucial building blocks in urban settlements and are major determinants of a city's social texture. The larger patterns formed by these building blocks are what make cities comprehensible to their inhabitants (see Penn and Dalton 1994), and they should therefore be of considerable interest to anthropologists and sociologists. Given the inherent complexity and diversity of cities, they are probably also the most useful entities for comparative studies.

Exploratory Spatial Data Analysis

In this project, I have attempted to develop a quantitative research strategy rooted in the full richness of variability expressed by thousands of individual collections, but capable of exploiting salient dimensions of this variability to distill higher-level, more general patterns. The approach that I have taken is explicitly exploratory in nature, a strategy facilitated by the use of GIS technology. By describing it as exploratory, however, I do not imply that the research program is unrelated to a body of explicit theory; on the contrary, my theoretical ideas about social life and how they can help guide research in an ancient urban context have been described in Chapters One and Two. Nor do I refer to the methods of Exploratory Analysis Data (EDA) pioneered by John Tukey (Hartwig and Dearing 1979), although I use some of them in my research. By using the term exploratory, I mean to convey an approach to analysis that is relatively unconstrained by *a priori* ideas about the spatial manifestations of social variability at Teotihuacan.

While this has proved to be an effective way to proceed, there is a suggestion in some recent archaeological literature that research that fails to adopt so-called “deductive” approaches—where priority is given to explicit testing of clearly-defined hypotheses and models—is wrong-headed and unlikely to be productive. This perspective became popular in the 1960s and 1970s as part of a broader attempt, especially by many North American and some European archaeologists, to adopt a style of scientific procedure similar to that perceived to characterize the more physically-based disciplines of “hard” science. Like a number of the ideas pursued under the banner of “new” or processual archaeology, this bias against “inductive” strategies is misguided. In fact, most research in the historical, social, biological and physical sciences proceeds in both directions, moving back and forth between data and theory, and is often inspired initially by recognition that an empirical case exists that exhibits patterns warranting interpretation or explanation (Cowgill et al. 1984:157-158; Kvamme 1999:160-162).

GIS-backed mapping is a particularly effective way to improve our understanding of situations that can be characterized as “data rich and theory poor.” Geographical information systems (Kvamme 1989, 1999) provide a dynamic means of data *visualization*, allowing researchers to examine a complex body of spatially-referenced data from a wider range of perspectives than is otherwise possible. This is chiefly a result of the way in which GIS systems combine flexible, rapidly produced, high-information-content maps with the pattern recognition skills that form such an important part of human cognition. Maps can be instrumental for identifying subtle patterns and relationships that might remain unrecognized in a study dedicated solely to the evaluation of pre-defined formal models. After the existence of such patterns has been documented they can be examined through more formally conceived analyses. Insightful, careful attempts to account for the existence of patterns encountered through exploratory methods can be highly illuminating, and they should not be automatically dismissed as atheoretical, “post hoc accommodative arguments." In fact, this type of research can help build theory in social scientific disciplines that, like anthropology, rest on relatively weak theoretical foundations, especially as they relate to more complex expressions of human behaviour. Most social theory currently available suggests only rather general directions for productive research, and we need to be creative, exploring new ground to make progress.

Methodological Overview

Various approaches and methods could be applied to the problem of identifying and describing patterns of variability in the ceramic data of the TMP, and they would likely produce quite different kinds of insights into ancient Teotihuacan. Cities are complex phenomena that encompass highly variable kinds of socio-cultural realities, and they can be profitably examined in different ways from different perspectives.

The general strategy that I have developed was inspired in part by an approach to spatial analysis first described by Robert Whallon as "unconstrained clustering" (Whallon 1984). This method, designed for studying spatial patterning in small-scale hunter-gatherer sites, uses a moving template to assign a vector of smoothed local densities of different artifact classes to the vertices of a grid imposed over the site area. These vectors are then used in cluster analysis to identify areas of the site in which sets of artifact classes captured by templates happen to be similar (Kintigh 1990:190). A map of cluster memberships may sometimes provide surprizingly clear evidence of otherwise rather subtle artifact distributional patterns—due to activity areas, for example—as well as a concise description of the material remains by which they are characterized.

Particularly relevant here is the potential for "unconstrained clustering" to systematically identify spatial differences that are marked by composite signatures involving a combination of different kinds of entities. In this regard, my overall strategy is similar. Treated in broad outline, it can be divided into the following three stages, which are shown schematically in Figure 5.1.

Stage 1: Assemblage Definition / Data Pretreatment: I begin by defining subsets of ceramic categories that are roughly contemporaneous with one another and share a reasonably clear affiliation with one of the major phases of occupation at Teotihuacan. Phase affiliation is primarily assessed using different types of correlation analysis. Tabulation counts of categories included within these subsets describe phase-specific assemblages for each collection. These counts are standardized as proportions that reflect the relative quantities of categories within individual collections, and the proportions are pretreated for subsequent analysis using Bayesian estimation procedures that help control the random effects of sampling error. A sample-size threshold for the inclusion of collections in subsequent stages of analysis is imposed at this stage, based in part on the relative contribution of sample data and prior information to the construction of posterior Bayesian estimates. Collections that fail to meet the threshold of five or more relevant sherds are eliminated from later stages of analysis.

Stage 2: Assemblage Classification: For individual temporal phases, collection tracts are assigned to a small number of classes according to similarities and differences in the proportion of different kinds of pottery within associated assemblages. Classification is done using k-means cluster analysis. To avoid confusion with the products of cluster analysis produced at a later stage of analysis, I frequently refer to the resulting classes as A-clusters (for "assemblage cluster"). A-clusters represent nodes and/or partitions in a multivariate space defined by axes of variability in different kinds of pottery and are used as measures of socio-economic variability at the lowest scale of analysis, that of the individual collection tracts sampled by the TMP. Among the products of this stage of analysis are phase-specific thematic maps in which each collection tract is assigned to one of a small number of compositionally-based A-clusters.

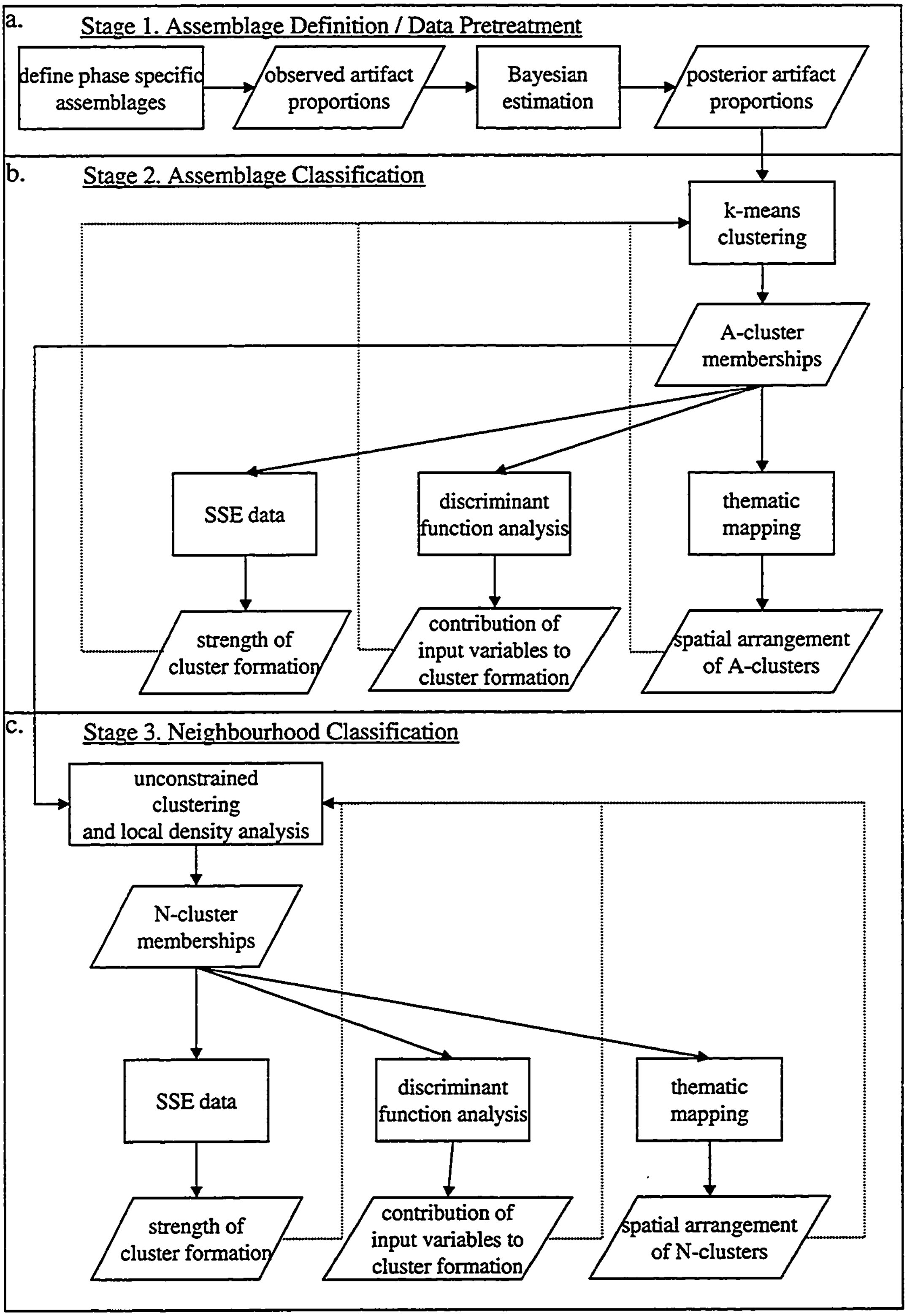

Figure 5.1: Major methods used in analysis. Rectangles indicate procedures or analyses, trapezoids indicate products generated by them.

Stage 3: Neighbourhood Classification: A key analytical tool for the third stage of analysis consists of larger spatial units centered around each collection tract, containing both the central tract, and all other surrounding tracts that fall within a specified distance of it. These overlapping units (called "buffers" in GIS terminology) constitute an analytical neighbourhood; tallies of A-cluster memberships are assembled within these units and used to characterize collection tracts in terms of the composition of larger, encompassing neighbourhoods, as expressed in the relative frequency of members of different A-clusters occurring within them. K-means cluster analysis is used to classify collection tracts on the basis of variation in A-cluster profiles of surrounding neighbourhoods. The classes that emerge are referred to as N-clusters (for "neighbourhood cluster") in order to emphasize the distinction between them and A-clusters. Spatial variation in N-cluster profiles is mapped thematically and used to divide the city into broader districts, units to which socio-spatial meaning can be attached.

Assemblage Definition and Data Pre-Treatment – Correlation Analysis and Bayesian Estimation

Assemblage Definition

Because of the diachronic nature of this study, it is important to identify sets of ceramic categories that could be (1) reasonably regarded as contemporaneous, at least within the structure of the fairly coarse ceramic chronology that exists for Teotihuacan, and (2) differentiated from other such sets. In this study, I use the term assemblage to refer to such phase-specific sets of categories. An assemblage is a subset of a collection; for any given collection tract/record, for example, the Miccaotli assemblage consists only of those artifacts that were assigned to one of the categories included in the Miccaotli analysis.

As noted in Chapter Four, the majority of the categories in the ceramic reanalysis project were created with the intention of being phase-specific—types of pottery used primarily, if not exclusively, in one or more of the main phases of occupation at Teotihuacan. The evidence and assumptions that underlie the ascription of specific categories to specific phases are not always very strong, however, and before determining which categories could be used to define phase-specific assemblages for collection tracts, I undertook a series of analyses designed to evaluate primary phase affiliations—Miccaotli to Metepec—for all of the ceramic types used in the ceramic reanalysis. This provided a check on the ideas of ceramic chronology that were current at the time of the reanalysis and in some cases generated new information about probable affiliations of categories that were never attributed to any specific phase.

To evaluate phase affiliations for the reanalysis categories I experimented with several methods, but all involved examining statistical correlations between counts derived from an individual category and a set of composite categories called "phase-totals." Phase-totals consist of the total count of sherds that were attributed to specific phases within individual collections; if the category under consideration is a phase-variant (and therefore a contributor to one of the phase-totals), its counts are subtracted from the appropriate phase-total. For the purpose of evaluating the phase affiliation of "Miccaotli comales", for example, "total Miccaotli" was the sum of all Miccaotli category counts <u>except</u> "Miccaotli comales," while "total Tlamimilolpa" was simply the sum of all Tlamimilolpa category counts, and so on. If most of the sherds used to calculate the phase-totals have been correctly phased, it is reasonable to expect that the "Miccaotli comal" category would show the strongest positive correlation with the "total Miccaotli" phase total. This implies that collections with relatively high counts of comal fragments attributed to the Miccaotli phase also tend to contain relatively high counts of other kinds of Miccaotli pottery; conversely, collections with relatively low counts of Miccaotli pottery tend to contain low counts of other Miccaotli phase pottery. This situation suggests that the "Miccaotli comal" category does in fact capture sherds that share a relatively strong affiliation with the Miccaotli phase; any other pattern suggests the likelihood of a systematic error, either in the definition of the "Miccaotli comal" category, in sorting procedures, or both. Product-moment correlation coefficients ('r') calculated for all four phase-variants of outcurving bowls provide a good example of a pattern that suggests reasonably well-phased categories.

Table 5.1: Outcurving bowl phasing (product-moment correlation coefficients).

	phase totals:			
outcurving bowl counts:	Miccaotli	Tlamimilolpa	Xolalpan	Metepec
Miccaotli	<u>.71</u>	.47	.18	.11
Tlamimilolpa	.71	<u>.78</u>	.48	.29
Xolalpan	.48	.60	<u>.64</u>	.45
Metepec	.10	.35	.72	<u>.77</u>

In each row in Table 5.1, the largest coefficients (which also happen to be moderately high) are found in the cells that fall on the diagonal, indicating that all four phase-variants are most strongly correlated with the appropriate phase-total. Recall that the phase-totals on which they are based do not include counts for their respective outcurving bowl phase-variant, so coefficients on the diagonal are not inflated by counting the same artifacts twice. Note, however, that the Xolalpan phase total has a higher correlation with Metepec outcurving bowls than with Xolalpan outcurving bowls. While it would be more reassuring if this were not the case, it is more important, from the point of view of evaluating the phasing of specific categories (outcurving bowls, for example) that the highest correlations within *rows* fall on the diagonal, rather than those within *columns*. The fact that the highest correlation for total Xolalpan is with Metepec outcurving bowls suggests that the Xolalpan phase total may contain significant counts of artifacts that really belong to the Metepec phase, possibly including outcurving bowls.

The various burnished comal categories illustrate a situation where correlation coefficients suggest a systematic phasing problem. In Table 5.2 (for reasons explained below), correlation is measured using the rank-based gamma coefficient ('γ') rather than the product-moment coefficient.

Table 5.2: Comal phasing (gamma rank-order correlation coefficients).

	phase totals:			
comal counts:	Miccaotli	Tlamimilolpa	Xolalpan	Metepec
Miccaotli	.41	.31	.06	.02
Tlamimilolpa	.45	.40	.15	.03
Xolalpan	.20	.31	.41	.34
Metepec	.03	.30	.48	.58

Three of the four comal phase-variants conform to the same general pattern exhibited by the outcurving bowls, and there is no reason on this basis to doubt that these categories were reasonably well-phased. Tlamimilolpa comales, however show a stronger correlation with the total-Miccaotli count than with the total-Tlamimilolpa count, less Tlamimilolpa comales. While the results support the interpretation that artifacts identified as Tlamimilolpa comales are indeed fairly early, a significant proportion of them may actually have been made in the Miccaotli rather than the Tlamimilolpa phase. A reasonable response to these results might be to exclude comales from analyses focussed on the Miccaotli and/or Tlamimilolpa phases.

As noted above, I used several methods to evaluate evidence for the phase affiliation of ceramic categories. I began by simply calculating 'r,' a method that George Cowgill (personal communication 2000) has used to check the phasing of categories in DF8 and related databases. This proved to be quite useful, and the results usually corroborated results obtained by other methods. A few comments about the use of the product-moment coefficient are in order, however.

First, a point estimate of 'r' only permits the relative strengths of correlations with phase-totals to be ranked, but says nothing about the significance of differences among them. Confidence intervals around 'r' would often be helpful in evaluating results, but the formulas for calculating such intervals assume that the distribution of input variables is close to bivariate normal. Without transformation, this is not even approximately the case for the data examined in this study, and I therefore never employed them. In a number of cases, however, especially where the point estimates suggested the possibility of phasing problems, I used bootstrap methods that do not depend on assumptions about the distribution of variables (Mooney and Duval 1993) to calculate confidence intervals for 'r'. This was done using custom programs that I wrote in Statistica Basic, a programming language included in the software package Statistica (StatSoft Inc. 1997).

Second, the intrinsic sampling error that underlies counts for all REANS categories [what Drennan (1996:151) calls 'vagaries of sampling'] means that all such estimates of 'r' will be to some extent deflated—lowered by the random error associated with counts for each of the two categories involved, within individual collections. Such effects of attenuation (Cowgill 1970) will be greater if counts for one or both variables are associated with high levels of sampling error—as would be the case for, example, with categories that are relatively uncommon. Assessing levels of attenuation so that they can be corrected necessitates making some estimate of the 'reliability' (Carmines and Zeller 1979) of counts for individual categories, and hence the proportion of variance that arises due to true differences among collections. This is something that can be readily calculated if it is possible to carry out parallel measurements on the same populations. Nance (1987:267-274) illustrates this approach by comparing counts of two gastropod species obtained from two test-pits (excavated in 10 cm levels) on the same archaeological site. Counts of the *same* species of gastropod obtained from the same level, but from different test-pits, were regarded as parallel measurements. Correlations between them were used to estimate the reliability of counts associated with each species, and these estimates were then used to correct correlations, calculated between *different* gastropod species, for the effects of attenuation. There is no similarly straightforward way to compare parallel counts on the ceramic categories that I work with in this study, although experiments that I have carried out using Monte Carlo methods for estimating reliability have been promising. While recognizing that the reliability of counts associated with less common categories must be less than that of more common ones, and therefore expecting that the effects of attenuation will be greater for correlations involving relatively rare categories, I did not attempt to formally correct for this.

Third, phase-totals for adjacent phases (e.g., Miccaotli and Tlamimilolpa) exhibit quite strong correlations with each other, presumably because occupational intensities in one phase are behaviourally related to occupational intensities in the subsequent phase. This means that a ceramic category associated *exclusively* with a single phase could be expected to exhibit a rather strong correlation with temporally adjacent phase totals as well. Along with attenuation, correlations between phase totals probably make the magnitude of 'r' (and any other correlation coefficient) of limited value for assessing phase affiliations—the rank order of correlations between a specific category and the various phase-totals is the most important evidence for or against systematic phasing problems. Using multiple regression to calculate *partial* correlations between the independent variables (phase-totals) and a dependent variable (an individual category) would probably yield estimates of 'r' for which the magnitude of the coefficient was meaningful. While I have experimented with the use of multiple regression in this fashion, the results play no part in this dissertation.

Probably the greatest problem in using correlation for assessing phase affiliations, especially based on the product-moment coefficient, has to do with the form of the bivariate relationship that exists between most categories and the four phase-totals. Relevant scatterplots are usually untidy, and seldom show clear linear relationships that are well described using correlation coefficients. When such relationships did appear to exist, it was possible to produce more meaningful results by excluding clear outliers. Where no such relationships existed, it was less clear how to proceed. In many cases, I found it useful to examine gamma instead of product-moment coefficients. Gamma coefficients, which are based simply on the rank of cases rather than the original, ratio-level observations, are less affected by outliers, and should therefore be less distorted by their presence.

The "Small-Number Problem"

The individual ceramic collections of the TMP vary greatly in size (Cowgill 1994), and some are relatively small—the median count is around 110, and 10% of the collections contain less than 30 potsherds. Within individual collections, the number of sherds pertaining to specific phases is obviously still smaller.

For purely descriptive purposes, variability in sample size is not an issue, and small samples are just as useful as large ones. However, in the procedures outlined below, the chief value of these samples lies primarily in their potential for inference—i.e., for estimating parameters of an underlying *population* that can be mapped thematically, or fed into other statistical analyses—and in this context small samples are problematic. Even if recovery and analysis procedures have not introduced other kinds of systematic bias, the random effects of sampling error are always present. Small samples are vulnerable to higher levels of sampling error, and estimates based on them are characterized by correspondingly higher measures of variance. This is the "small-number problem" (Kennedy 1989), something that arises frequently in archaeological contexts, and for which archaeologists have an intuitive, if not necessarily very clear, appreciation. The relationship between sample size and sampling error can be illustrated more formally by considering the standard error for the estimate of a proportion, approximated by $\sqrt{\frac{p(1-p)}{n}}$, where p is the proportion of some entity in a sample of size n (see Drennan 1996:140). This equation shows that, if half of the sherds in a sample of 10 are found to be of the same type, p for that type is .5, and the standard error is .16; if exactly the same proportion of this sherd type is observed in a sample of 100 (i.e., p is still .5) the standard error drops to .05 (Robertson 1999:139).

In many circumstances, undesired effects of small samples can be reduced by aggregation. In spatial analysis, grid cells can be used to group records that are close to one another, thereby creating larger total sample sizes. This form of aggregation may often be quite useful for characterizing broad differences across horizontal space. At finer scales of analysis, however, potentially important variation may be obscured (Cowgill et al. 1984:159-160). Marked differences among nearby cases have proved to be crucial information in this study, something that would be impossible to characterize using grid-based aggregation.

Both in archaeology and other disciplines (Kennedy 1989), the "small-number problem" is often addressed by simply focussing on the largest collections, eliminating samples from analysis that fail to meet a specific sample-size threshold. This is often sensible, although thresholds are probably most often based not on explicit considerations of sampling theory, but rather on vague ideas about the minimum size of samples that yield "reliable" estimates and how many samples need to be retained for the results of the desired analysis to be meaningful. An inherent shortcoming of a sample-size "cut-off" is the fact that the distinction between "unacceptably small" and "acceptably large" collections is defined as a single point in the sample size distribution. The arbitrariness of this is made clear if one imagines a situation in which the loss or gain of a single artifact would shift the determination either way—if the sample is retained, artifact proportions observed within it are taken essentially at face value; if discarded, the effective assumption is that the sample contained no information worth analyzing.

In this study, I have addressed the small-number problem in two interrelated ways. The first involves the use of a Bayesian method of statistical estimation designed to dampen the effect of sampling error on all collections. The second is the implementation of sample-size thresholds that remove many of the smallest samples from further analysis. The thresholds are based in part on data generated by the Bayesian procedure; while still equating to a single point in the sample size distribution, and in that sense arbitrary, the way they are defined is informed by an explicit consideration of the information content of individual samples. Furthermore, estimates based on samples that are retained are not taken at face value, since they have, in specific ways, been "improved" by the estimation procedure.

Bayesian Estimation of Proportions

Bayesian statistical methods for estimating population parameters can provide a less arbitrary response to sampling error than either grouping collections, or simply eliminating "small" ones. The first application of Bayesian procedures to the sample-size problem in an archaeological context was that of Miriam Chernoff (1982), who also worked with TMP datafiles under the direction of George Cowgill; my initial experiments in the use of Bayesian estimation were done at the suggestion of Cowgill. In the following paragraphs, I outline how I have built on Chernoff's work by adapting a Bayesian estimation method for the purpose of pretreating data used at later stages of analysis. More detailed information on this approach can be found in Robertson (1999). A useful general introduction to Bayesian methods is by Iversen (1984).

Bayesian statistics consist of formal methods for specifying how new empirical evidence ought to change prior beliefs about the nature of a population. By integrating a *prior* estimate of some population parameter with sample data, Bayesian procedures produce *posterior* estimates that are characterized by smaller standard errors and are therefore likely to be closer to the true value of parameters of interest.

In Bayesian analyses, prior beliefs must be made mathematically explicit, a fact that evokes consternation in many statistical practitioners who believe that this compromises an idealized stance of scientific objectivity (Buck et al. 1996:171-172). To Bayesian statisticians, the need to formally acknowledge one's ideas about a population of interest is a virtue. Acknowledged or not, such ideas usually do exist and are seldom unimportant in scientific research. The fact that they must be given concrete mathematical recognition in a Bayesian analysis does not mean that they have to be very precise; statements of prior knowledge can be generalized to the point that they express something very near to a complete lack of knowledge about an underlying population. Often, however, researchers possess prior beliefs that can be defined quite clearly, perhaps on the basis of previously collected empirical information. Provided these beliefs do not reflect absolute certainty, they are subject to revision when new, relevant data are obtained. Under Bayesian procedures, the relative weight assigned to prior knowledge in arriving at posterior estimates is inversely related to the quantity of new sample data (Iversen 1984:68). Given the relationship between sample size and sampling error that was set out above, this is intuitively reasonable and makes Bayesian methods an attractive strategy for dealing with variable and especially small-sized samples (Robertson 1999:140).

Bayesian methods have been developed for a variety of parameters, all ultimately derived from Bayes' Theorem. Bayes' Theorem can be expressed in various ways, including $\mathrm{P}(\theta \mid y) = l(y \mid \theta)\mathrm{P}(\theta)$. In this equation, $\mathrm{P}(\theta \mid y)$ is the posterior probability distribution of some parameter θ , given sample data y. This distribution is defined by the product of $\mathrm{P}(\theta)$ (the prior distribution of θ) and a likelihood function ($l(y \mid \theta)$) that specifies the likelihood of y as a function of possible values of θ .

Certain stages in the analysis on which this dissertation is based make use of artifact counts expressed as proportions (i.e., category counts standardized according to the size of a larger encompassing collection), and I have used Bayes' Theorem in all such circumstances to pre-treat these data. For each artifact category, in each individual collection, I combine the observed proportion p (where $p = x/n$; x being the count of the category, and n the size of the encompassing assemblage) with prior beliefs about the population parameter π, the true but unknown proportion of the category within the population represented by the assemblage. The result is an improved, posterior estimate of π (Iversen 1984:31-33) in which the effect of sampling error has been dampened. The observed proportion p is a single value. The prior and posterior estimates of π are probability density functions that can be characterized by measures of central tendency and dispersion and yield probability values for the likelihood that π lies in a given interval.

The prior distribution for the estimate of a proportion captures beliefs about the probability of specific values for π and can be defined in various ways (Iversen 1984:64-66). A density function that is particularly well suited to expressing prior information about π in the empirical cases considered here, and which has the considerable advantage of yielding a mathematically simple posterior distribution, is a unimodal *beta* function defined as

$$f(\pi) = C'\pi^{a-1}(1-\pi)^{b-1} \qquad [1]$$

where C' is a constant defined as

$$C' = \frac{(a+b-1)!}{(a-1)!(b-1)!} \qquad [2]$$

It can be shown that the mean μ' and variance σ'^2 of the prior *beta* distribution for π are

$$\mu' = \frac{a}{a+b} \qquad \sigma'^2 = \frac{\mu'(1-\mu')}{a+b+1} \qquad [3a, 3b]$$

and if μ' and σ'^2 are specified, a and b can be derived as follows:

$$a = \mu'\left[\frac{\mu'(1-\mu')}{\sigma'^2} - 1\right] \qquad b = (1-\mu')\left[\frac{\mu'(1-\mu')}{\sigma'^2} - 1\right] \qquad [4a, 4b]$$

These two values [1] are combined with the sample data (x and n) to yield a posterior (i.e., based both on prior knowledge and sample data) estimate of the proportion; this estimate is characterized by a mean (μ'') and variance (σ''^2), calculated as follows:

$$\mu'' = \frac{x+a}{n+a+b} \qquad \sigma''^2 = \frac{\mu''(1-\mu'')}{n+a+b+1} \qquad [5a, 5b]$$

The ratio $\frac{a}{a+b}$ is equivalent to the mean of the prior distribution, and provided $\frac{a}{a+b}$ and $\frac{x}{n}$ are not exactly the same, equation 5a will result in a posterior mean (μ'') that falls somewhere between p and μ'. This means that the prior knowledge has the same weight as $a+b$ items in the body of empirical sample data; in essence, equations 5a and 5b take this information into account by combining mathematically the observed sample with a hypothetical body of data composed of exactly $a+b$ items, a of which are of the same type or category as x.

The relative roles that prior knowledge and observed sample data play in the calculation of μ'' can be judged by comparing the magnitude of n and $a+b$. A relatively high value for n indicates a large sample, subject to relatively low levels of sampling error. A relatively high value for $a+b$ reflects a more peaked prior distribution and thus less prior uncertainty about π. If n happens to be much larger than $a+b$, then information from the sample data will dominate expression 5a, and the posterior mean will not differ very much from the observed proportion p. On the other hand, the effect of prior knowledge becomes more important as $a+b$ approaches the magnitude of n, and the posterior mean is drawn correspondingly closer to the mean of the prior distribution.

These relationship between n and $a+b$ are shown graphically in Figure 5.2. The prior probability density function in this figure is based on a beta distribution with a mean of .25 and a variance of .10. The sum of constants a and b (from equations 4a and 4b) is 17. The posterior distributions are derived from two data samples, one five-times as large as the other, but both exhibiting identical observed proportions (.50) of some entity. The smaller sample (n=20) yields a posterior mean of .38—about midway between a point estimate suggested by the mean of the prior and a point estimate suggested purely on the basis of the observed sample data; note that, for this sample, n is just slightly larger than $a+b$. The sample for which n=100 (n nearly six-times the magnitude of $a+b$) yields a posterior mean of .46, much closer to the observed proportion of .50.

Prior Knowledge about Ceramic Proportions

In my work with TMP data, I have used μ'', the mean of the posterior estimate of the population proportion (π), as a point estimate for π. Replacing the observed proportion p with μ'' in thematic maps and subsequent analyses reduces some of the random variability associated with small assemblages. The only assemblages that are not affected at least to some degree by this estimation procedure are those for which p is identical to $\frac{a}{a+b}$ (i.e., the observed proportion is the same as the mean of the prior distribution). In general, the smaller assemblages happen to be, the more posterior estimates derived from them resemble prior expectations, and statistical estimates diverge from prior expectations to the extent that they are bolstered by a robust body of

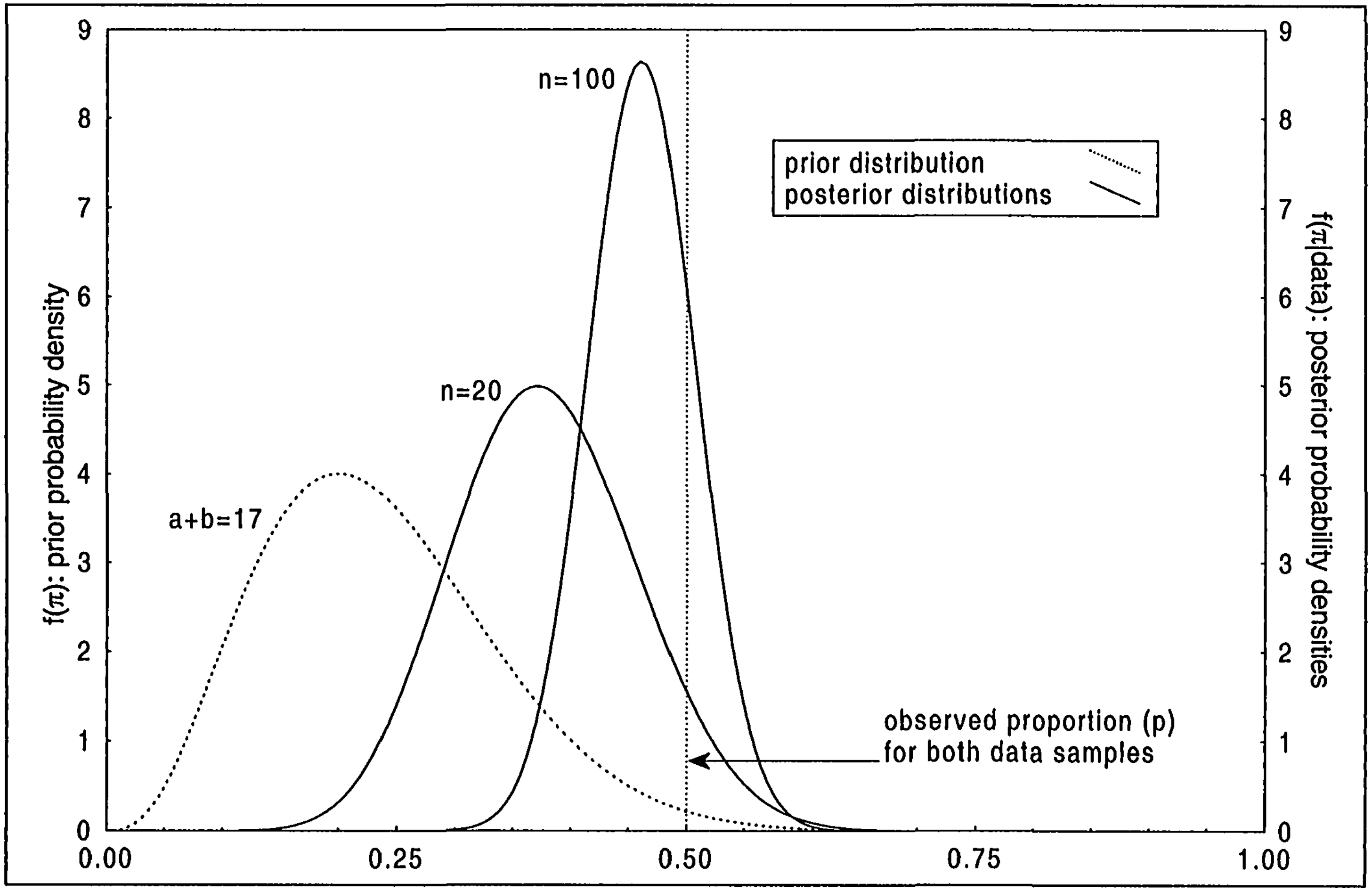

Figure 5.2: Prior and posterior probability distributions (density functions) for a proportion. The 'prior' is based on a beta distribution with a mean of .25 and a variance of .10; the sum of constants a and b is 17. The posterior distributions are based on two samples, one considerably larger than the other, but yielding identical observed proportions (.50). The smaller sample (x=10, n=20) yields a posterior mean of .38. The larger sample (x=50, n=100) yields a posterior mean of .46, much closer to the observed proportion of .50.

empirical data.

In order to calculate posterior probability distributions for the proportion of different kinds of pottery in individual TMP collections, it is first necessary to define prior beliefs about the populations that underlie each assemblage. This could be done in many different ways, and nothing in Bayesian estimation methods guide a researcher toward a single, "correct" statement of prior knowledge. Nevertheless, because the effect of prior knowledge may be large where sample data are limited, the definition of the "prior" is not a trivial matter.

It may be the case that so little is known about a population that all values that a parameter may potentially exhibit should be regarded as equally likely—such a belief could be captured by a "flat prior," a rectangular density function formed by a horizontal line (Iversen 1984:61-64). In other cases, however, enough is known about the population that a flat prior is unrealistic, and a more informative density function is called for.

In creating prior density functions for the proportion of the various pottery categories that exist in individual TMP collections, I have taken the position that a great deal of prior knowledge is available and that this information is manifest in larger "pools" comprised of individual collections. One that might be applied to this problem is a "site-wide" pool, composed of all of the collections from the city (Robertson 1999:141). For a given artifact type, a histogram showing the distribution of observed proportions within the individual assemblages that constitute this pool suggests which values are, *a priori*, most likely to be observed within any single, unexamined sample. Proportions that are the most common, falling near the peak value of this distribution, would be assigned relatively high probabilities in a statement of prior knowledge, while conversely, proportions that are the least common would be assigned correspondingly low probabilities. If the distribution of the observed proportions is unimodal and reasonably smooth, its mean and standard deviation can be used to define a *beta* density function that exhibits the same general shape and mathematically describes appropriate probabilities. The values of a and b defined by the *beta* function can then be used to calculate posterior estimates for the proportion of this artifact type within individual assemblages.

Under this procedure, the parameters used to describe a prior density function are based on characteristics exhibited collectively by a number of related data samples (individual assemblages) and the "prior" is subsequently used to calculate individual posterior estimates for these same samples. This kind of approach to Bayesian estimation is sometimes described as "empirical" (Maritz and Lwin 1989); data play a role at both ends of an empirical Bayesian estimation procedure, although the contribution that individual samples make to the definition of prior knowledge is partial and may be very small.

An empirical Bayesian estimation procedure based on a site-wide pool of assemblages applies the same global description of prior knowledge to individual assemblages, but it does not assume that π is the same in each case. The likelihood that the true proportion may be quite different for any individual assemblage is accommodated explicitly by the standard deviation of the *beta* function, and I have found this approach to be highly useful.[2] Nevertheless, there are drawbacks to the use of a global prior. In the case of Teotihuacan, for example, proportions of some artifact categories vary systematically across space, and form subregions that express significant departures from the measure of central tendency expressed by the city as a whole. The possibility that artifact categories may be subject to effects of spatial autocorrelation is not taken into account by a global prior, which by design, incorporates no information about spatial variability. This matters relatively little in the case of larger samples (i.e., assemblages) that are not affected much by prior information. Smaller samples, however, which produce posterior estimates that resemble more or less closely the parameters of the prior, may appear as anomalies when viewed against a broader background pattern created by nearby, but larger, samples yielding posterior estimates that happen to be similar to one another, but quite different from the prior. Such anomalies are essentially spurious, however, since the large variance tied to the small samples is compatible with point estimates that are closer to the local trend expressed by large samples.

In this study, instead of using a single, global prior, I have used multiple "local" priors that take into account more localized information. A custom computer program that I wrote in Microsoft Visual Basic (Microsoft Corporation 1999) and ESRI MapObjects (Environmental Systems Research Institute 1999) defines a local prior for every record, based on a pool that consists of the 100 nearest collection tracts with phase-totals that, for the phase in question, equal or exceed the median phase-total across the entire city. Restricting the pool to 100 nearest neighbours is based on an arbitrary value that assembles enough cases to reasonably characterize local trends of central tendency and dispersion, while drawing on information from locations as close as possible to the record in question. After each pool is defined, the calculation of statistics estimating the posterior distribution of proportions proceeds as it would with a global prior: the mean and standard deviation of p within the pool are used to calculate values of a and b that are unique to the record in question, and which serve in turn to calculate posterior estimates for π. Using this procedure, the prior knowledge that contributes to the estimation of μ'' and σ''^2 is derived from information obtained from the vicinity of the record in question, based on relatively large samples in which the effects of sampling error are correspondingly limited. It should be noted that if <u>no</u> examples of a particular category are found within the local pool of 100 collections (i.e., p=0 for all cases), then a and b are undefined. In such cases, I have used the global prior to calculate posterior estimates for that particular record and category.

The Sample-Size Threshold

The Bayesian procedure described above dampens the random effects of sampling error that exist in all collections, but it is most useful for pretreating collections that are "intermediate" in size—not so large that sampling error can be regarded as negligible, nor so small that posterior estimates are overwhelmingly dominated by prior knowledge. Collections that fall into the latter category, however, are simply homogenized by the calculation of posterior proportion estimates. The procedure does not increase their information content, or make them any more desirable—especially when viewed in a spatial context in which larger samples yield estimates that are distinctly higher or lower than the prior.

In this study, I have augmented the use of an empirical Bayesian estimation method with more traditional sample-size thresholds, defined partly on a relatively informal assessment of the loss of spatial coverage entailed by them and partly by the results of the Bayesian work. For both Miccaotli and Tlamimilolpa phase analyses, I excluded cases for which the phase-total did not include at least five sherds. The rationale for a threshold of five sherds is outlined below.

As noted previously, for any specific record and category, the relative weight of prior beliefs and sample data can be measured by comparing the magnitude of the sample-size n and the sum of the constants a and b. A useful index is $\frac{n}{(a+b)}$; values above 1 indicate that sample data are more important than prior information, while values below 1 indicate that the prior carries more weight than sample data.

Whether derived from global or local priors, the sum of a and b varies among categories and tends to be relatively small for common categories and relatively large for uncommon categories—this is a largely predictable effect due both to the fact that variance tends to be larger for categories exhibiting high proportions and the nature of equations 4a and 4b.[3] Because of this, the ratio $\frac{n}{(a+b)}$ yields different assessments of the contribution that a given sample can make to posterior estimates when applied to relatively rare, as opposed to relatively common, categories. Figure 5.3a and Figure 5.3b show the mid-spread of the distribution of $\frac{n}{(a+b)}$ for Miccaotli and Tlamimilolpa ollas and outcurving bowls, both quite common categories; these data (assembled during the calculation of local priors for these two categories) are broken down by phase-total (n) and shown only for collections with phase-totals of 10 or fewer sherds. For both phases, about 75% of the smallest samples retained (those with 5 sherds) contribute 50% or more of the information used to calculate posterior estimates for these categories. This is reflected in the fact that the lower bound of the mid-spreads for phase-totals greater than or equal to five falls above the line marking $\frac{n}{(a+b)}=.5$. The magnitude of the ratio of n to $a+b$ increases steadily as phase-totals increase. As Figure 5.3c indicates, imposing a sample-size cut-off of 5 or more sherds resulted in the removal of 28% (1321) of the Miccaotli assemblages and 24% (1118) of the Tlamimilolpa assemblages.

Assemblage Classification – K-Means Cluster Analysis

The second stage of the analytical procedure centers around the use of cluster analysis to classify collection tracts, based on the content of their ceramic collections. As noted earlier in this section, the rationale for classifying phase-specific assemblages recovered from the TMP collection tracts is one that is common to classification work in much scientific research and fundamentally has to do with the need to convert raw data—empirical variability exhibited by large numbers of individual units of observation—into comprehensible information. In this particular case, classification methods reveal broad, general patterns of difference and similarity collectively expressed by ceramic assemblages. Posterior estimates of mean proportion, variously

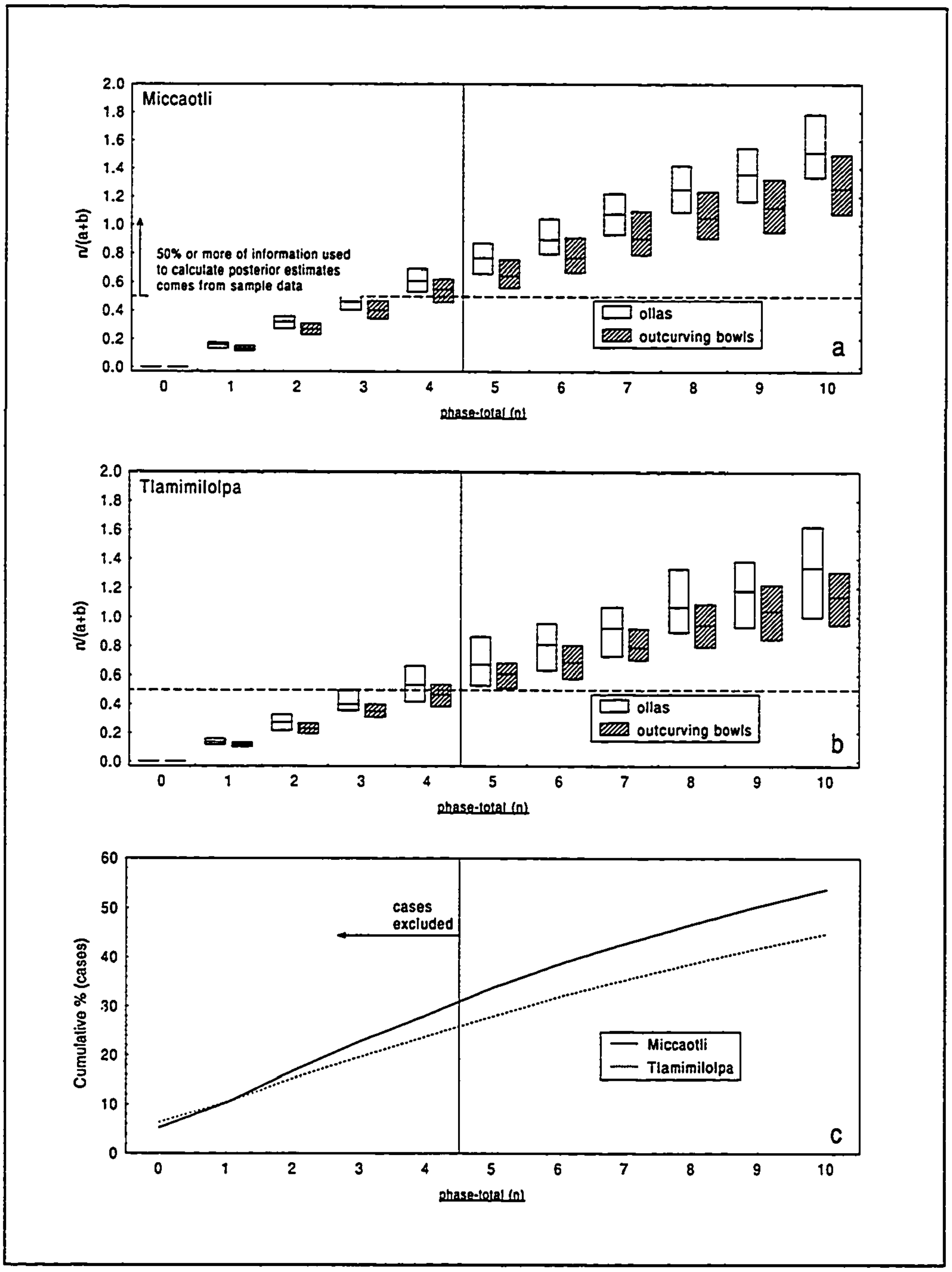

Figure 5.3: Sample-size thresholds and information content. The first two graphs (a and b) show the median and midspread for n/(a+b), the ratio between information provided by sample data and information provided by prior knowledge, as calculated for ollas and outcurving bowls, and broken down by phase and phase-total. The third graph (c) plots the cumulative frequency of cases against Miccaotli and Tlamimilolpa phase-totals; the vertical line indicates the sample-size threshold for inclusion in analyses beyond Bayesian estimation procedures.

transformed so as to weight their effect on the creation of "A-clusters," were used as input. Collection tract memberships in A-clusters—the output of classification—feed into a third stage of analysis that characterizes still broader socio-spatial differences at Teotihuacan.

Cluster Analysis

The specific method of cluster analysis employed in this research, k-means analysis, is an iterative partitioning method (Aldenderfer and Blashfield 1984:45-49; Doran and Hodson 1975:180-184) included in the Statistica statistical software package (StatSoft Inc. 1997). A non-hierarchical clustering method, k-means analysis results in a solution consisting of the exact number of clusters (*k*) specified by the user. K-means clustering routines typically begin by defining *k* clusters composed of randomly assigned cases. Cases are then reallocated amongst clusters using an iterative procedure that attempts to produce increasingly well-defined clusters. The k-means clustering program in Statistica uses an algorithm based on an analysis of variance method which partitions sums of squares values such that within-cluster variance is minimized, and between-cluster variance is maximized (StatSoft Inc. 1999).

A criticism that is occasionally made of archaeological applications of all forms of cluster analysis is that it will define clusters in data sets in which clustering behaviour is weak or even absent (see Read and Christenson 1978). This is a fair observation, but as a criticism it fails to acknowledge that, at least for descriptive purposes, it is frequently useful to define classes even when they do not occupy well-bounded units in multivariate space; doing this should be no more remarkable, for example, than dividing a continuous, univariate distribution into quartile ranges, perhaps as preparation for some visualization method. Nevertheless, clusters that can be shown to be "internally cohesive and externally isolated" (Baxter 1994:155; Cormack 1971:329; Cowgill 1990) are, generally speaking, likely to be more meaningful than those that are created simply by partitioning dimensions of continuous variation, and it is worthwhile to try to decide if a particular cluster solution is closer to one of these extremes than the other. Unfortunately, this is seldom straightforward, and to a large extent the relative merits of different cluster solutions have to be assessed in practical terms, such as the degree to which they can be used to illuminate other problems, or support other kinds of analyses. Sometimes, cluster memberships can be shown to correlate with observations not included among input data, and this may also be cited as evidence for at least some level of validity.

Variable Transformation

When variance among input variables is highly uneven, solutions obtained from cluster analysis will tend to be dominated by variables exhibiting the highest variance (Romesburg 1990:78-91). This has the effect of differentially weighting the contribution of input variables, not necessarily in a desirable way. It is quite conceivable, for example, that a strong tendency toward clustering might exist in a data set, but fail to be reflected in the results of cluster analysis because the tendency happens to be expressed in variables that, in comparison to other input variables, show relatively low variance. Even if cluster analysis is called upon simply to partition largely continuous variation in multivariate space (i.e., if "natural" clustering either does not exist, or is not of primary interest), very uneven variance in input variables may still be undesirable—the variables with "low" variance will simply have little or no effect on the outcome of the analysis and might as well not be included. A set of input variables with relatively equal variance will contribute more equally to cluster solutions and to the characterization of similarities and differences that they express.

As will be noted in the following chapter, the posterior estimates of mean ceramic category proportions that are used as input for cluster analysis are typically characterized by highly uneven variance and tend also to be highly skewed. The various phase-variants for ollas, for example, are often very common within individual assemblages, exhibit proportions that range widely from collection to collection, and have a distribution that shows a clear left-skew (i.e., the median is well to the left of the peak of the distribution). Categories associated with more highly decorated, less utilitarian, vessels are relatively uncommon, tend to vary across a correspondingly narrow range of proportions, and show a clear right-skew.

In an attempt to classify assemblages in ways that made use of variation in both common and uncommon, utilitarian and non-utilitarian forms of pottery, I modified input variables in a way calculated to more equally weight their effect on cluster analysis. There are a number of ways in which this could have been accomplished, including various forms of data transformation and standardization (see Baxter 1994:40-47; Drennan 1996:56-63).

In this study, a simple transformation procedure was used that involved raising posterior estimates of mean proportions to a power, selected on a variable-by-variable basis so as to effect desired changes in input variables. The most important of these changes was to decrease differences in variance exhibited across variables. A possibly advantageous side-effect of transformation was to reduce the very marked skew exhibited by almost all variables. Multivariate normality is frequently regarded as desirable in many multivariate statistical methods (Baxter 1994:40), although not necessarily an important consideration in cluster analysis.

It should be noted that the process of transforming variables was not subject to very rigorous rules. Powers ultimately used in the final transformations were selected after experimenting with various possibilities, while (1) examining box plots that summarized the distribution of both transformed and untransformed variables; and (2) examining the effect of variously transformed variables on cluster solutions. In general, variables exhibiting relatively high variance were raised to powers of having greater magnitude than those with low variance; when variance for all variables is plotted against the corresponding transforming power a fairly clear, positive, linear relationship can be discerned.

As will be made clear in the next chapter, the transformation procedure used here does not eliminate the wide differences in variance exhibited by input variables, but only reduces them. Input variables might have been standardized in the form of z-scores, and this would have resulted in a set of variables for which variance was exactly the same (i.e., 1). After some experimentation, I decided not to standardize variables as z-scores, as this gives too much weight to relatively rare ceramic categories that are subject to high levels of sampling error. Weighting by means of power transformation was a compromise between doing nothing about uneven variance, and standardization by z-scores.

Cluster Evaluation

As an important component of my exploratory strategy, many cluster solutions were generated in this research project, varying in terms of input variables used, transformations applied to them, and the number of clusters produced. Only a subset played larger roles in this research project, and even fewer receive more than passing documentation in this dissertation. Nevertheless, all cluster solutions were examined in more or less detail in order to assess their interpretive potential and suitability for inclusion in other stages of description and analysis. While a small set of specific procedures played an important role in the evaluation of cluster solutions, it should be made clear that decisions to focus attention on one solution instead of another were based in large measure on partially arbitrary judgments in which practical considerations were as important as theoretical ones. Presumably all of the cluster solutions that were generated reflect something "real" about empirical variability in the ceramic samples of the TMP and are therefore potentially relevant to the general research problem of this dissertation.

The goal of cluster evaluation was to identify a few solutions that were useful for specific purposes, made relatively good sense, and were amenable to other analytical and visualization procedures.

The principal analytical procedures used to evaluate cluster solutions are shown schematically in the third tier or row of section b, Figure 5.1. The various kinds of information generated by them (in the next tier) connect back to the k-means clustering procedure through feedback loops and were used to identify cluster solutions that were likely to be particularly informative, and could be regarded as in some sense "final" from the perspective of this particular research project. They also provide important auxiliary information for interpreting such cluster solutions. Three main types of evaluation procedures and the information they generate are described below.

SSE data: Using a custom program written in Statistica Basic (StatSoft Inc. 1997), sum-squared error (SSE) data were calculated in an attempt to (1) identify solutions that represented a good balance between the number of clusters generated and the relative dispersion of individual cases contained by them, and (2) assess the relative strength of cluster formation inherent in such solutions.

A feature of many good classifications is the provision of a relatively small set of labels for describing a relatively large set of cases, while still retaining a useful percentage of the original information content inherent in the description of individual cases. This represents a compromise. On one hand, smaller numbers of clusters are preferred because they are more manageable, easier to think about, and more readily accommodated by visualization tools such as maps and graphs. On the other hand, larger numbers of clusters tend to be characterized by greater internal cohesion, so that a single class or label provides more precise information about the nature of individual members.

For any given cluster solution, the SSE is the sum of the squared distances between individual cases and the centroid of their respective cluster. The centroid of each cluster is simply the mean value of all of the input measurements exhibited by member cases; smaller SSE values indicate collectively "tight" clusters, with individual cases located close to the mean. A useful way to use this information, following a procedure described by Kintigh (1990:185) in the context of pure locational clustering, is to generate SSE values for successive cluster solutions, covering the range of clustering levels that could conceivably be of interpretive interest. SSE values (expressed as a percentage of the SSE value associated with the smallest clustering level and plotted against the number of the cluster in the form of a "scree" plot) aid in the identification of solutions that provide a good trade-off between the number of clusters, and levels of intra-cluster variance. Cluster solutions that may be of particular interest are indicated by inflections in the resulting curve. Such inflections mark cluster levels that are associated with a fairly rapid drop in SSE relative to smaller numbers of clusters, followed by a flattening of the curve that indicates relatively little further return (as measured by SSE values) for embracing higher-level cluster solutions. Examples of such plots will be considered in Chapter Six, in the context of actual cluster analyses.

Discriminant Function Analysis: Discriminant function analysis (DFA) is a statistical procedure that is concerned with how, for a given set of cases, membership in mutually exclusive groups is expressed in another set of variables (Klecka 1980). In this study, DFA is used to illuminate the results of cluster analysis by identifying the combination of input variables that was most influential in creating clusters. This information is used to characterize A-clusters and define central tendencies for the individual cases that they encompass.

Input for a discriminant function analysis consists of a single nominal categorization variable specifying membership in one of two or more groups (clusters) and a set of descriptive input variables. The main product of the analysis is a set of discriminant functions—linear equations that describe axes in the multivariate space defined by the variables. The first axis is defined so as to maximize both the separation of group means and the isolation of group members; any subsequent axes are similarly defined with respect to the goal of isolating groups, but with the constraint that they are orthogonal to those previously defined. The largest number of discriminant functions that can be defined is normally one less than the number of groups specified by the categorization variable. Often the first few discriminant functions separate groups well enough so that the others can be reasonably ignored.

The basic meaning of a set of discriminant functions lies (1) in the degree to which they isolate members of different groups, and (2) how they represent the effect of input variables on such isolation. The first question is most readily assessed by calculating scores for individual cases on the discriminant functions; graphs of such scores—dotplots or scatterplots with different symbols used for different groups—will show which function, or combination of functions, discriminates among which groups. Assessing the contribution of individual variables to the various discriminant functions is more complex and can involve several lines of evidence. So-called "stepwise" DFA methods use an iterative procedure to eliminate variables that fail to exhibit a specified level of discriminating power. The discriminant functions that emerge from the analysis are based only on the variables that remain; if the original set of input variables does not show high levels of inter-variable correlation (Baxter 1994:207-208), this can be useful for focussing attention on variables that make a significant contribution to group discrimination. Whether or not a stepwise method has been employed, the coefficients associated with discriminant functions, after appropriate standardization (Baxter 1994:190-191), reflect the relative contribution of individual input variables toward calculating the score of any individual case, measured along the axis represented by that function. This is certainly related to a variable's importance, but a better, more interpretable means of assessing the relationship between various discriminant functions and input variables is through factor structure coefficients (Klecka 1980:33; StatSoft Inc. 1999). These coefficients are simply the product-moment correlation between an individual variable and one of the discriminant functions. High absolute values (near 1.0 or -1.0) show that both carry much of the same information content, and discriminant functions can be "named" or interpreted in terms of variables carrying high factor structure coefficients.

In this analysis, a discriminant analysis module included in Statistica (StatSoft Inc. 1997) was used to characterize the role that the various ceramic categories included in phase-specific analyses played in the definition of A-clusters. In some instances, with cluster solutions involving more than two clusters, a series of separate DFAs were run for each cluster, each based on a binary categorization variable that simply recorded if a case was a member of that particular cluster, or one of the others. This procedure produces a single discriminant function for each cluster (i.e., a function that describes differences between the cluster and all other clusters taken together). This is highly useful for clarifying interpretation when ambiguous results were obtained from a more conventional DFA based on a multi-state classification variable.

<u>Thematic Mapping</u>: Experimental research in the TMP data quickly showed that collection tracts assigned to a given A-cluster (i.e., based directly on differences among individual pottery assemblages) do not cluster together into clear or well-bounded spatial units and are instead quite highly interspersed with tracts assigned to different A-clusters. This is an important observation, and the spatial arrangement of A-clusters is highly relevant to the subject matter of this dissertation. However, defining units of analysis that reflect broader, more regional differences

within the city is also important; above all, such units provide an objective way of tracking the differential distribution of A-clusters across time and space. A second stage of analysis aimed at defining N-clusters was developed for this purpose (see below), and it is at that stage that I invest the most effort in characterizing spatial patterns.

Nevertheless, like DFA, thematic maps were used during the assemblage classification stage as a partial means of identifying and describing cluster solutions that showed potentially interesting and interpretable patterning and that would be worth examining in more detail as part of the next stage of analysis. Maps of large numbers of cluster memberships were made in MapInfo, most simply reviewed on a computer screen for evidence that some clusters were more common in some parts of Teotihuacan than in others. No formal spatial statistical tests were carried out on the data displayed in these maps, which simply served as a means of visually screening the results of large numbers of cluster analyses.

Neighbourhood Classification – Local Density Analysis and Unconstrained Clustering

One of the things that was learned by examining thematic maps showing the spatial distribution of A-cluster memberships is that most parts of Teotihuacan show a high degree of heterogeneity in terms of basic types of ceramic assemblages. As noted near the beginning of this chapter, the procedures that I have used to distill a higher-level settlement pattern out of the mosaic produced by the assemblage classification stage involve describing how the mixture of different kinds of ceramic assemblage maps onto horizontal space within the city. This is done using a procedure called local density analysis. In this procedure (see below) a series of overlapping polygons ("buffers") are used to define neighbourhoods around each of the TMP collection tracts; each tract is then characterized in terms of local densities of the various A-cluster classes within its immediate neighbourhood, as defined by the encompassing buffer. Differences and similarities in the composition of neighbourhoods are explored using a second phase of k-means analysis. The different classes of neighbourhood that emerge from this work (described as "N-clusters," for neighbourhood cluster) are then characterized in terms of spatial association and internal content.

Local Density Analysis

As noted earlier in this chapter, the idea of exploring spatial patterns at Teotihuacan by characterizing locations in the city in terms of the composition of larger, overlapping neighbourhoods was inspired by a procedure suggested by Robert Whallon for exploring spatial patterning in artifact scatters (Whallon 1984). Whallon's original description of "unconstrained clustering" showed how evenly-spaced, overlapping series of circular templates could be used to calculate smoothed local densities of different artifact classes at the vertices of an overlying grid. These densities could then be used in cluster analysis with the expectation that cluster memberships might reveal spatial patterns in assemblage composition (Gregg et al. 1991:158-166; Whallon 1984). Unconstrained clustering was originally conceived as a strategy for analyzing the internal structure of fairly small-scale sites using individual artifacts as the basic units of observation. While the scale of analysis and the units of observation were quite different, it was clear that Whallon's general approach—the idea of using some kind of search tool to characterize spatial localities in terms of larger encompassing neighbourhoods—could also provide important insights into the spatial structure of TMP data.

Kintigh (1990:191-194) pointed out that Whallon's template configuration is biased in the way in which it samples the surface of the site; depending on their location relative to grid vertices, some artifacts may have as much as twice the effect on density calculations as others. As a more direct and less biased way of generating local artifact densities, Kintigh recommended using the neighbourhood composition data generated as a by-product of a procedure called local density analysis. Also developed for examining spatial patterning at a fairly small scale, local density analysis involves the calculation of global measures of spatial association (local density coefficients) between nominally classified observation points, at specific scales (Johnson 1976, 1984). As described by Kintigh, the local density coefficient $C_{ij(r)}$ is the ratio between the mean local density of points of type j in the vicinity of points of type i and the global density of type j points (Kintigh 1990:177). Note that taking into account the global densities of point types means that this coefficient is effectively standardized according to how common the various types happen to be. Note as well that local density coefficients can be calculated to measure the density of points of one type in the vicinity of points of the same type (i.e., where $j = i$), or of different types (where $j \neq i$).

In order to calculate local point densities, a circular search radius is defined around each point and used to capture the set of neighbouring points within distance r. The set of points, tallied according to type, provide a vector that measures the composition of a neighbourhood of fixed size around each point. Kintigh recommended using the neighbourhood composition data—counts of different point types within a fixed radius of each point, standardized by the total number of points—as input for the clustering stage of unconstrained clustering, using the original observation points as cases, rather than each vertex of an overlying grid.

The research context for both Whallon and Kintigh's discussions of unconstrained clustering has been the analysis of "point pattern" data in which the provenience of empirical observations can be described by single pairs of coordinates in two dimensional space. As described in the previous chapter, the TMP data are organized around the more complex shapes of collection tracts, and MF2 (the current electronic version of the TMP map) preserves these shapes in the form of a polygon lattice. It would not be unreasonable to convert this lattice into a point-pattern by calculating centroids for each of the polygons in MF2, then using these points as a basis for local density analysis as described by Kintigh. I have, in fact, done this for certain procedures, particularly where it was important to take advantage of the extremely fast computation speed of Kintigh's local density analysis program LDEN, which is designed to operate on point provenienced data (Kintigh 1993:36-39).

The disadvantage in using LDEN, however, is that the TMP collection tracts are highly variable both in size and shape, and this means that the distance effectively searched *outside* of the boundary of the original polygon, by a standard, circular search radius, varies considerably among cases. This makes it difficult to compare and interpret results, especially those generated by relatively short radii. As an alternative to the point-pattern solution offered by LDEN, a custom program written in MapBasic was used to carry out lattice-based local density analysis in the MapInfo environment using overlapping "buffers," individually defined for each polygon, to calculate local density coefficients and gather neighbourhood composition data describing the local densities of A-cluster members. Buffers are geometric shapes created by enlarging a central polygon, preserving its basic shape, but expanding its boundaries outward a set distance in all directions. Buffers are typically used in GIS programs to identify sets of spatial entities located within a set distance of another spatial feature.

I have used both Kintigh's point-based program LDEN and the lattice-based MapBasic program in this study. The former was used to generate important information about the strength of association between A-cluster types over a wide range of spatial scales—this is a computer intensive task that would have been impractical using the comparatively slow lattice-based program that I wrote. Among other things, the LDEN results indicate the general distances over which patterns of association are the most pronounced, and this information helps determine the size of buffer appropriate for collecting more refined information about neighbourhood composition. This is done by the lattice-based local density analysis program, based on a single run and a single scale of analysis.

One modification in the way in which I have used and presented output from LDEN needs to be specified. Local density coefficients, like nearest-neighbour and similar measures of global spatial association that depend on a single and somewhat arbitrary description of site area, is affected by what are described as "boundary problems" (Kintigh 1990). This makes the theoretical baseline of the measure (1.0, indicating no association or segregation) essentially meaningless, and conventional local density coefficients are therefore useful as relative, rather than absolute measures of association. Kintigh notes that Monte Carlo methods could be used to determine confidence intervals for local density coefficients, thus making them more interpretable; interestingly, experiments involving repeated randomization of point type assignments yielded coefficients that appeared to trend toward values that could be obtained by simply running the ordinary analysis, but with all cases assigned to a single type (Kintigh 1990:178-179). This is a highly useful observation that suggests a straightforward way of converting measures of local density to a more meaningful scale. Local density coefficients obtained when cases are "pooled" into a single type (C_r) serve as an absolute baseline for conventional inter- and intra-type analyses. At any given scale r, a comparison of C_r and $C_{ij(r)}$ will indicate whether or not any pair of types shows a higher or lower degree of spatial association than exists in the dataset in general, i.e., if type memberships are simply ignored. A useful way of operationalizing this baseline is by calculating a value that, for convenience, I describe as D, where $D_{ij(r)} = \frac{C_{ij(r)} - C_r}{C_r}$. A value of 0.0 indicates a lack of inter- or intra-type association and segregation; in other words, the mean density of type j points within distance r

of type i points is about the same as the mean density of all points, *relative to their respective global densities*. If D equals 0.5, on the other hand, the mean local density of type j points is relatively high—half as large again as the mean density of points in general.[4]

Cluster Analysis

The use of k-means clustering at this stage of the broader analysis serves a purpose that is similar to that which it served earlier, i.e., to reduce observational variability associated with individual cases through a systematic process of classification. The goal is to generate classes (N-clusters) that reflect broad patterns of similarity and difference in neighbourhood composition in terms of A-clusters, rather than assemblage composition.

Auxiliary methods of cluster evaluation similar to those described for the A-cluster study—particularly the interpretation of SSE data and thematic mapping—are used to illuminate the results of N-cluster classification. To anticipate slightly some of the results presented in the next chapter, the creation of N-clusters produces a high level of broad spatial patterning within the city, and significantly more effort is invested at this stage of the analysis in describing and interpreting these patterns. In particular, indices that measure local diversity are used to characterize differences in neighbourhood composition, both across space and across time.

Summary

In a nutshell, the series of procedures that were described above were designed to reveal basic patterns in ceramic consumption practices at Teotihuacan, particularly as expressed spatially, and at two different scales of analysis—the individual collection tract, and larger encompassing neighbourhoods. Table 5.3 summarizes in point form much of the material that was presented in the preceding sections of Chapter Five. The results that emerge from the implementation of the research procedures are presented in the next chapter.

Table 5.3: Summary of methods used in analysis.

stage	goal	input	method	output
data pretreatment	•reduce noise effects of sampling error	•collection-specific category counts, broken down by phase	•Bayesian estimation of posterior proportions •imposition of sample-size threshold	•improved estimates of category proportions in individual collections
assemblage classification	•elucidate ceramic variability at the level of the individual collection	•posterior estimates of the mean proportion in individual collections	•k-means clustering •discriminant function analysis •thematic mapping	•definition of A-cluster memberships •thematic map of assemblage type(s) •contribution of input variables to cluster formation •patterns of variable association
neighbourhood classification	•elucidate ceramic variability at the level of local, overlapping neighbourhoods	•A-cluster memberships	•local density analysis •unconstrained clustering using k-means method •discriminant function analysis •thematic mapping	•definition of N-cluster memberships •contribution of input variables to cluster formation •patterns of variable association

Notes for Chapter Five:

[1] So that C' can be easily calculated using the factorial expressions in equation 2 (rather than a more complex gamma function), a and b are normally rounded to the nearest integer (Iversen 1984:23-24). This is unnecessary unless one wishes to graph the *beta* function described by equation 1. To calculate μ'' and σ''^2 (the mean and variance of a posterior *beta* distribution for π), it is better to use the non-integer values for a and b obtained directly from equations 4a and 4b, and that is the procedure followed in this study.

[2] The use of a site-wide data pool as the basis for making empirical Bayesian estimates was suggested to me by George Cowgill.

[3] There is a negative, log-linear relationship between the values of $a + b$ associated with each category and category proportions, both averaged across cases.

[4] The advantage in dividing $C_{ij(r)} - C_r$ by C_r was pointed out to me by Keith Kintigh.

Chapter Six

ANALYSIS AND RESULTS

The previous chapter laid out the methodological foundation for this study in general terms. Chapter Six focusses directly on the specific ways in which analytical procedures were put into action and the results that they produced.

The Miccaotli Phase

Assemblage Definition

As explained in Chapter Five, I am adopting the word *assemblage* in this study to refer to a subset of artifacts within individual collections that are roughly coeval and which can therefore serve as a basis for phase-specific analyses. In this usage, assemblages are subsets of individual collections. Eleven REANS categories were used to define Miccaotli phase assemblages. Table 6.1 lists these categories, grouped under headings that reflect plausible functions of these different kinds of pottery, broken down according to a tripartite scheme consisting of the headings 'cooking/storage,' 'ritual,' and 'service.'

Not all of the categories for which Miccaotli phase-variants exist in the ceramic reanalysis (see Appendix A) were included in this study. According to evidence derived from correlation and other analyses, both "Miccaotli burnished jars" and "Miccaotli floreros" exhibit maximum phase affiliations with phases later than Miccaotli and may therefore contain a mixture of artifacts from more than one phase. Both of these categories were excluded, reducing the total number of sherds by 1,516 sherds (1,468 jar, 48 florero sherds) and leaving tabulations on just over 78,000 sherds available for the Miccaotli analysis.

Table 6.1: Counts and proportions of Miccaotli phase ceramic categories in individual collections.

category	no. of valid cases	total sherds	sherd count per collection		count x 100 phase-total	
			mean	sd	mean	sd
cooking/storage						
R453: Miccaotli olla	4696	47406	10.09	14.31	61.9	26.2
R483: Miccaotli comal	4696	1663	0.35	1.28	2.0	6.7
R503: Miccaotli cazuela/crater	4696	9207	1.96	3.76	11.1	15.8
ritual						
R683: Miccaotli censer	4693	1552	0.33	0.93	2.0	6.5
service						
R923: Miccaotli outcurving bowl	4663	11953	2.56	5.48	14.8	18.2
R943: Miccaotli polished bowl	4636	2452	0.53	1.76	3.7	9.9
R733: Miccaotli polished black	4694	178	0.04	0.66	0.1	1.1
R913: Miccaotli polished vase	4679	1421	0.30	1.16	1.6	6.0
R743: Miccaotli pattern polished	4668	53	0.01	0.13	0.1	1.4
Miccaotli incised	4583	244	0.05	0.36	0.2	1.9
R873: Miccaotli nubbin	4695	2069	0.44	1.17	2.5	6.6

Two other categories that were considered for elimination were "Miccaotli polished black" and "Miccaotli cross-hatch incised." Counts of both "polished black" and "cross-hatch incised" show a very clear drop-off for phase-variants postdating Miccaotli, and it is apparent that these modes were regarded as pertaining mostly to the Miccaotli phase and nearly absent in later phases. Correlation analyses, however, indicate that the Miccaotli phase-variants may also share a significant phase affiliation with Tlamimilolpa, and it is possible that the criteria used to sort these two categories did not clearly distinguish between the two phases. The counts on which this evidence is based are relatively low, however, and the correlation analyses were not regarded as conclusive enough to warrant their exclusion.

Correlation studies carried out on denseware (a category that lacks phase-variants under ceramic reanalysis procedures) suggest that it was probably made during Miccaotli and Tlamimilolpa, but not primarily affiliated with either phase. Denseware, a fairly rare category represented by less than 400 sherds in the TMP collections, was therefore not included in the definition of Miccaotli assemblages.

While the Miccaotli "regular incised" category appears to be reliably phased, correlation analyses indicate that Miccaotli "cross-hatch" may be about as strongly affiliated with the Tlamimilolpa phase as with Miccaotli. Because all three types of incision that have Miccaotli phase-variants under ceramic reanalysis procedures (regular incised, cross-hatched incised, and gouge incised) were represented by low or very low counts, they were combined as a composite category and retained in the analyses.

The format of Table 6.1 is similar to that used in Appendix A to present summary data about individual ceramic categories, and the first five columns are identical. The first column records the name of the ceramic category. For each category, the next column records how many cases in the REANS database have non-missing data, while the third indicates the total number of such sherds in REANS. The next two columns show the mean and standard deviation of counts within individual collections. The final two columns show the mean and standard deviation for the proportion of each category within individual assemblages; the denominator used to calculate the proportions is the phase total for the assemblage (i.e., the number of sherds assigned to one of these 11 categories, not the total number of sherds in the collection). Figures in both columns have been multiplied by 100 to enhance readability.

Bayesian Estimation

Posterior estimates of proportions were calculated for each category included in the Miccaotli analysis using the Bayesian procedures described in the previous chapter; relevant information is summarized in Table 6.2. Counts of each category within individual assemblages were converted to proportions, using the total count for these categories (i.e., a measure of the total number of "Miccaotli" sherds within each collection) as the denominator. The mean (μ) and variance (σ^2) of observed proportions of each category (the third and fourth columns of Table 6.2) describe the central tendency and dispersion of these values across the entire city. The mean and variance of proportions in a spatially and numerically restricted pool (the 100 nearest neighbours with Miccaotli phase-totals equal to or greater than the median value of 9 sherds) were used to describe a "local" prior distribution for each combination of record and category; the coefficients a and b associated with these priors were then used to define a posterior distribution of proportions within each collection. Average values of a and b (i.e., calculated across all collections) are given in the fifth and sixth columns of Table 6.2. The final two columns of this table provide summary information about Bayesian estimates for each category—shown are the mean and variance (again, calculated across all collections) of the mean of the posterior distribution for each category.

Table 6.2: Miccaotli phase analysis: statistics and constants used in Bayesian estimation.

category	valid n	μ	σ^2	$\bar{a}$	$\bar{b}$	$\overline{\mu''}$	$\overline{\sigma''^2}$
R453: Miccaotli olla	4684	0.62	0.068	4.19	2.64	0.61	0.019
R483: Miccaotli comal	4684	0.02	0.004	0.22	12.15	0.02	0.001
R503: Miccaotli cazuela/crater	4684	0.11	0.025	0.89	6.77	0.11	0.006
R683: Miccaotli censer	4681	0.02	0.004	0.25	13.07	0.02	0.001
R923: Miccaotli outcurving bowl	4651	0.15	0.033	1.20	6.95	0.15	0.008
R943: Miccaotli polished bowl	4625	0.04	0.010	0.32	10.51	0.03	0.001
R733: Miccaotli polished black	4682	0.00	0.000	0.02	15.91	0.00	0.000
R913: Miccaotli polished vase	4667	0.02	0.004	0.19	11.87	0.02	0.000
R743: Miccaotli pattern polished	4660	0.00	0.000	0.01	26.06	0.00	0.000
Miccaotli incised	4572	0.00	0.000	0.05	17.38	0.00	0.000
R873: Miccaotli nubbin	4683	0.03	0.004	0.37	13.75	0.03	0.000

Note that for all categories in Table 6.2 the mean posterior estimate is close or identical to the mean of the observed proportions, while the variance associated with posterior point estimates is less than the variance associated with observed proportions. Note also that the maximum number of cases for which valid data exists for each category (column 2, Table 6.2) is slightly reduced relative to Table 6.1. This is because locational information contained in the current digital map of Teotihuacan (MF2) was used to calculate local priors, and not all collections in REANS are matched by spatial entities in MF2; cases without a matching record in MF2 were removed from the analysis.

Assemblage Classification

The Bayesian estimates of posterior means summarized in the last two columns of Table 6.2 were used in subsequent analyses as point estimates of the proportion of Miccaotli phase-variants that make up individual assemblages. Variation in these estimates forms the basis for classifying assemblages and, by extension, the localities from which they were recovered. This is assessed using cluster analysis, which produces groups that capture broad patterns of similarity and difference among Miccaotli phase pottery assemblages collected from individual collection tracts. As discussed in Chapter Five, collections with phase-totals of less than 5 sherds were eliminated from this and subsequent stages of analysis, reducing the number of cases from 4684 to 3372 cases.

Cluster Analysis

As the last column in Table 6.2 indicates, the variance exhibited by the posterior estimates of the mean proportion varies widely, with the highest variance associated with the most common category ("Miccaotli ollas") and the lowest variance associated with rare categories such as "Miccaotli pattern-polished" and "Miccaotli polished black." As described in the previous chapter, highly uneven variance among input variables makes it difficult to define clusters in ways that make use of much information about rarer categories. In order to increase the contribution of such categories to cluster formation, estimates of mean proportions were raised to various powers. The powers used to transform these data are shown in Table 6.3. The effect of transformation on the distribution of the ceramic categories can be seen in Figure 6.1, which shows box plots for input variables before and after transformation.

Table 6.3: Miccaotli phase analysis: powers used for transforming posterior proportions of input categories.

category	power
R453: Miccaotli olla	1.00
R483: Miccaotli comal	0.20
R503: Miccaotli cazuela/crater	0.40
R683: Miccaotli censer	0.20
R923: Miccaotli outcurving bowl	0.40
R943: Miccaotli polished bowl	0.20
R733: Miccaotli polished black	0.10
R913: Miccaotli polished vase	0.20
R743: Miccaotli pattern polished	0.10
Miccaotli incised	0.10
R873: Miccaotli nubbin	0.20

The k-means procedure in the cluster analysis module of Statistica (StatSoft Inc. 1997) was used to classify Miccaotli assemblages based on variation in the 11 categories specified above, as measured by transformed posterior estimates of proportions. Cases missing data on any of the 11 variables were not eliminated; instead, missing data codes were replaced by the mean for the variable in question, thus maximizing the spatial coverage of output data. The number of cases included in the clustering procedure was 3372. Cluster memberships were obtained for all cluster solutions between two and ten clusters.

A scree plot of the %SSE data associated with this series of cluster analyses (Figure 6.2) shows a clear inflection at two clusters; the drop in %SSE values associated with increasingly high cluster levels is fairly constant, with no clear inflections discernible. While dividing the full data set into two groups results in a significant improvement in intra-cluster cohesion, the %SSE data do not identify any other cluster solution as offering a particularly good return for embracing larger numbers of clusters.

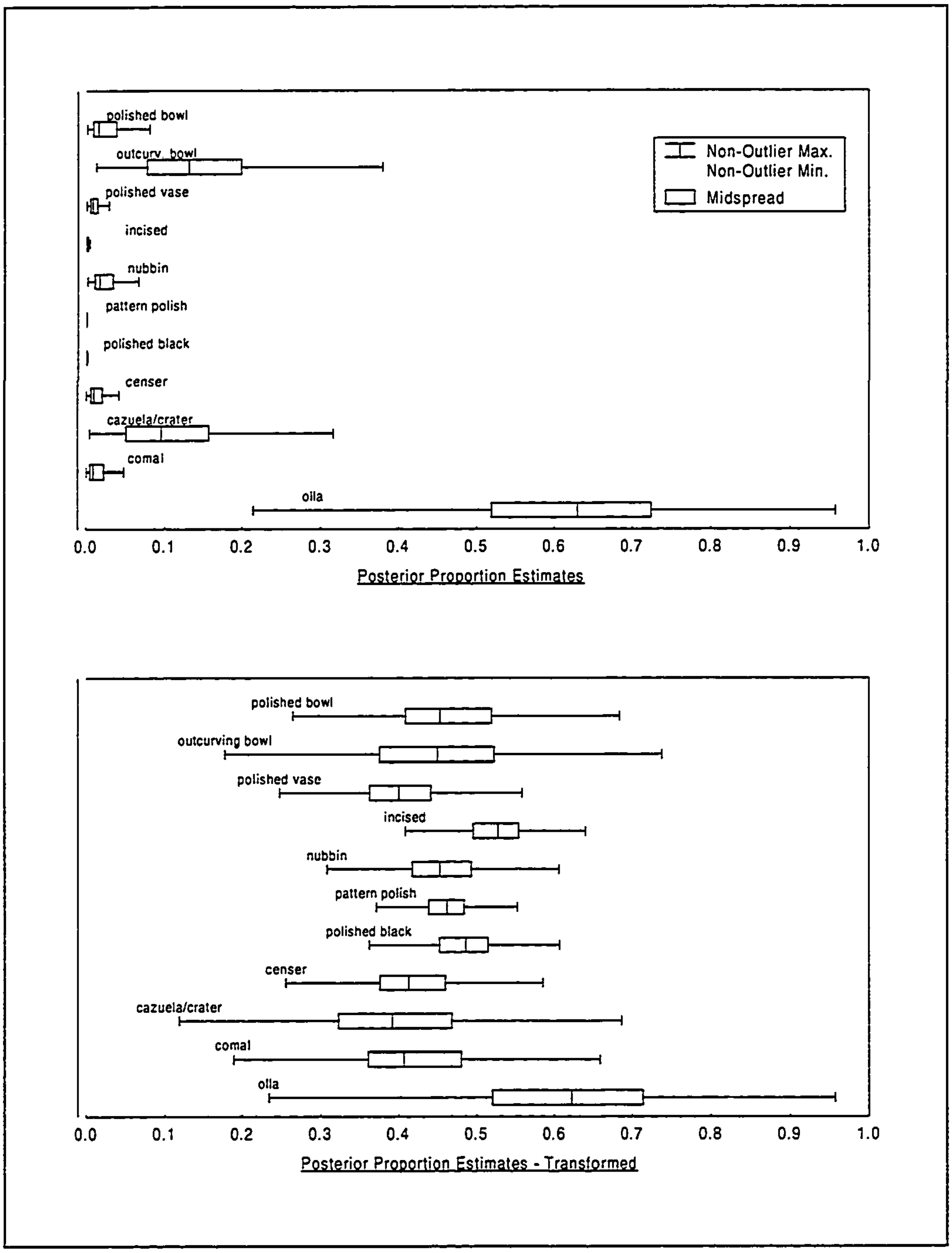

Figure 6.1: Ceramic categories used in Miccaotli phase analysis. The top graph shows the distribution of posterior proportions estimated by means of the empirical Bayesian method; the bottom graph shows posterior estimates after transformation.

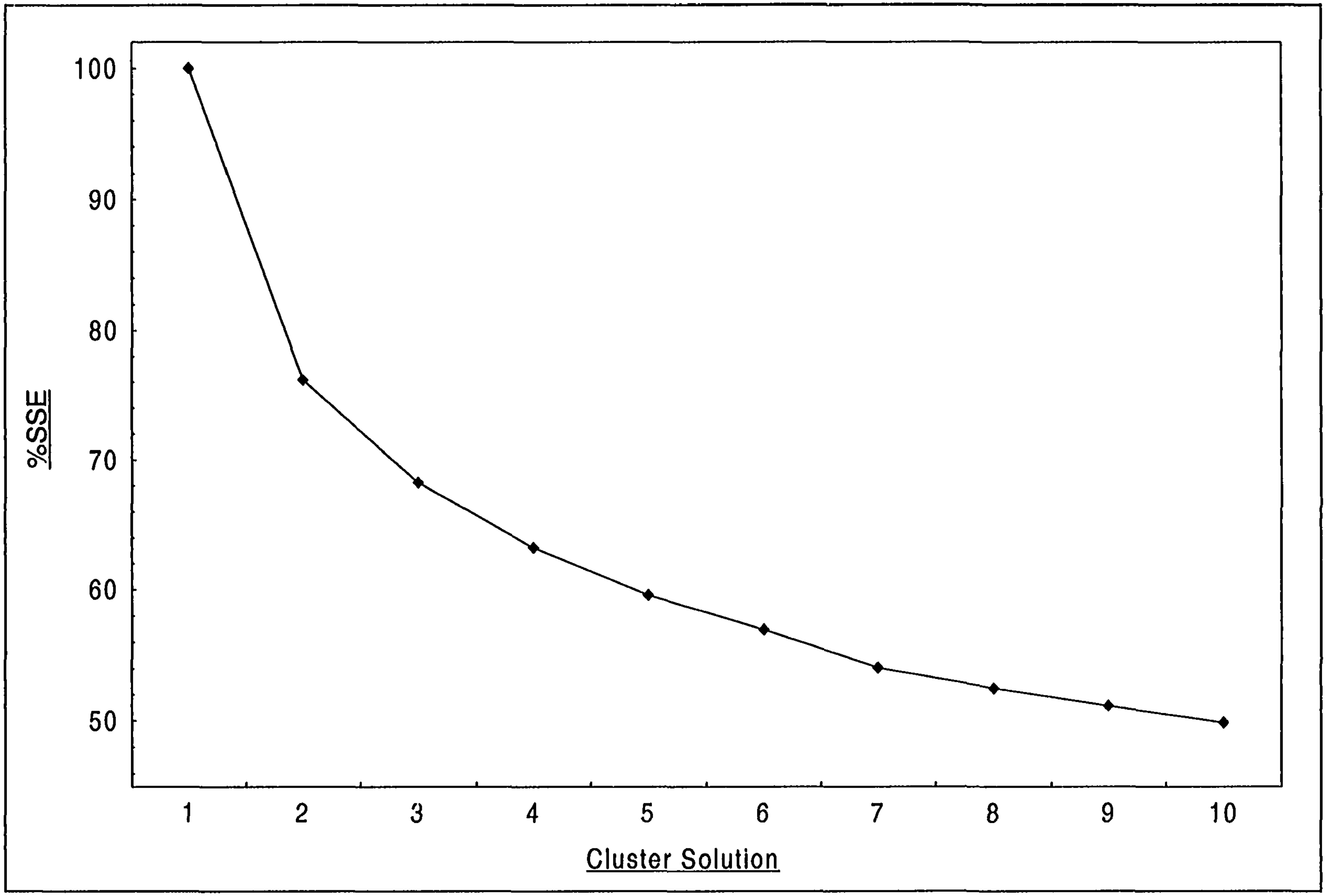

Figure 6.2: Sum-squared error plot associated with k-means analysis of assemblage composition data for the Miccaotli phase.

Data files describing cluster memberships for all solutions from 2 to 10 were exported to MapInfo for exploratory thematic mapping and formatted for analysis in the Statistica discriminant function module. Cluster levels between 2 and 6 were examined in detail; ultimately, I decided to concentrate descriptive work and subsequent analysis on the 4-cluster solution. Discriminant function analyses carried out on higher level clusters indicated relatively minor differences that were more difficult to account for and interpret. The 3-cluster solution, while attractive because of its greater simplicity, failed to capture interesting distinctions that were highlighted by the 4-cluster solution. Four clusters appear to represent a good compromise between the detail that is captured by larger number of clusters, and the manageability associated with smaller numbers of clusters. Accordingly, the 4-cluster solution was used as the basis for classifying the Miccaotli assemblages into A-clusters.

A-Cluster 1 (MC:acls4/1[1]) is composed of 678 cases. Assemblages assigned to this cluster show a fair amount of dispersion throughout the city, but there is a clear tendency to concentrate in a vaguely circular area centered around the city core and at the extreme northwest periphery, in the northern part of the Oztoyahualco district (Figure 6.3a). Collections from tracts located on and around major civic-ceremonial monuments are included in this cluster, including the Pyramids of the Sun and Moon and the Ciudadela.

A-Cluster 2 (MC:acls4/2) includes 858 cases that tend to be concentrated in the northwest quadrant of the city, especially north and west of the Pyramid of the Moon and along the northwest periphery of the city in general (Figure 6.3b). A somewhat less obvious concentration exists to the south and southwest of the city core. While cluster 2 assemblages are relatively uncommon in much of the city core, there is a clear concentration north of the Río San Juan, on both sides of the Street of the Dead (squares N2W1 and N2E1).

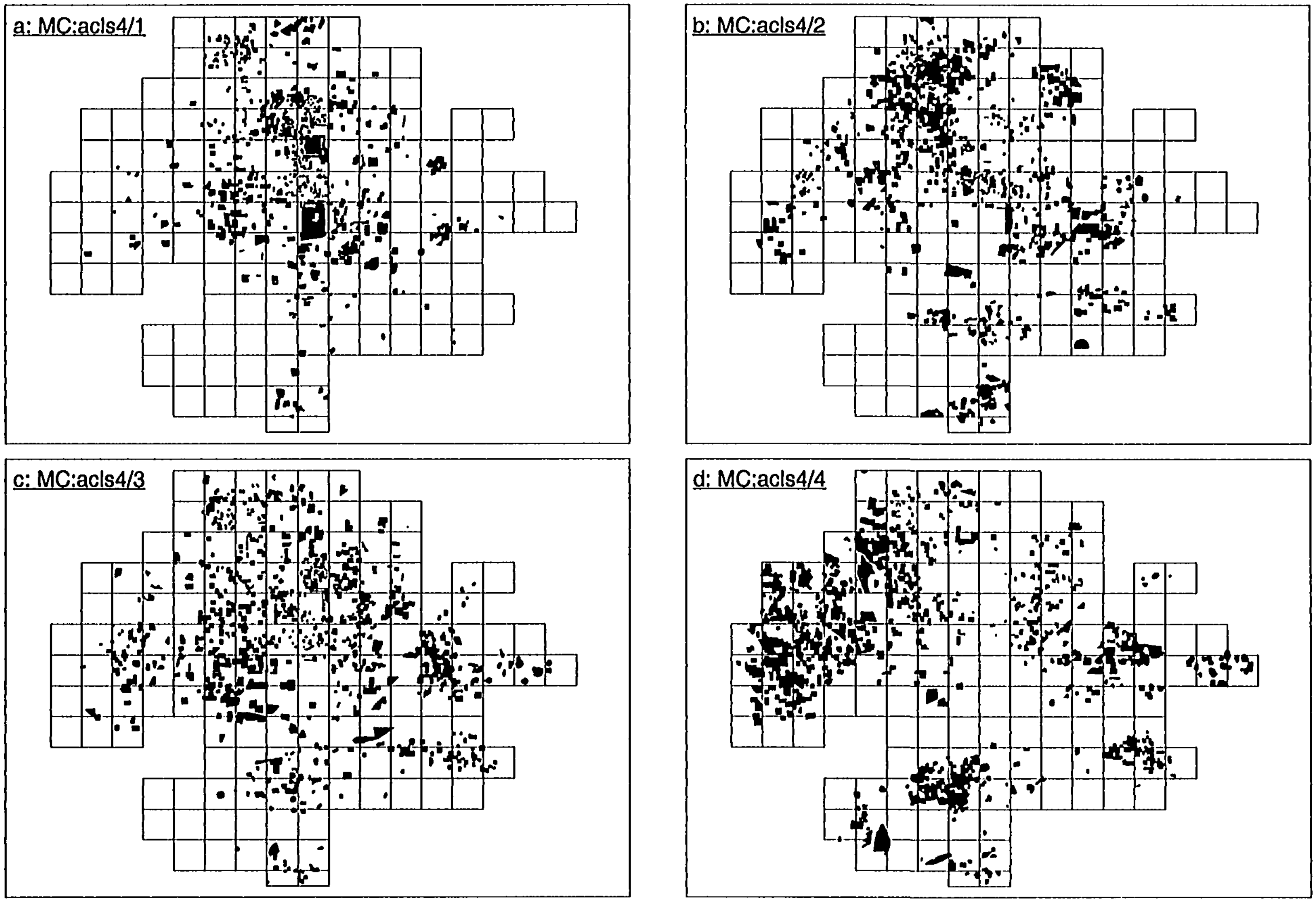

Figure 6.3: Maps illustrating the spatial distribution of Miccaotli A-Clusters.

A-Cluster 3 (MC:acls3/4) contains 932 cases that are widely dispersed within the city, but exhibit concentrations that suggest complementarity with certain concentrations of tracts assigned to cluster 1, at least in specific parts of the city. For example, there are concentrations of cluster 3 assemblages near various parts of the city's periphery (in the vicinity of N1W6, S4W1/S3W1 [the Tlajinga district], S3E6 and N1E6/N2E6), all areas where cluster 1 members are fairly rare. On the other hand, cluster 3 assemblages are fairly uncommon in the vicinity of the Great Compound/Ciudadela and at the northern end of the Street of the Dead, areas where cluster 1 tracts are fairly common (Figure 6.3c).

A-Cluster 4 (MC:acls4/4) contains 904 cases, most of which are clearly concentrated in peripheral areas of Teotihuacan in a number of directions. Particularly notable are concentrations along the somewhat elevated, northwestern flank of the city; to the south, in the Tlajinga district (an area in which a number of Cluster 2 and 3 members also occur); and other localities south of the Río San Lorenzo (Figure 6.3d). Members of MC:acls4/4 are notably rare in the city core.

Discriminant Function Analysis

Two sets of discriminant function analyses (DFA) were employed to describe differences among the 4 clusters that emerged from assemblage classification procedures. The transformed posterior proportions that served as input in the clustering routines served as independent discriminating variables in both analyses. In the first analysis, a variable recording memberships in the four A-clusters described above was used as the grouping variable. In the second analysis, four different DFAs were run (one for each A-cluster), each based in turn on a binary grouping variable that recorded membership either within the A-cluster in question (scored '1'), or in any other A-cluster (scored '0').

Although the first analysis generated three discriminant functions, case scores on the first two functions do a good job of distinguishing among members of each of the four clusters. A bivariate plot of these scores (Figure 6.4) indicates that variation along function 1 differentiates among cases assigned to clusters 1, 4, and clusters 2 and 3 combined; function 2 distinguishes cluster 2 from cluster 3. Plotting cases on both functions distinguishes all four clusters quite clearly, with little overlap.

As explained in the previous chapter, factor structure coefficients (the correlation between individual variables and the discriminant functions) assist in the interpretation of functions by assigning meaning both to the location of cases, and clusters, along the axes that they define. The barcharts in Figure 6.5a and Figure 6.5b show factor structure coefficients for the first two functions and each of the independent variables.

Figure 6.5a indicates that ollas, outcurving bowls and cazuela/craters are the categories with the clearest correlation with function 1. Ollas show an extremely strong negative correlation, while outcurving bowls and cazuela/craters show significantly weaker positive correlations; still weaker positive correlations are exhibited by comales and several other categories, which, along with outcurving bowls, constitute a group of mostly rather "fine" serving wares. This suggests that differences between clusters 1, 4, and clusters 2 and 3 (combined) are largely driven by differences in the proportions of ollas, with outcurving bowls, cazuela/craters, comales and other fine wares having lesser effects. More specifically, cases assigned to MC:acls4/4 (which score low on function 1) can be expected to exhibit high olla proportions and low proportions of other categories, particularly outcurving bowls and cazuela/craters; the opposite should characterize cases assigned to MC:acls4/1. Most of the cases in clusters 2 and 3 (MC:acls4/2 and MC:acls4/3) exhibit proportions of these categories that fall between those of clusters 1 and 4.

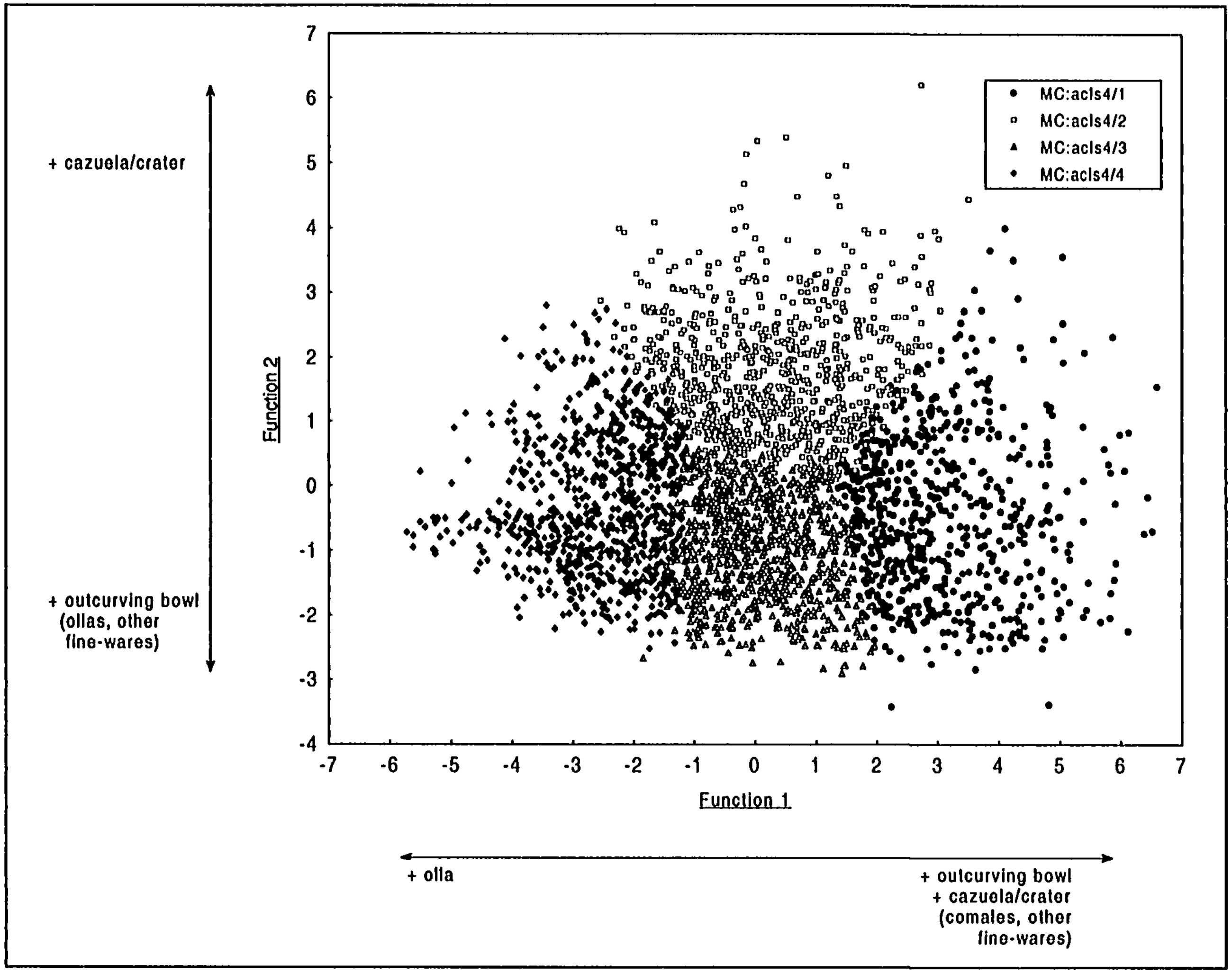

Figure 6.4: Case scores calculated for the first two functions generated by discriminant analysis, using Miccaotli A-cluster membership as the grouping variable and posterior estimates of ceramic category proportions as discriminating variables.

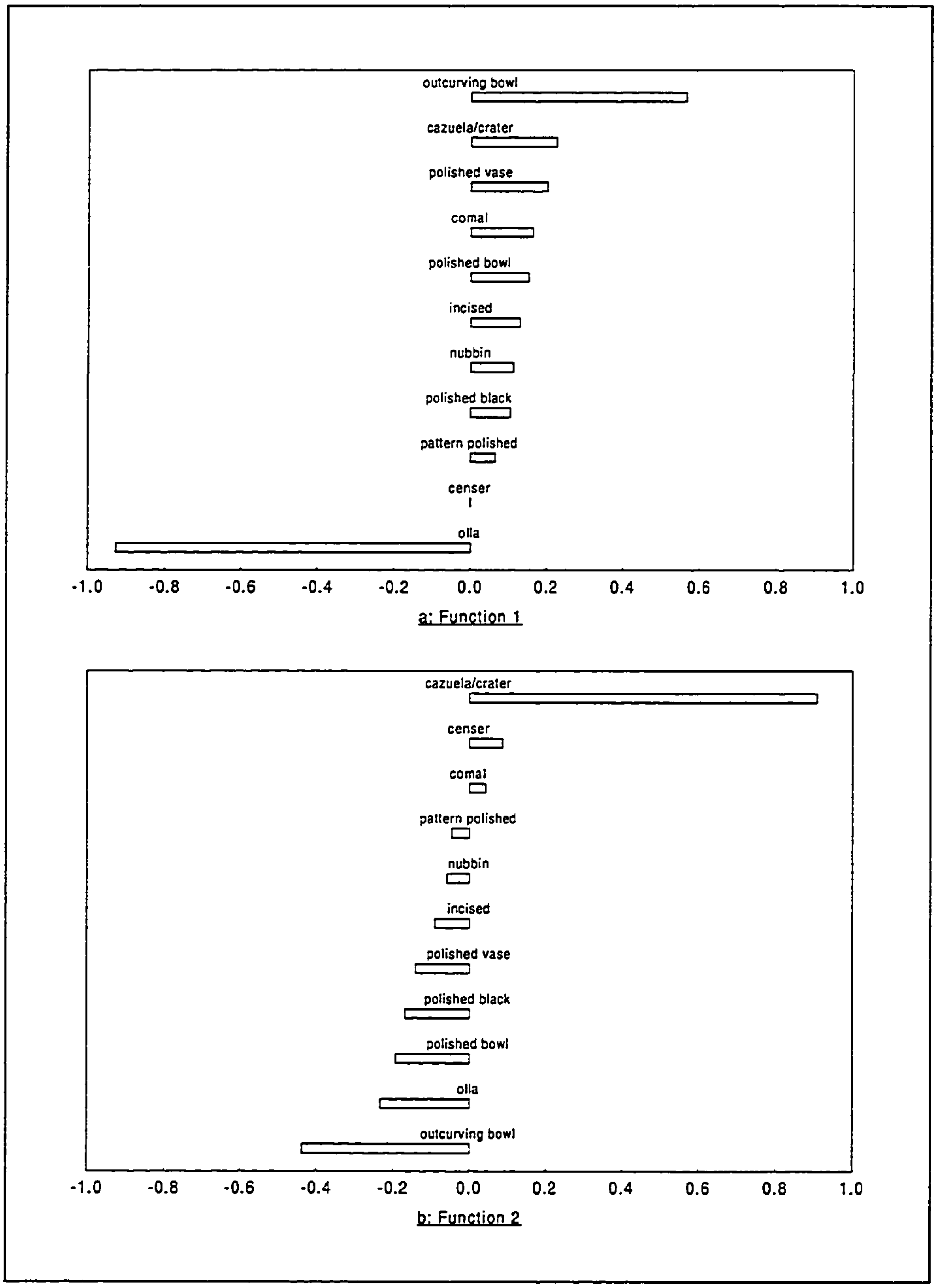

Figure 6.5: Factor structure coefficients: These values show the correlation between Miccaotli ceramic categories and the first two discriminant functions. Categories exhibiting high positive or negative values are the most important for discriminating among A-clusters.

The highest positive correlation with function 2 (Figure 6.5b) is exhibited by cazuela/craters; a comparatively weaker negative correlation is associated with outcurving bowls, possibly also ollas and various forms of polished ware categories. This suggests that variation in the proportions of cazuela/craters and outcurving bowls is most important in distinguishing cases from MC:acls4/2 from MC:acls4/3. Most of the cases assigned to cluster 2 are characterized by relatively high proportions of cazuela/craters, and low proportions of outcurving bowls, ollas, and possibly other "fine" serving wares, compared to cluster 3.

Some of the general observations set out in the previous two paragraphs are summarized on Figure 6.4 by labeled axes.

While the discriminant functions described by the first DFA provided useful information, interpretation is complicated by the fact that variation along two axes needs to be considered simultaneously, and potentially important ambiguities remain. It is unclear, for example, whether Cluster 1 cases, which score relatively high on function 1 and somewhat low on function 2, ought to be characterized by high or low proportions of cazuela/craters.

In an attempt to clarify further the relationship between input variables and cluster memberships, a separate set of DFA analyses was carried out, one for each cluster. In each case, a binary grouping/categorization variable was used that simply recorded whether or not cases were a member of that particular cluster. As described in the last chapter, each of these generates a single function that simply attempts to maximize discrimination between cases assigned to the cluster in question, and all other cases. The factor structure coefficients for the second set of discriminant function analyses based on binary categorization variables are shown in Figure 6.6.

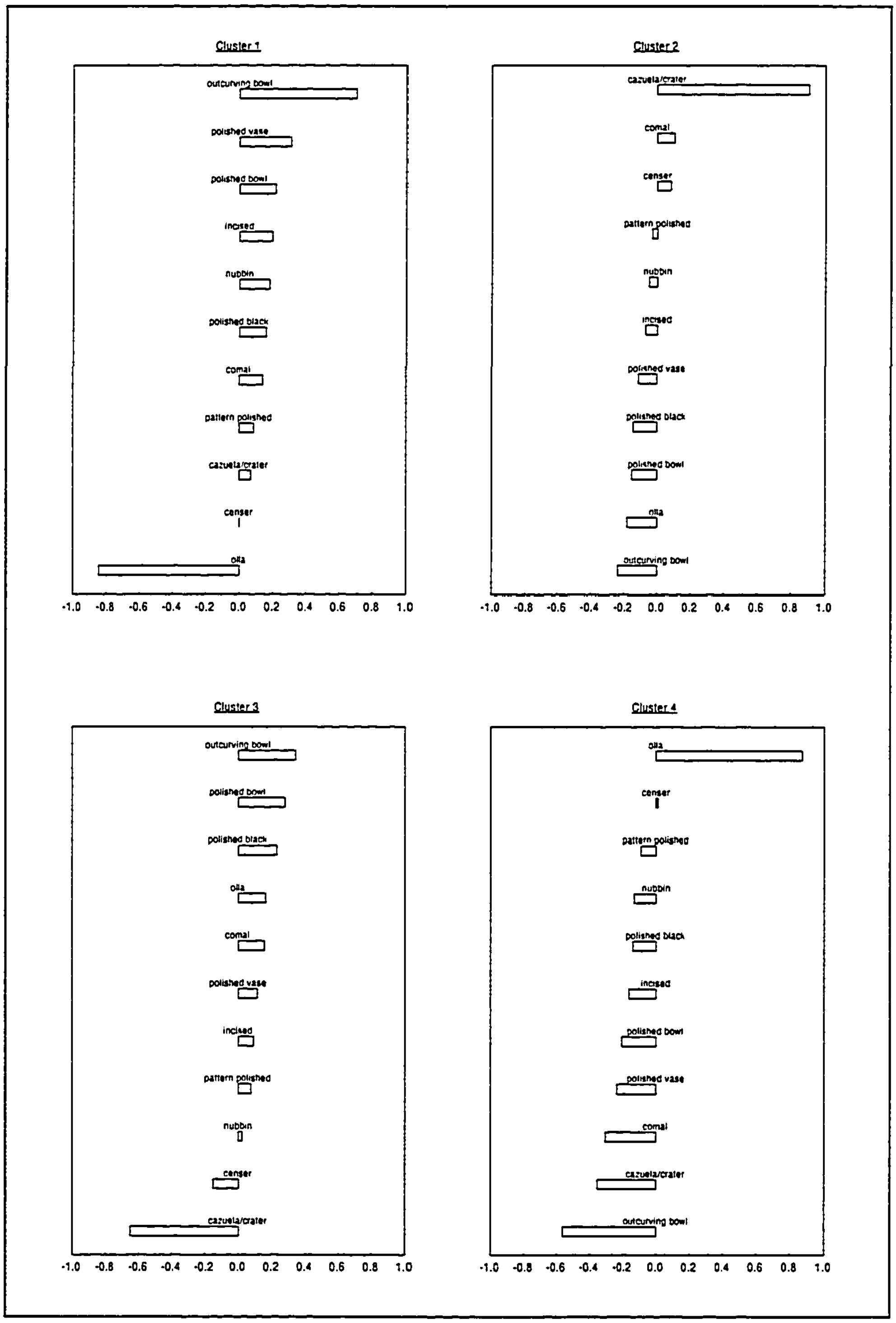

Figure 6.6: Factor structure coefficients generated by four separate DFA analyses using binary grouping variables derived from Miccaotli A-cluster memberships. A single discriminant function is associated with each A-cluster.

The main contribution of the second set of discriminant function analyses has been to indicate, for each cluster, one or two more variables that also have (perhaps somewhat weaker) positive or negative correlations with a function that seeks to discriminate its members from all other clusters. These analyses confirm, for example, that Cluster 1 is characterized by relatively high proportions of outcurving bowls (as indicated by the first DFA), but also suggest that proportions of polished vases and bowls, and possibly also nubbin supports, various other kinds of fine ware categories and perhaps comales, may also be characteristically quite high in cases assigned to this cluster. They also suggest that cazuela/crater proportions make relatively little contribution toward discriminating Cluster 1 cases from all other cases.

Discriminant function analysis may suggest that certain variables included in the analysis have low discriminating power, possibly because there is relatively little difference among group means measured on these variables compared to other variables, or perhaps because they are strongly correlated with other variables and therefore redundant for discrimination (Klecka 1980:52). It does not follow, however, that such variables can exhibit no meaningful variation relative to the groups under consideration. In this analysis, some interesting patterns are revealed by comparing measures of the central tendency of proportions amongst the four A-clusters. The first four columns in Table 6.4 record the median posterior proportions for each ceramic category, broken down by A-cluster; the last four columns show the same values after being row-standardized in the form of z-scores (i.e., expressed in units based on the standard deviation, above or below the mean). Standardizing the median in this fashion makes it possible to construct 'profiles' of central tendency that can be readily compared amongst categories, whether they are common or rare. Such profiles are displayed as line-plots in Figure 6.7, with ceramic categories arranged in groups that highlight four basic patterns.

Table 6.4: Miccaotli assemblage classification: median posterior proportions, broken down by A-cluster. The final four columns are based on row-standardized z-scores.

category	(non-standardized)				(standardized)			
	A-cluster				A-cluster			
	1	2	3	4	1	2	3	4
R453: Miccaotli olla	0.434	0.580	0.641	0.778	-1.411	-0.230	0.268	1.373
R483: Miccaotli comal	0.013	0.010	0.010	0.005	1.136	0.229	0.246	-1.611
R503: Miccaotli cazuela/crater	0.109	0.192	0.062	0.057	0.075	1.605	-0.790	-0.891
R683: Miccaotli censer	0.010	0.012	0.009	0.011	-0.800	1.400	-1.081	0.481
R923: Miccaotli outcurving bowl	0.260	0.103	0.164	0.073	1.538	-0.660	0.199	-1.077
R943: Miccaotli polished bowl	0.024	0.013	0.020	0.012	1.291	-0.798	0.641	-1.134
R733: Miccaotli polished black	0.001	0.000	0.001	0.000	1.136	-0.973	0.854	-1.017
R913: Miccaotli polished vase	0.013	0.008	0.010	0.006	1.522	-0.567	0.197	-1.151
R743: Miccaotli pattern polished	0.000	0.000	0.000	0.000	1.036	-0.656	0.911	-1.291
Miccaotli incised	0.002	0.001	0.002	0.001	1.405	-0.640	0.431	-1.196
R873: Miccaotli nubbin	0.022	0.017	0.016	0.015	1.689	-0.291	-0.493	-0.905

Many of the patterns revealed by Figure 6.7 have already emerged through discriminant analysis. Ollas, for example, clearly occur in higher proportions in cases assigned to A-cluster 4 than A-cluster 1 (Figure 6.7a), while high cazuela/crater proportions are most characteristic of cases assigned to A-cluster 2 (Figure 6.7c). A new observation is that medians of almost all of the fine-ware categories exhibit highly similar profiles when standardized in this manner (Figure 6.7d); the least common of these categories (such as incised ware and pattern polished ware) vary in approximately the same manner as the most common categories, particularly outcurving bowls, that also figured strongly in the results of the DFA analyses. Nubbin support and comal proportions show patterns somewhat similar to those exhibited by fine wares, i.e., they are often most common in A-cluster 1 and often least common in A-cluster 4; these categories differ from fine-wares in being characteristically about as common in cases assigned to A-cluster 2 as A-cluster 3 (Figure 6.7b). Interestingly, censers show a pattern somewhat similar to that exhibited by cazuela/craters, with a median that is highest in A-cluster 2, and relatively low in A-clusters 1 and 3 (Figure 6.7c).

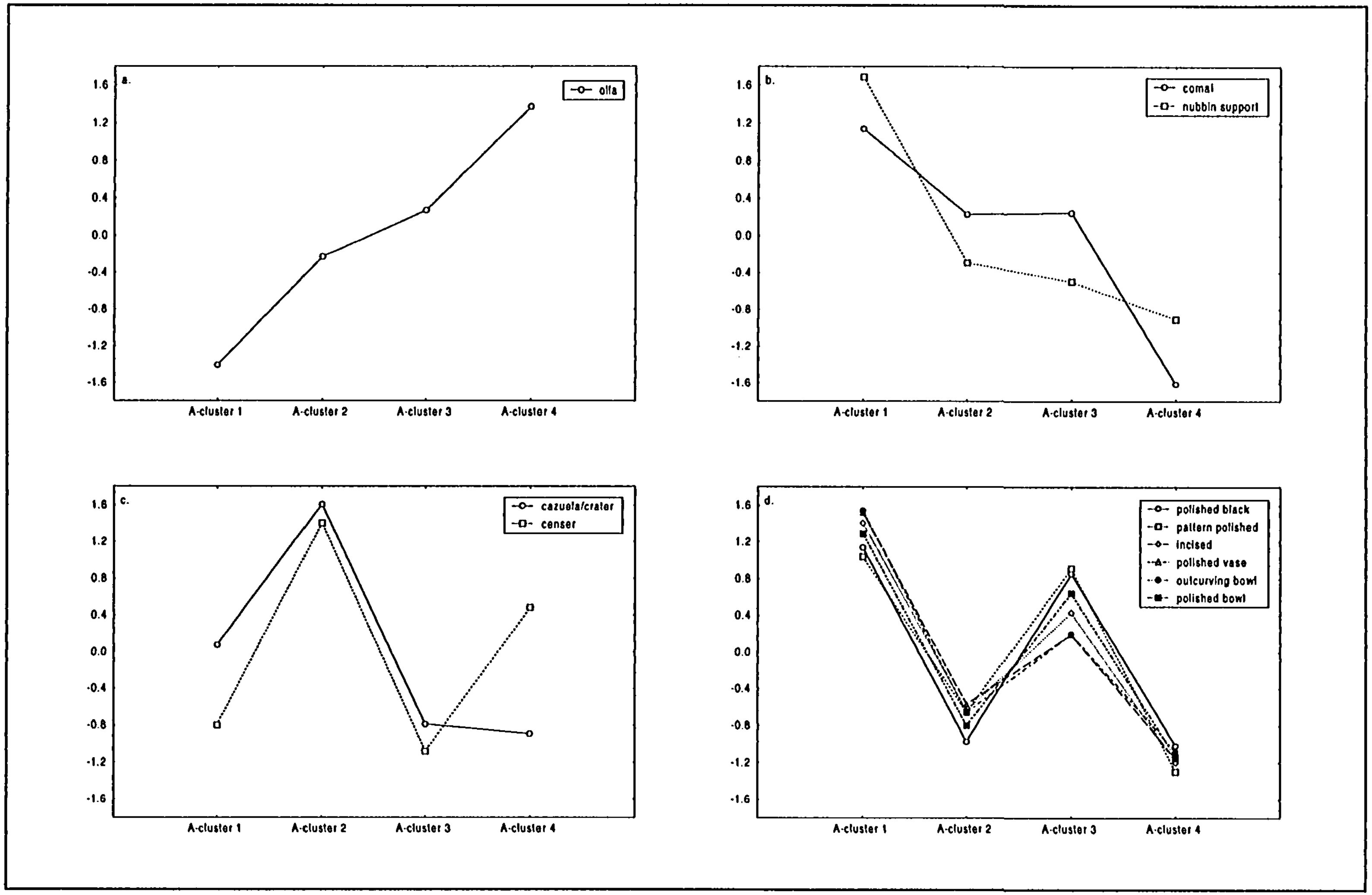

Figure 6.7: Median posterior proportions of Miccaotli ceramic categories, broken down by A-clusters. To facilitate comparison between both rare and common categories, values have been standardized as z-scores, calculated within the set of four proportions associated with individual categories (see Table 6.4).

A-Clusters - Summary

The spatial patterns that have been described for Miccaotli A-clusters are reinforced by patterns of spatial variation expressed by the ceramic categories that were used to create them. The four thematic maps in Figure 6.8 show the distribution of cases showing relatively high and low posterior proportions of four categories that were identified by DFA as influential in the definition of Miccaotli A-clusters. In each case, themes are based on upper and lower quartiles, with the midspread omitted; only cases that were included in procedures for defining A-clusters (i.e., with assemblage totals of 5 or more sherds) are included. Not surprizingly, these maps support conclusions suggested by the spatial distribution of A-clusters (Figure 6.3) and by the general discussion of how A-clusters relate to variation in input variables. The upper and lower quartiles for olla proportions, for example, are fairly dispersed and intermingle in certain areas (Figure 6.8a), but cases falling into the upper quartile are clearly more common in the outskirts of the city, especially to the west, while lower quartile cases are more common near the city core. This pattern resembles the distribution of MC:acls4/4, the A-cluster characterized principally by relatively high olla proportions. Polished bowls exhibit a distributional pattern that tends toward the opposite of ollas—the two quartiles are also well dispersed and intermingled, but cases from the upper quartile are visibly more common in areas away from the city's outskirts (Figure 6.8d); this is similar to the distribution of MC:acls4/1, which among other traits is characterized by relatively high proportions of polished bowls. An even closer match to the distribution of MC:acls4/1 cases can be seen in outcurving bowls. Collections with high proportions of these artifacts concentrate conspicuously in areas on and flanking the Street of the Dead, but also the Oztoyahualco district (Figure 6.8c). Finally, cases exhibiting relatively high proportions of cazuela/craters tend to be more common in the northwest quadrant (especially to the north and west of the Pyramid of the Moon), in the vicinity of the Ciudadela, and along the

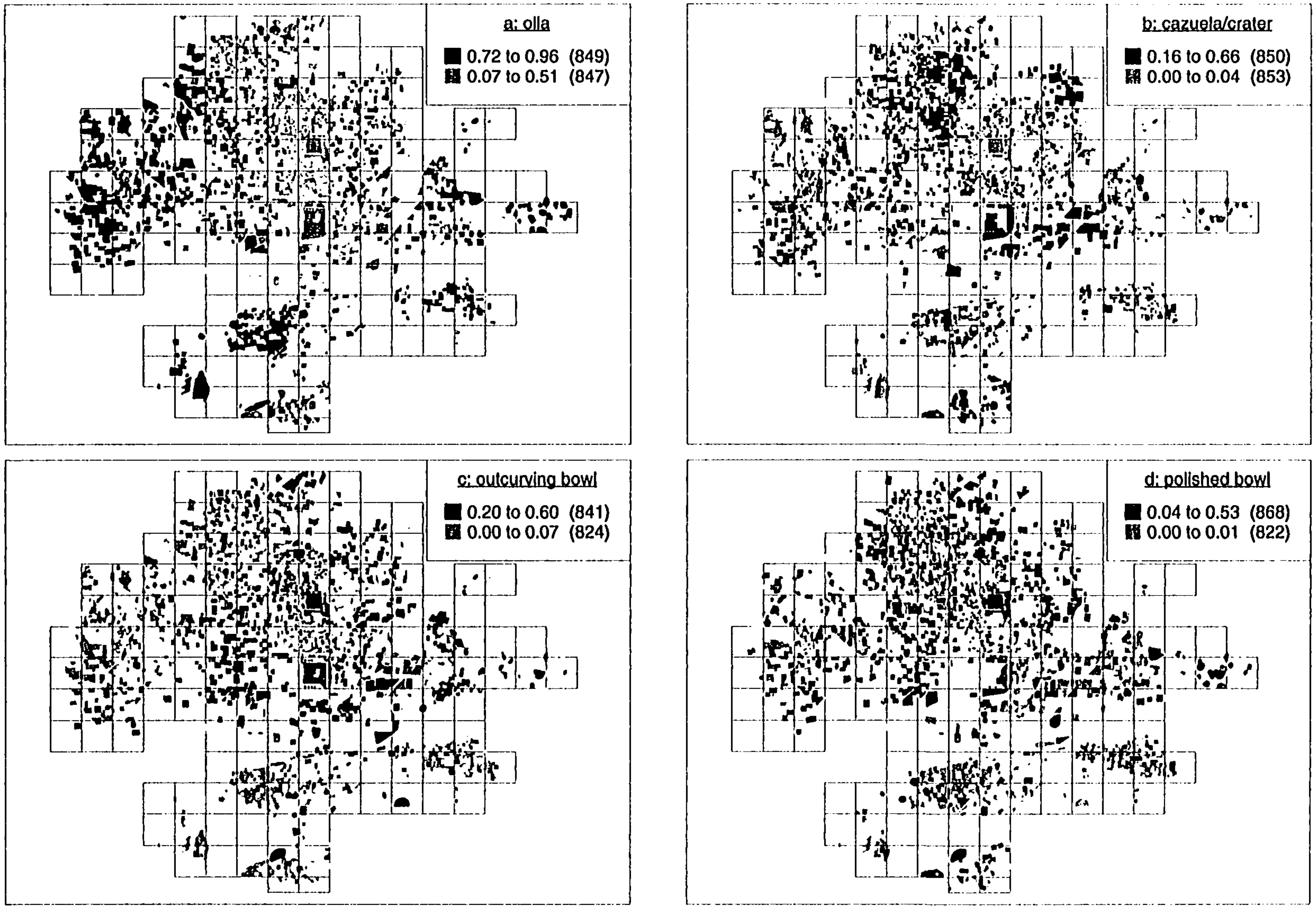

Figure 6.8: Major Miccaotli ceramic categories: Spatial distribution of upper and lower quartiles of posterior proportion estimates.

East Avenue (Figure 6.8b). This distribution mirrors very closely the spatial distribution of MC:acls4/2.

Table 6.5 summarizes the main differences among the four Miccaotli A-clusters. In this table, the fifth and sixth columns list categories that show characteristically high and low proportions within each of the four A-clusters. In these two columns, I have underlined categories that were identified by discriminant function analysis as most important for differentiating amongst members of the various A-clusters. Other categories for which medians appear to show patterned variation vis-à-vis cluster memberships, as suggested by Figure 6.7, are simply listed on subsequent lines.

Table 6.5: Miccaotli assemblage classification: summary of spatial and artifactual patterns associated with A-clusters.

cluster	code	n	spatial parameters	high proportions	low proportions
1	MC:acls4/1	765	• somewhat dispersed, but clear concentration discernible near the city core, less clearly near the extreme northwest periphery of the city (Oztoyahualco)	<u>outcurving bowl</u> cazuela/crater fine-ware nubbin support comal	<u>olla</u> censer
2	MC:acls4/2	831	• most common in the northwest quadrant, along the northwest periphery, and southeast of the city core; rather uncommon in parts of the Street of the Dead area	<u>cazuela/crater</u> censer	<u>outcurving bowl</u> olla fine-ware nubbin support
3	MC:acls4/3	907	• widely dispersed, but concentrations ring the city core and avoid parts of the Street of the Dead area	<u>outcurving bowl</u> fine ware olla	<u>cazuela/crater</u> censer
4	MC:acls4/4	869	• widely dispersed, but with clear concentrations in several peripheral areas especially to the west and northwest, and south of the Río San Lorenzo	<u>olla</u> censer	<u>outcurving bowl</u> fine-ware nubbin support comal cazuela/crater

The combination of spatial and artifactual data presented in Table 6.5 make it possible to attach tentative, interpretative meanings to each of these classes:

MC:acls4/1 is most clearly characterized by heightened proportions of various kinds of fine serving wares. Proportions of two kinds of utilitarian vessel forms, the cazuela/crater and comal, may also be relatively high in A-cluster 1, compared to at least some of other A-clusters, while olla and censer proportions are relatively low. Although by no means confined to this area, members of this cluster show a clear tendency to concentrate in and around the civic-ceremonial core in the vicinity of the most elaborate architectural remains known to exist in the city. A pattern indicating proximity to the city core, driven as it is by a suite of particularly well-made and elaborate kinds of pottery, suggests that artifact assemblages assigned to this class were most often generated by activities involving individuals of relatively high wealth and/or status levels, likely including feasting and the storage and preparation of food for feasts. While architectural observations recorded by TMP workers do not often pertain very directly to the Miccaotli phase, the specific kinds of structures that provided the context for such activities probably included a mixture of types, including residential, administrative, and civic-ceremonial buildings. Interestingly, the fact that the median censer proportion for A-cluster 1 collections is low, at least relative to A-clusters 2 and 4, suggests that ritual activities involving these objects may have been engaged in more intensively in other urban contexts, especially areas somewhat peripheral to the city core.

MC:acls4/4 is associated with spatial and artifactual patterns that are largely the opposite of those described for MC:acls4/1. Concentrations are evident near the edges of Teotihuacan, areas in which the architectural remains recorded by the TMP emphasize "insubstantial buildings," with very elaborate constructions being relatively rare and widely dispersed. These observations probably pertain most directly to later periods of occupation, but it is unlikely that architecturally impressive buildings were any more common in peripheral parts of the city during the earlier Miccaotli phase; relatively modest dwellings were probably most common in these areas for most of the city's history. Ceramic assemblages assigned to this cluster show characteristically high proportions of utilitarian ollas. The most common type of service vessel in the city as a whole, the outcurving bowl, is correspondingly less common, as are fine-wares in general, and it is probably reasonable to describe the content of ceramic assemblages assigned to A-cluster 4 as impoverished compared to those assigned to A-cluster 1. This composition, coupled with a peripheral spatial concentration, suggests that these assemblages were most often created by activities involving households that occupied positions near the other end of the social spectrum from Cluster 1, composed mostly of individuals of relatively low wealth and status levels.

In broad terms, the artifactual and spatial patterns that have been described for both MC:acls4/2 and MC:acls4/3 fall more or less between those that characterize the other two classes. While not clear-cut, cases from both clusters tend to be most common in intermediate zones of Teotihuacan, roughly between the city core, an area dominated by elaborate architectural remains, and the city's periphery, where such remains are all but absent. To the extent that proximity to the civic-ceremonial precincts relates to social or wealth/status differences, it is likely that cases assigned to both Clusters 2 and 3 relate to parts of a socio-economic continuum that fall somewhere between that occupied by Clusters 1 and 4. This general interpretation is also supported by ceramic data. For many categories, the central tendency for the distribution of proportions for Clusters 2 and 3 is intermediate to that of Clusters 1 and 2. Exceptions to this pattern are really only clear for cazuela/craters and censers, proportions of which are characteristically higher in Cluster 2 than in any other cluster (Figure 6.7).

In terms of spatial patterns, Cluster 3 is more similar to Cluster 1 than to Cluster 4. The shape of areas in which Cluster 3 cases concentrate to some extent mimics Cluster 1, effectively surrounding the part of the city—the ceremonial core—where Cluster 1 cases are most common. The connection between Clusters 1 and 3 can also be seen in artifactual patterns; although they contrast with regard to proportions of ollas and cazuela/craters, they both tend to have relatively high proportions of the outcurving bowl and other fine-ware categories, and relatively low censer proportions. Cluster 2, in contrast to Cluster 3, is more like Cluster 4 than Cluster 1. Like Cluster 4, Cluster 2 cases are more common toward the edge of the city, particularly in the northwest. Censer proportions tend to be relatively high among cases assigned to both these clusters, while proportions of outcurving bowls and various other fine-ware categories are relatively low.

It is quite likely that neither Clusters 1 and 3 nor Clusters 2 and 4 are well separated and that they represent a kind of 'dissection' of rather continuous variation in multivariate space. It is difficult to be sure about this, but the %SSE scree plots (Figure 6.2), and scores on discriminant functions (Figure 6.4) certainly provide no evidence to the contrary. The conservative view is to regard the classification based on these clusters as an analytical tool, a relative measure of wealth/status variation that does not necessarily reflect well-bounded categories with clear emic meanings.

Neighbourhood Classification

Having classified localities based on differences in the content of associated ceramic assemblages, in accordance with the general procedure laid out in the previous chapter, a second phase of cluster analysis was used to classify localities on the basis of neighbourhood composition. Neighbourhood composition was measured in terms of A-clusters—the mix of different assemblage classes within a set distance of each collection tract. This second set of classes constitute a higher level analytical entity that I refer to as an N-cluster.

Local Density Analysis

In preparation for classification into N-clusters, local density analysis was used to get a general idea of the patterns of spatial association that exist between different types of A-clusters, and especially the scales at which they are most pronounced. After defining the spatial centroid of each of the 3372 collection tracts included in the Miccaotli analysis, the point-based LDEN program (Kintigh 1993) was used to calculate local density coefficients between all ten possible pairs of the four A-clusters, using 20 radii that ranged between 50 and 1000 m. Four of these ten pairs consist of the same A-cluster, so that coefficients obtained from them measure the tendency of these types for self-association; the remaining six pairs were based on different A-clusters. A parallel local density analysis was calculated on a data set in which all cases were merged into a single type. As was described in the last chapter, the values so obtained ($C_{(r)}$) were used to calculate $D_{ij(r)}$, local density coefficients that have been standardized around baseline local density values, using the original local density coefficients ($C_{ij(r)}$), and the equation

$$D_{ij(r)} = \frac{C_{ij(r)} - C_r}{C_r}.$$

The results are summarized in Figure 6.9, a series of line plots that record how the local density coefficient D varies with the size of the search radius used to identify neighbours. The solid horizontal line at $D=0$ separates values of higher magnitude, which suggest some level of spatial association, from lower values that imply some level of spatial segregation.

The points to which I want to call attention on this graph are the following: Four of the 10 pairs show relatively sharp, initial increases in D, several peaking at around 75 or 100 m. This particular feature of these plots is not readily interpretable, however, and to at least some extent they must be artifacts produced by combining the point-based LDA program with the spacing effect that collection tract boundaries impose on centroid locations. A 50 m radius around the centroid of many collection tracts, for example, may frequently fail to encompass and therefore select the centroids of other collection tracts that are actually immediately adjacent. Initial trends in the other direction are working against this effect and therefore ought to be meaningful. For

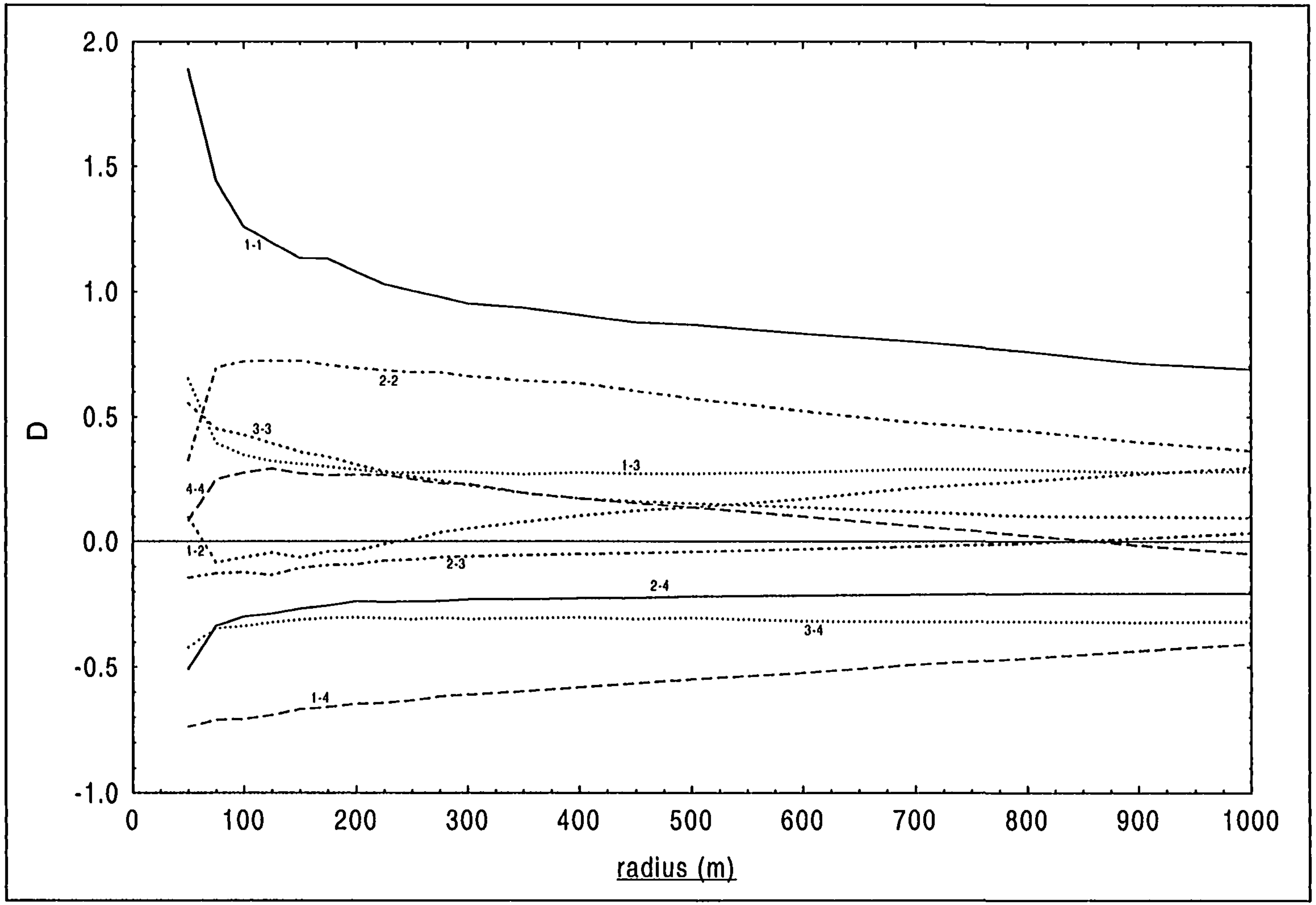

Figure 6.9: Local density coefficient D calculated for Miccaotli phase A-cluster pairs for radii between 50 and 1000 m. Locations above the solid horizontal line ('0.0') indicate spatial association; locations below indicate spatial segregation.

example, the peak exhibited by the 1-1 pair at 50 m, and its rapid drop over larger radii, suggests that the very strong pattern of self-association exhibited by A-cluster 1 is largely caused by collection tracts that are very close together, and in fact probably mostly adjacent to one another. This is consistent with the fact that smaller collection tracts are more frequent near the center of the city, where many tracts have been assigned to A-cluster 1.

Most lines become fairly flat over the longer distances; relatively high and low values, as well as the most salient fluctuations, are mostly found at distances of less than about 150 m. Within about this same distance, local density coefficients can be usefully (if somewhat arbitrarily) described according to several more or less clear groups. Isolated from the other eight pairs are 1-1 and 2-2, which show the strongest evidence for association; at 100 m, for example, local densities for these pairs are around 125% and 70% higher (D =1.26 and 0.72, respectively) than the local density of cases calculated without regard to A-cluster type. Much lower measures of association are exhibited by an intermediate group consisting of A-cluster pairs 3-3, 4-4, and 1-3. At the same scale (radius=100 m), they yield values of D that range roughly around 0.3 and 0.4. A third, slightly more dispersed group, includes all but one of the remaining pairs (1-2, 2-3, 2-4, and 3-4), all exhibiting negative D values that are suggestive of at least a slight effect of segregation. Finally, very low local density coefficients are associated with A-cluster pair 1-4, which has a D value of -0.71 at 100 m. Local densities for this pair are about 70% less than the local density of cases calculated with all A-cluster types pooled together. In other words, A-clusters 1 and 4 co-occur in neighbourhoods much less often than one would expect if A-cluster assignments were random.

The most general pattern exhibited by the local density coefficients is that within-cluster association tends to be stronger than between-cluster association—at most distances, and especially at less than about 500 m, localities show the strongest spatial association with other localities yielding similar artifact assemblages. It is interesting, however that local density coefficients generated by A-clusters 1 and 3 are the highest of any of the between-cluster coefficients, and are in fact somewhat higher than those associated with the 4-4 pair. This suggests the possibility of an at least slight spatial association between localities that, as I noted above, may have been occupied by households of high status or wealth, and one of two types of household that I have interpreted as occupying an intermediate status. It is tempting to try to relate this fact to some form of emic behavioural pattern—a spatial connection between two distinct types of household that may have its root in some form of economic symbiosis, for example. This interpretation is difficult to justify on the basis of present evidence, however. It is more parsimonious simply to reiterate that assemblages assigned to A-clusters 1 and 3 may have been generated by households engaged in activities that simply were not very different from one another, and that the pattern of elevated association levels is due to the fact that these classes tend to concentrate in parts of the city that are proximal to one another, and/or overlap.

It is also important to note that the strongest effects of segregation, even over relatively short distances, are exhibited by the 1-4 pair, involving localities that may have been occupied by households on opposite ends of a wealth-status dimension.

Neighbourhood Composition Data

Selecting a buffer size for characterizing the internal composition of neighbourhoods was partially guided by the results of the point-based LDA work. As noted above, these data show that peak associations between most of the different A-clusters occur at a scale of less than about 150 m, measured between the centroids of collection tracts. It makes sense to define neighbourhoods at roughly the same scale—this facilitates relating patterned variability in the composition of such neighbourhoods to the behavioural factors that also underlie patterns of spatial association. Another concern, however, is the number of collection tracts that are likely to be selected by a given buffer size. Buffers are essentially a device for taking spatial samples, and if large numbers of the samples that they define are relatively small, it is possible that localized, behaviourally unimportant variation may distort what might otherwise be revealed as broader patterns.

The shapes of most collection tracts approximate the form of squares and rectangles; the median value for the maximum east-west dimension of collection tracts is about 58 m, while the median north-south dimension is about 57 m. Taking 60 m as a reasonable characterization of central tendency for both dimensions, 120 m buffers (i.e., buffers created by extending original boundaries outward 120 m) would sample localities approximately as distant from the central collection tract as would centroid-based search radii of 150 m—a rough upper limit of the distance at which the strongest spatial association among A-clusters appears to operate. In a grid-like lattice of identical 60x60 m collection tracts, such buffers would most often select 21 collection tracts—smaller numbers of tracts would be selected near the outer edge of the lattice. In the real-world lattice based on the TMP survey map, of course, the size of neighbourhoods defined by such buffers would vary quite widely, because of variation in the size, shape, and spacing of collection tracts included in these analyses. An experimental application of a 120 m buffer on the TMP map produced a mean neighbourhood size of only about 16 cases, with a standard deviation of roughly 8; almost 30% of the neighbourhoods were based on 10 or fewer members.

Ultimately, I elected to increase the number of cases that define most neighbourhoods in two ways: First, the size of the selection buffers was increased to 130 m. In addition, I used geographic selection criteria based simply on the intersection of borders—buffers select any collection tract that they happen to overlap, without regard to the location of centroids. This produced a mean neighbourhood size of about 25 cases, with only about 10% having ten or fewer members; 3,303 cases had neighbourhoods containing five or more cases, and these were retained in the cluster analyses aimed at defining neighbourhood composition classes.

Cluster Analysis

Counts of each of the four A-clusters within each of these 3,303 overlapping neighbourhoods were tallied and standardized as proportions within neighbourhoods. The proportions were used as input data in a series of k-means cluster analyses. Cluster solutions were obtained for 2 to 10 clusters.

A %SSE scree plot based on these solutions (Figure 6.10) provides only a moderate amount of useful information about the relationship between the number of clusters and within and between-cluster cohesion; the plot begins to flatten discernibly after about 4 clusters, but any solution between about 2 and 6 clusters would appear to be worth considering on other grounds. Data describing all cluster solutions from 2 to 10 were exported to MapInfo for exploratory thematic mapping, while a smaller subset were examined using a variety of descriptive graphic procedures.

In this presentation, I focus on the 4-cluster solution and use it as the exclusive basis for defining N-clusters. A 4-cluster solution produces clear regional entities, each dominated numerically by one of the A-cluster types that served as input data. As will be seen, a 4-cluster solution also provides a useful basis for comparing and contrasting results from both the Miccaotli and Tlamimilolpa phases.

Miccaotli N-Clusters

Table 6.6 cross-tabulates cases on the basis of A-cluster and N-cluster memberships. Note that the diagonals (underlined) contain the largest values in both rows and columns; this reflects

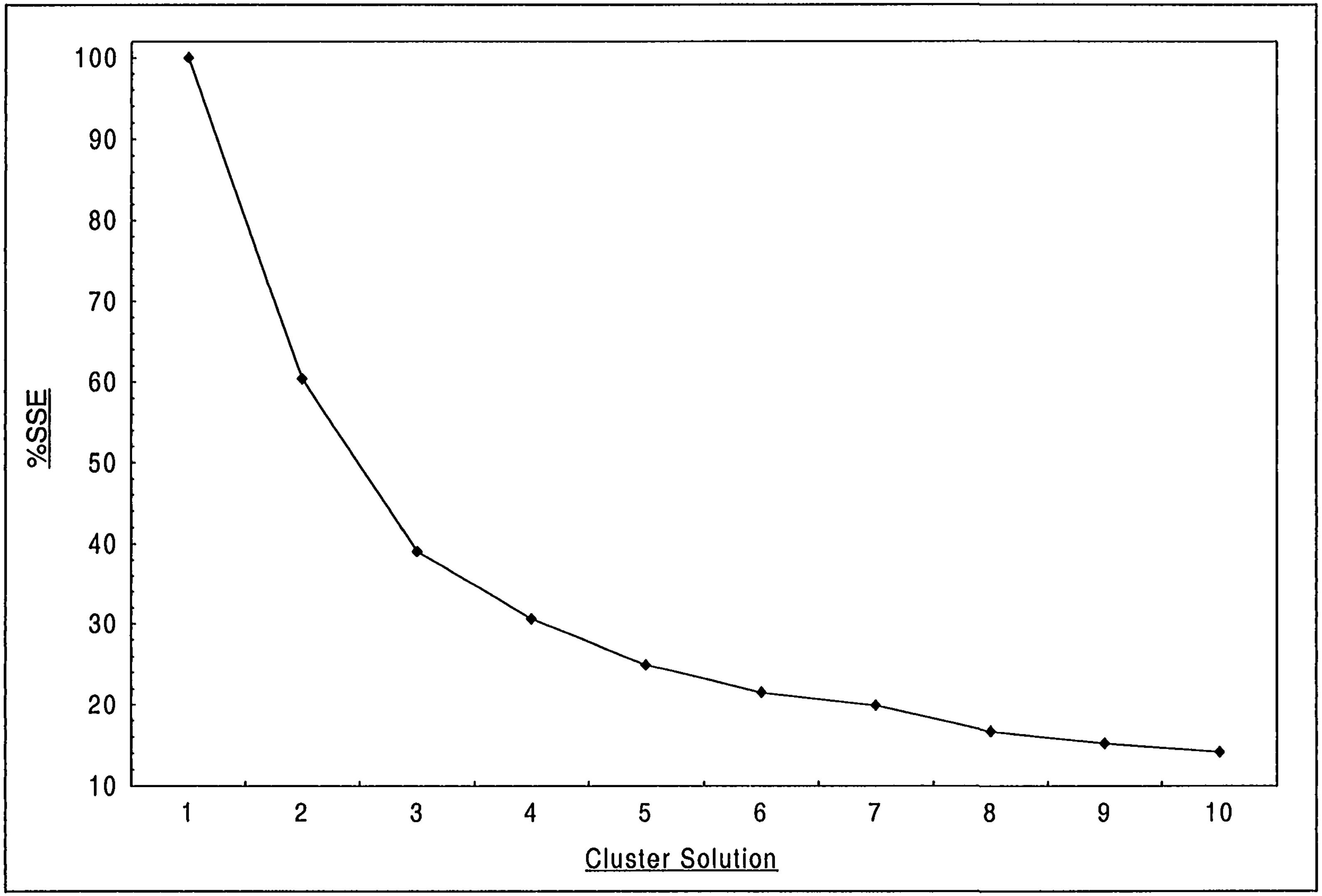

Figure 6.10: Sum-squared error plot associated with k-means analysis of neighbourhood composition data for the Miccaotli phase.

the fact, noted above, that each of the N-clusters is dominated by one of the A-clusters. A thematic map of N-cluster memberships (Figure 6.11) exhibits spatial patterns that are quite similar to those based on A-cluster memberships (Figure 6.3), the strongest differences having to do with the greater dispersion and interspersion of A-clusters, and the relatively clear delineation of the spatial entities reflected in N-clusters. Compared to A-cluster concentrations, N-clusters are much more clearly segregated from each other, and mostly form large, contiguous zones. To some extent, this is a predictable effect attributable to the use of moving buffers as a means of characterizing neighbourhood composition. Nevertheless, the size of most contiguous blocks formed by N-cluster definitions greatly exceeds the size of these buffers, and at a broad scale of analysis they reflect a spatial reality that cannot simply be attributed to underlying methods.

Table 6.6: Cross-tabulation of A-cluster and N-cluster class memberships for the Miccaotli phase analysis.

A-cluster:	N-cluster: MC:ncls4/1	MC:ncls4/2	MC:ncls4/3	MC:ncls4/4	total
MC:acls4/1	315	125	197	26	663
MC:acls4/2	69	506	126	148	849
MC:acls4/3	138	189	414	170	911
MC:acls4/4	15	151	144	570	880
total	537	971	881	914	3303

The 537 cases assigned to N-cluster 1 (MC:ncls4/1) are dominated by A-cluster 1 (Table 6.6) and show a clear spatial association with the core of the city (Figure 6.11a).[2] They include many localities on or near the northern part of the Street of the Dead and form a block that extends from somewhat south of the Pyramid of the Sun to just north of the Pyramid of the Moon. This area includes major civic-ceremonial monuments, including the two largest pyramids, and a number of major temple complexes. Further south, collection tracts in the immediate vicinity of the Ciudadela, as well as to the south and east, were also assigned to N-cluster 1. It is noteworthy, however, that many collection tracts immediately north of the Great Compound/Ciudadela

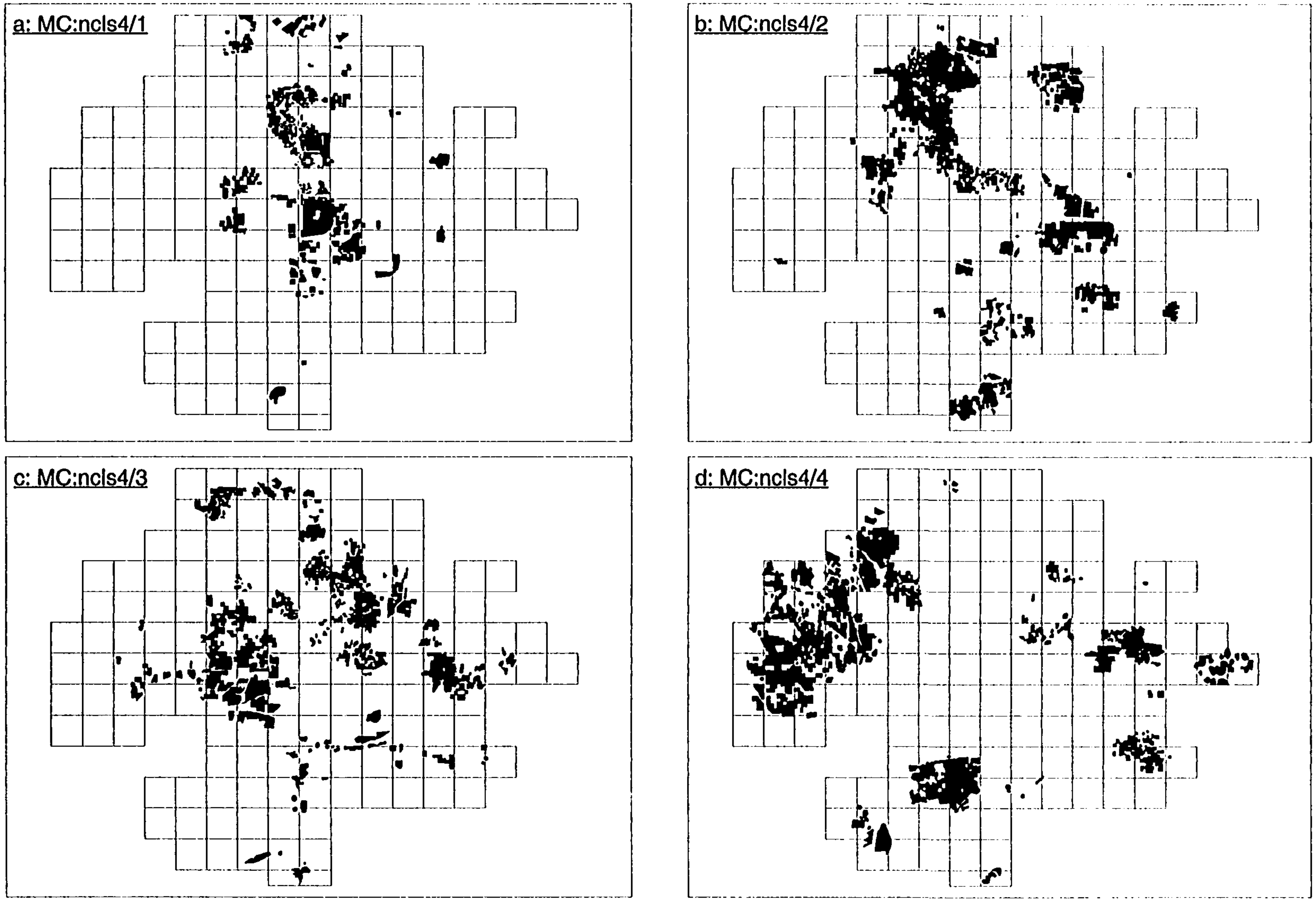

Figure 6.11: Maps illustrating the spatial distribution of Miccaotli N-Clusters.

complex, especially on the west side of the Street of the Dead, were not assigned to N-cluster 1, and the ceremonial core of the city is clearly bisected in this area by collection tracts assigned to N-cluster 2.

A concentration of N-cluster 1 cases is also found some distance to the west of the Street of the Dead area, forming two discrete clusters near squares N2W2 and N1W3. Several well known excavated apartment compounds—the so-called Zacuala Palace and Patios, Yayahuala, Atetelco and Tetitla—are located in the immediate vicinity of the northernmost of these two concentrations.

Other concentrations of N-cluster 1 members occur on the northern edge of the city, including a portion of the Oztoyahualco district. This general area, but especially parts of squares N6W3, N7W3, and N6W2, was covered with remains of closely packed apartment compounds at the time of the TMP survey—part of what René Millon labeled the "Old City" (Millon 1973b:38-39). Presumably these apartment compounds date to no earlier than some time in the Tlamimilolpa phase and may well be somewhat later. The Miccaotli phase occupants of this part of this city presumably lived in other kinds of structures.

The 971 cases assigned to N-cluster 2 (MC:ncls4/2) are most visibly concentrated in a large block of terrain to the west and northwest of the northern part of Teotihuacan's ceremonial core, extending toward and into the Oztoyahualco district (Figure 6.11b). As noted above, a clear concentration of cases assigned to this cluster divides the Street of the Dead area into halves just north of the Río San Juan and the Ciudadela/Great Compound complex. There are notable and relatively well-delimited concentrations of N-cluster 2 cases in the northeast periphery of the city (around square N5E3) and on both sides of the East Avenue (around squares N1E4 and S1E3). Concentrations of N-cluster 2 cases are also found on the southeast periphery, east of the Street of the Dead (squares S3E4 and S4E1). There is a clear concentration near the southern terminus of the Street of the Dead, around squares S6W1 and S6E1.

The majority of the 881 cases assigned to N-cluster 3 (MC:ncls4/3) also belong to A-cluster 3, and exhibit a clear tendency to concentrate in areas adjacent and peripheral to N-cluster 1 concentrations (Figure 6.11c). This is quite evident, for example, in the way N-cluster 3 concentrations flank areas dominated by N-cluster 1 cases along the Street of the Dead (especially to the east), and surround the two discrete concentrations in the vicinity of squares N2W2 and N1W3. There is a large concentration of N-cluster 3 cases near the eastern terminus of the East Avenue, around square N1E5.

The 914 cases assigned to N-cluster 4 form a peripheral spatial entity, associated in particular with the extreme northwestern flank of the city (Figure 6.11d). Another strong concentration is evident near the southern edge of Teotihuacan, including almost all of the Tlajinga district west of the Street of the Dead. Other smaller concentrations are found in several areas on the eastern periphery, in the vicinities of squares N1E8, N2E5, and S3E6.

The Tlamimilolpa Phase

The procedures used to analyze Tlamimilolpa phase materials conform to what was presented in Chapter Five and parallel closely what was just described for the Miccaotli phase. To reduce repetitious text and focus attention more directly on results, the description of methods in this section is somewhat abbreviated compared to the previous section.

Assemblage Definition

Twelve of the categories included in the REANS datafile were selected to define assemblages for the Tlamimilolpa phase. Summary data for these categories are presented in Table 6.7, which is formatted exactly as Table 6.1.

Table 6.7: Counts and proportions of Tlamimilolpa phase ceramic categories in individual collections.

category	no. of valid cases	total sherds	sherd count per collection		count x 100 phase-total	
			mean	sd	mean	sd
cooking/storage						
R454: Tlamimilolpa olla	4696	33375	7.11	14.04	31.3	25.3
R474: Tlamimilolpa jar	4586	890	0.19	0.84	0.8	4.0
R504: Tlamimilolpa cazuela/crater	4696	9582	2.04	4.56	8.7	13.5
ritual						
R684: Tlamimilolpa censer	4693	7810	1.66	3.89	7.5	12.5
service						
R584: Tlamimilolpa R/N bowl	4695	490	0.10	0.51	0.5	2.9
R614: Tlamimilolpa R/N vase	4694	1145	0.24	0.98	0.8	3.3
R924: Tlamimilolpa outcurving bowl	4663	38534	8.26	16.29	36.4	24.3
R944: Tlamimilolpa polished bowl	4637	2636	0.57	1.90	2.7	8.3
R914: Tlamimilolpa polished vase	4679	3584	0.77	2.20	3.1	7.3
R744: Tlamimilolpa pattern polished	4668	47	0.01	0.11	0.0	0.5
Tlamimilolpa incised	4686	3132	0.67	1.89	2.3	5.1
R874: Tlamimilolpa nubbin	4695	7830	1.67	4.23	6.2	8.5

As was done in defining Miccaotli assemblages, several categories that have Tlamimilolpa phase-variants were excluded from the analysis because of possible systematic phasing errors. Correlation coefficients suggest that significant numbers of Tlamimilolpa red vases (a relatively rare category) may have been made in the Miccaotli phase, although no such phase-variant of red vases exists in REANS. Tlamimilolpa phase-variants for comales and basin/bowls show peak correlations with Miccaotli rather than with Tlamimilolpa phase-totals. Tlamimilolpa floreros may be about as strongly correlated with total Xolalpan as with total Tlamimilolpa sherd counts, although the relatively small number of examples recorded makes it very difficult to be sure. Tlamimilolpa red-on-natural vases, round and slab supports (and possibly also red vases) exhibit unusually high correlations with total Metepec counts, and these categories may combine artifacts that were actually made and used during quite distinct periods of occupation. All seven of these categories were excluded from analysis.

Tlamimilolpa Polished Black counts were eliminated from the analysis because of their rarity.

Categories lacking conventional Tlamimilolpa phase-variants, but which on the basis of correlation coefficient patterns might well have been made or imported mostly in this phase include "Regular Thin Orange vase," "Regular Thin Orange incised," "Lustrous Ware," and "lid." While all of these categories were examined in experimental assemblage classification work, they were excluded from the final analyses reported here.

Three of four types of decorative incision that have Tlamimilolpa phase-variants (regular incised, groove incised, and gouge incised) were combined into a composite "incised" category similar to that used for the Miccaotli analysis. The "Tlamimilolpa cross-hatched incised" category was not included in this group because of the large number of cases with missing data. Similarly, Tlamimilolpa "form adornos" were excluded from the analysis because of the large number of cases (378) with missing data.

Bayesian Estimation

Bayesian posterior estimates of the mean proportion were calculated using statistics and constants summarized in Table 6.8. Counts of each category within individual assemblages were converted to proportions, using the total count for these categories (i.e., a measure of the total number of "Tlamimilolpa" sherds within each collection) as the denominator. The mean (μ) and variance (σ^2) of observed proportions of each category (the third and fourth columns in Table 6.8) describe the central tendency and dispersion of these values across the entire city. The same statistics (mean and variance) in a pool restricted to the 100 nearest neighbours with Tlamimilolpa phase-totals equal to or greater than the median phase-total (12) were used to calculate a "local" prior distribution for each record and category; the coefficients a and

b associated with this prior were used in turn to define posterior distributions for category proportions, characterized by an estimate of its mean and variance. Values of a and b, averaged across all collections, are displayed in the fifth and sixth columns of Table 6.8. The final two columns show the site-wide mean and variance of estimates of the mean of posterior proportion distributions.

Table 6.8: Tlamimilolpa phase analysis: statistics and constants used in Bayesian estimation.

category	valid n	μ	σ^2	$\bar{a}$	$\bar{b}$	$\overline{\mu''}$	$\overline{\sigma''^2}$
R454: Tlamimilolpa olla	4684	0.31	0.064	2.53	5.85	0.31	0.026
R474: Tlamimilolpa jar	4575	0.01	0.002	0.12	16.89	0.01	0.000
R504: Tlamimilolpa cazuela/crater	4684	0.09	0.018	1.00	10.79	0.09	0.004
R684: Tlamimilolpa censer	4681	0.08	0.016	0.99	13.30	0.07	0.004
R584: Tlamimilolpa R/N bowl	4683	0.00	0.001	0.07	15.39	0.00	0.000
R614: Tlamimilolpa R/N vase	4682	0.01	0.001	0.18	19.82	0.01	0.000
R924: Tlamimilolpa outcurving bowl	4651	0.36	0.059	3.47	6.31	0.36	0.021
R944: Tlamimilolpa polished bowl	4626	0.03	0.007	0.25	10.89	0.03	0.001
R914: Tlamimilolpa polished vase	4667	0.03	0.005	0.47	14.04	0.03	0.001
R744: Tlamimilolpa pattern polished	4657	0.00	0.000	0.02	57.96	0.00	0.000
Tlamimilolpa incised	4674	0.02	0.003	0.49	18.02	0.03	0.000
R874: Tlamimilolpa nubbin	4683	0.06	0.007	1.15	16.21	0.07	0.001

Assemblage Classification

The Bayesian posterior estimates summarized in the last two columns of Table 6.8 were used as point estimates of the proportion of these types within individual collections. Variation in these estimates provided a basis for classifying individual Tlamimilolpa assemblages using cluster analysis; the groups produced capture broad patterns of similarity and difference in the relative quantities of Tlamimilolpa phase pottery collected from individual collection tracts at Teotihuacan. As with the Miccaotli analysis, and as discussed in Chapter Five, only collections with phase-totals of 5 or more sherds were included in this and subsequent stages of analysis, reducing the number of cases from 4,684 to 3,578 cases.

Cluster Analysis

As with the Miccaotli data, the variance exhibited by posterior estimates of the proportion varies widely (Table 6.8, last column). In order to increase the contribution to the definition of clusters made by less common categories with relatively low variance, posterior estimates of proportions were raised to various powers. The powers used to transform these data are recorded in Table 6.9. The effect of transformation on the distribution of the ceramic categories can be seen in Figure 6.12, which shows box plots for these variables before and after transformation.

Statistica's (StatSoft Inc. 1997) k-means cluster analysis was used to classify assemblages using transformed posterior estimates of the mean proportion of the twelve Tlamimilolpa categories as input. Cases with missing data on one or more input variables were included in the analysis after substitution by the mean of the variable in question, as calculated across all cases included in the analysis. Solutions were obtained for all clusters between 2 and 10.

Table 6.9: Tlamimilolpa phase analysis: powers used for transforming posterior proportions of input categories.

category	power
R454: Tlamimilolpa olla	1.50
R474: Tlamimilolpa jar	0.10
R504: Tlamimilolpa cazuela/crater	0.30
R684: Tlamimilolpa censer	0.30
R584: Tlamimilolpa R/N bowl	0.10
R614: Tlamimilolpa R/N vase	0.10
R924: Tlamimilolpa outcurving bowl	1.50
R944: Tlamimilolpa polished bowl	0.15
R914: Tlamimilolpa polished vase	0.20
R744: Tlamimilolpa pattern polished	0.10
Tlamimilolpa incised	0.20
R874: Tlamimilolpa nubbin	0.40

A scree plot of %SSE data generated by these analyses (Figure 6.13) is relatively unhelpful in identifying solutions that represent a particularly good trade-off between number and internal cohesion of clusters. There are no clear inflections at cluster levels higher than 2; as was the case

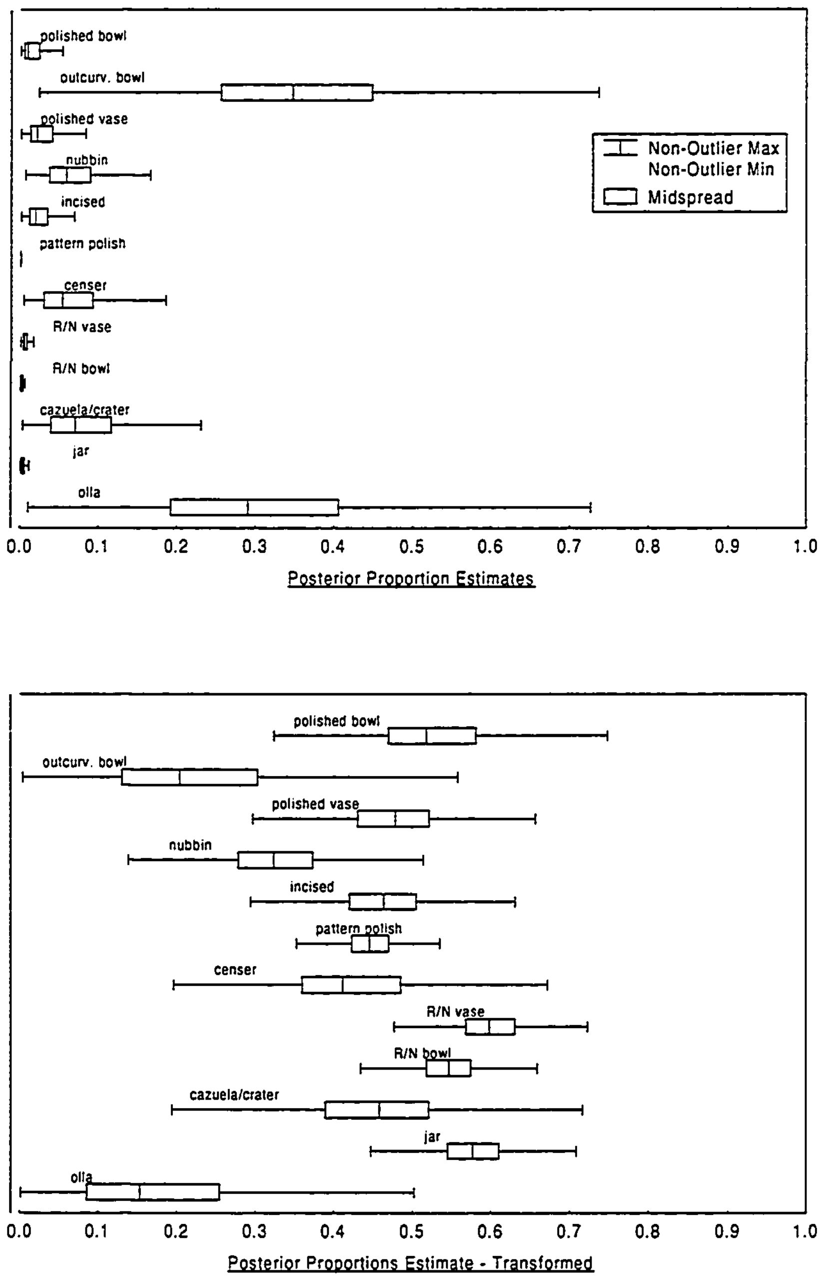

Figure 6.12: Ceramic categories used in Tlamimilolpa phase analysis. The top graph shows the distribution of posterior proportions estimated by means of the empirical Bayesian method; the bottom graph shows posterior estimates after transformation.

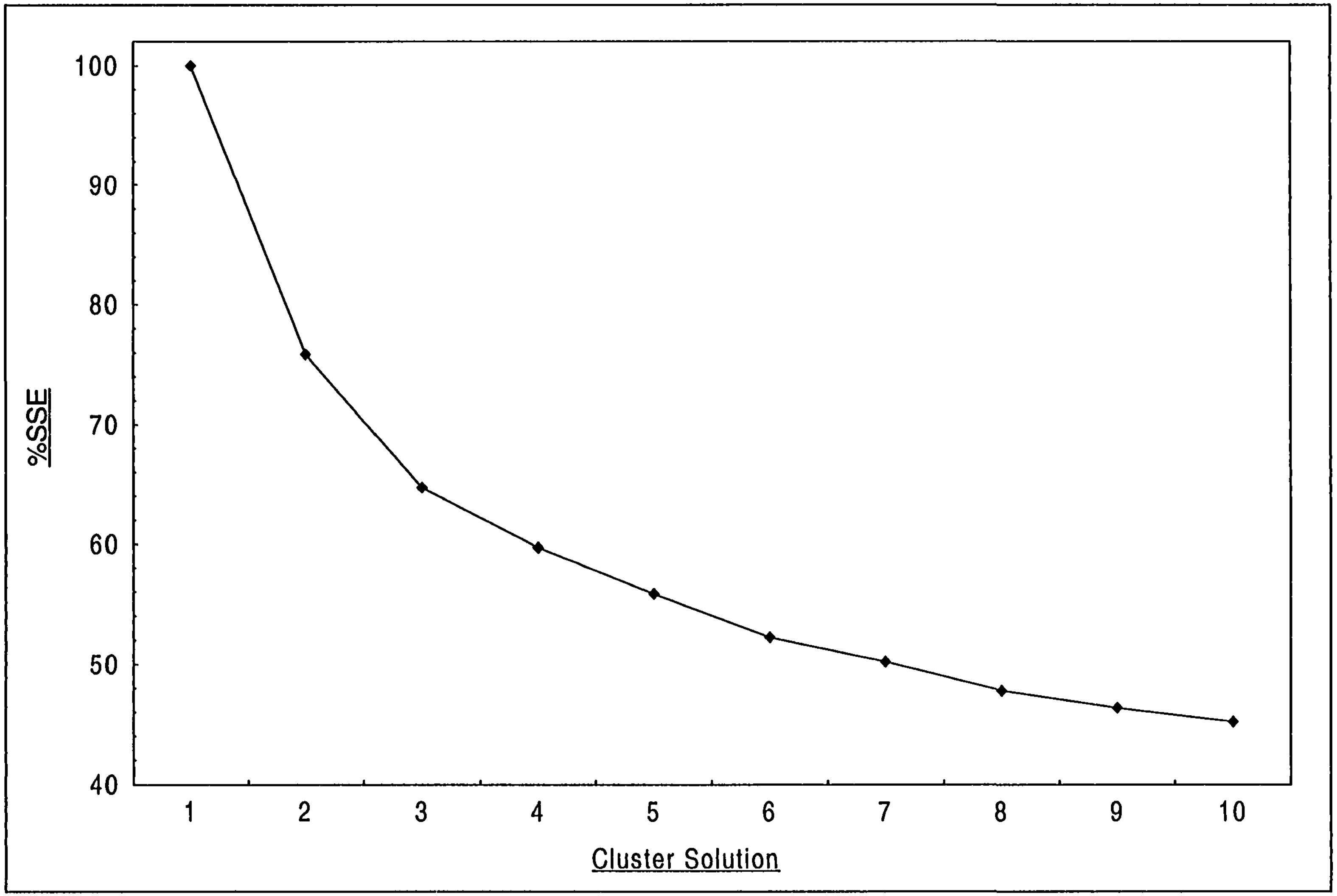

Figure 6.13: Sum-squared error plot associated with k-means analysis of assemblage composition data for the Tlamimilolpa phase.

in the Miccaotli analysis, the %SSE data show that dividing cases into two groups effects a major improvement in intra-cluster cohesion compared to other cluster solutions but does not highlight any higher-level cluster solutions.

Cluster memberships for all solutions from 2 to 10 were exported to MapInfo for exploratory thematic mapping and formatted for analysis in the Statistica discriminant function module. Cluster levels between 2 and 5 were examined in some detail, but subsequent descriptive and analytical work was focussed on the 4-cluster solution. The same observations made with respect to the Miccaotli analysis apply here: the 3-cluster solution failed to describe important distinctions highlighted by the 4-cluster solution and higher level cluster solutions described relatively minor differences that did not repay the extra work inherent in managing larger numbers of clusters. From a practical perspective, using the 4-cluster solution as a basis for classifying the Tlamimilolpa assemblages facilitates comparison with the Miccaotli analysis, which, as will be shown, reveals important parallels both in overall spatial patterning and in the variables that characterize differences among A-clusters.

A-Cluster 1 (TL:acls4/1) exhibits a spatial distribution that is very similar to the Miccaotli A-cluster MC:acls4/1. The 878 cases assigned to this cluster also concentrate in a roughly oval-shaped area centered around the city core, especially along the Street of the Dead (Figure 6.14a). The TL:acls4/1 cases, however, are less widely dispersed elsewhere in the city, and unlike the MC:acls4/1 cases, show no tendency to concentrate in the Oztoyahualco district.

A-Cluster 2 (TL:acls4/2) consists of 1094 cases. In general, cases assigned to this cluster show patterns of spatial concentration that are highly similar to MC:acls4/2. Large numbers of cases concentrate in the northwest quadrant of the city, notably in and to the immediate southeast of the Oztoyahualco district (Figure 6.14b); a much less dense scatter occurs over the rest of the

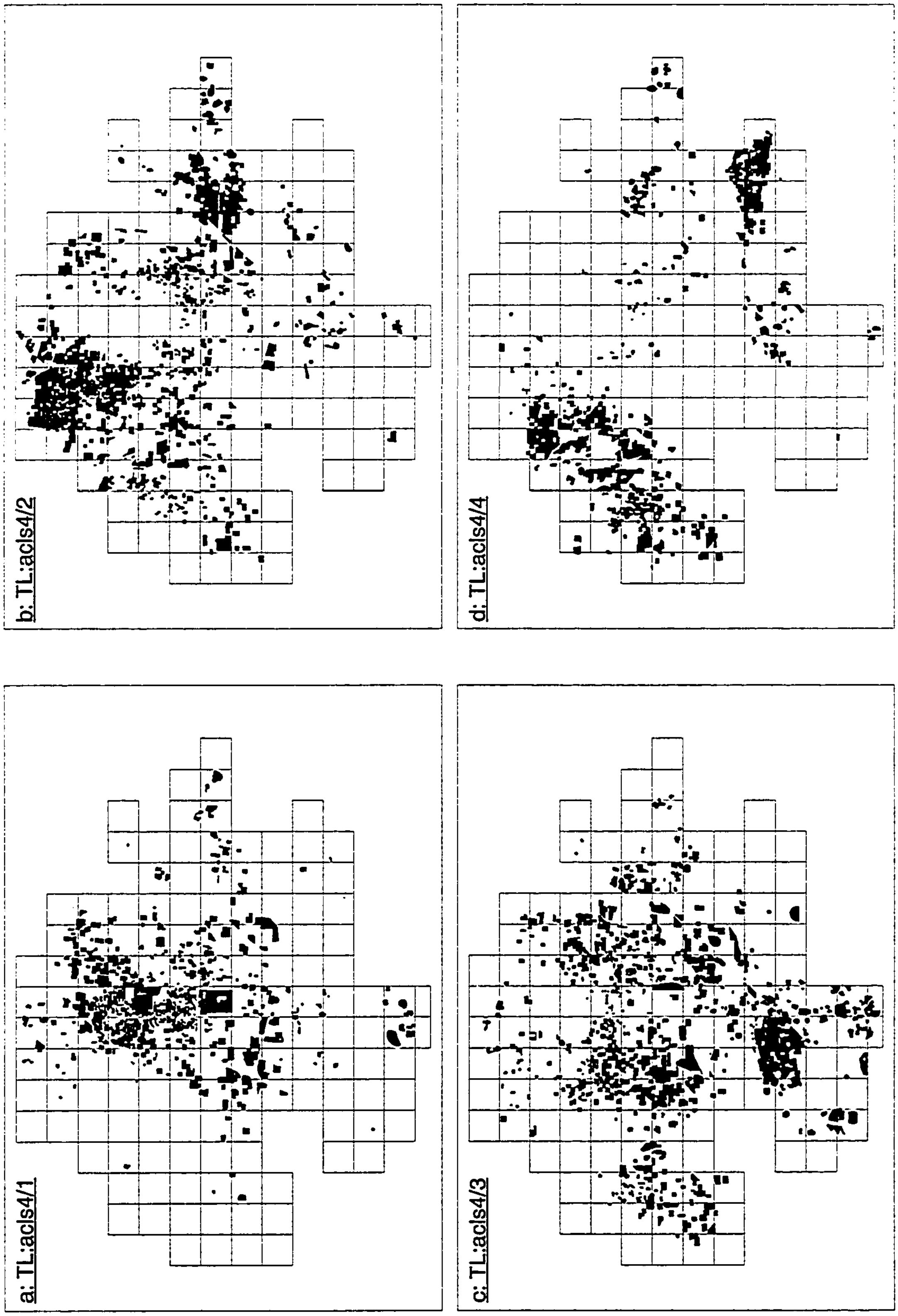

Figure 6.14: Maps illustrating the spatial distribution of Tlamimilolpa A-Clusters.

northwest quadrant of the city. A very strong concentration of TL:acls4/2 cases also occurs near the eastern edge of Teotihuacan, in the vicinity of square N1E5. A less dense concentration exists a short distance to the west, in a north-south trending strip paralleling the city core. TL:acls4/2 cases are rare in most parts of the Street of the Dead area.

A-Cluster 3 (TL:acls4/3) consists of 985 cases. In terms of patterns of spatial concentration, TL:acls4/3 most closely resembles MC:acls4/3 from the Miccaotli analysis. This is possibly the most evenly dispersed of the Tlamimilolpa A-clusters, and reasonably large numbers of cases are found in most parts of the city. A particularly strong concentration occurs in the Tlajinga district. Areas with a notable lack of Cluster-3 cases include the Oztoyahualco district and connected areas to the southwest. Cases assigned to this cluster are also relatively uncommon in the Street of the Dead area (Figure 6.14c).

A-Cluster 4 (TL:acls4/4) shows obvious similarities to the Miccaotli analysis MC:acls4/4. The main concentrations are in peripheral zones to the northwest and southeast; TL:acls4/4 cases are notably uncommon in central parts of the city, and the 617 cases included in this cluster are distributed in a way that shows a high degree of complementarity relative to TL:acls4/1 cases.

Discriminant Function Analysis

As with the Miccaotli phase analysis, discriminant function analyses were used to describe differences among the four Tlamimilolpa A-clusters, clarifying the contribution made by specific input variables in the allocation of cases to clusters. The first discriminant analysis used posterior proportions as independent (discriminating) variables and a variable recording memberships in one of the four A-clusters as the dependent (grouping) variable. Figure 6.15 is a bivariate scatterplot of case scores on the first two of three discriminant functions defined by the analysis. While this plot exhibits somewhat more overlap among clusters than the comparable plot from

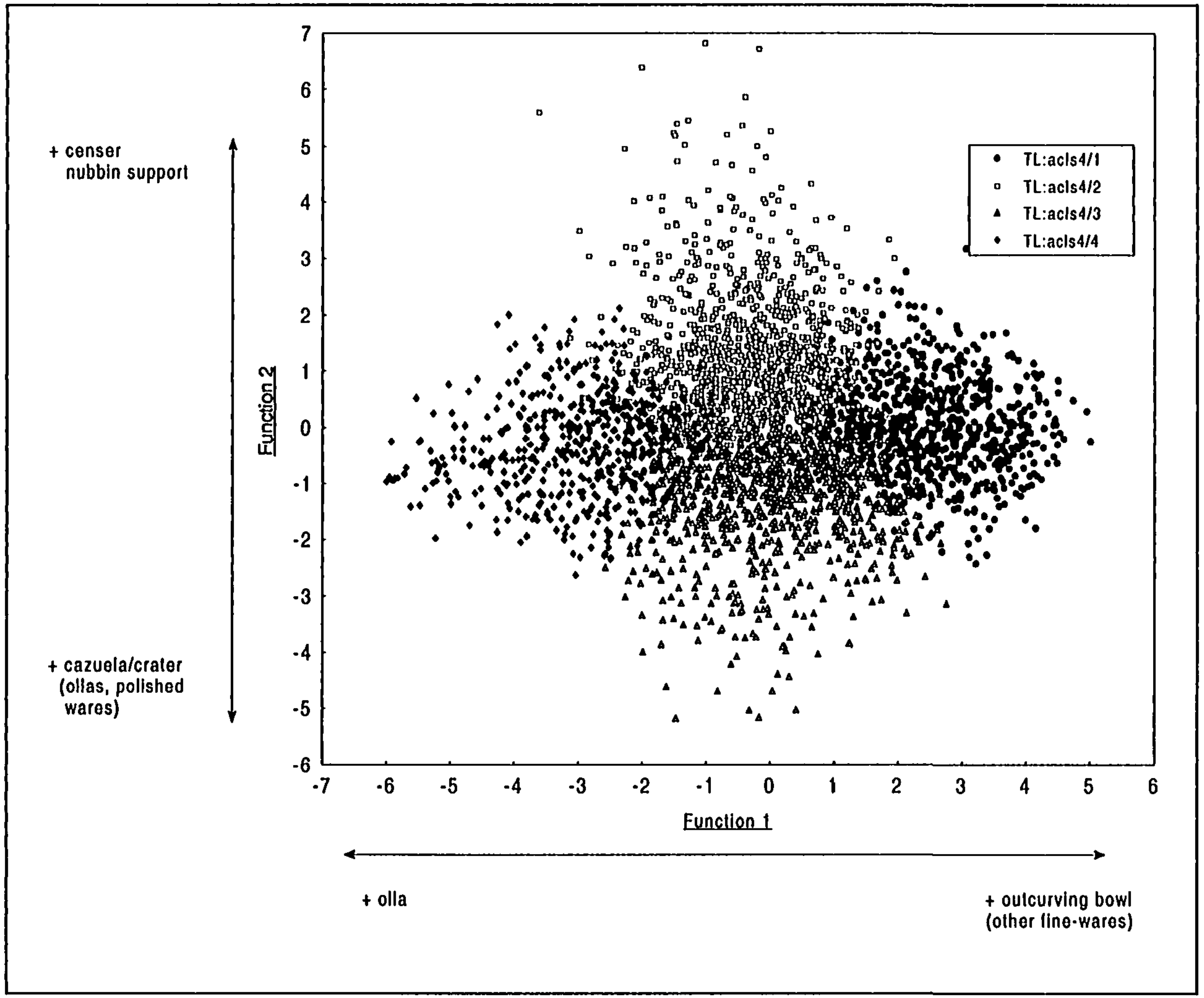

Figure 6.15: Case scores calculated for the first two functions generated by discriminant analysis, using Tlamimilolpa A-cluster membership as the grouping variable and posterior estimates of ceramic category proportions as discriminating variables.

the Miccaotli analysis (Figure 6.4), the first two functions nevertheless clearly differentiate most cases belonging to different clusters. Function 1 discriminates among Clusters 1, 4, and Clusters 2 and 3 combined. Function 2 discriminates between Clusters 2 and 3.

Factor structure coefficients associated with the first two discriminant functions (Figure 6.16) show that outcurving bowls have a high positive correlation with Function 1, while much smaller correlations are exhibited by several fine-ware categories including incised ware and polished bowls and vases. A very strong negative correlation is exhibited by ollas. This implies that cases assigned to A-cluster 1 characteristically show relatively high proportions of outcurving bowls and other fine wares and low proportions of ollas. A-Cluster 4 categories should exhibit the opposite characteristics (Figure 6.16a). The most salient differences between cases assigned to the other two clusters should be reflected in the relative proportions of censers and cazuela/craters, the former most common in Cluster 2, the latter most common in Cluster 3. Cluster 2 cases may also show characteristically elevated proportions of nubbin supports and possibly outcurving bowls. In addition to cazuela/craters, Cluster 3 cases may exhibited higher proportions of polished bowls, polished vases, and ollas. These observations are summarized in Figure 6.15 by two labeled axes.

As was done in the Miccaotli analysis, a second series of four discriminant function analyses based on binary categorization variables was carried out. The factor structure coefficients associated with each cluster are summarized in Figure 6.17. The results contribute relatively little new information and serve primarily to confirm results provided by the standard DFA based on a four-state grouping variable, as discussed immediately above. They do suggest, however, that Cluster 1 cases may often be characterized by relatively low proportions of cazuela/craters and censers, in addition to ollas (Figure 6.17a); this observation is compatible with, if not

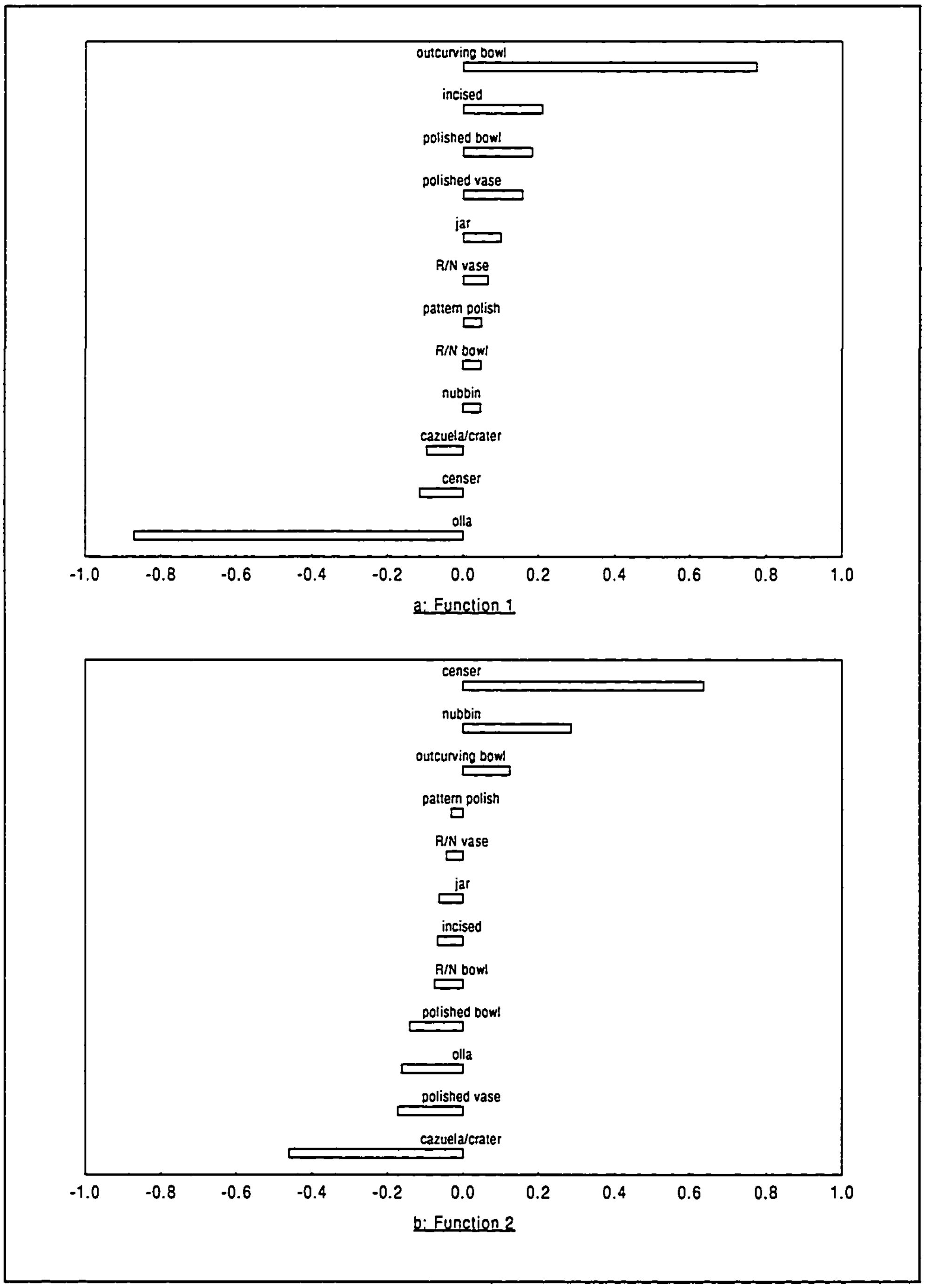

Figure 6.16: Factor structure coefficients: These values show the correlation between Tlamimilolpa ceramic categories and the first two discriminant functions. Categories exhibiting high positive or negative values are the most important for discriminating among A-clusters.

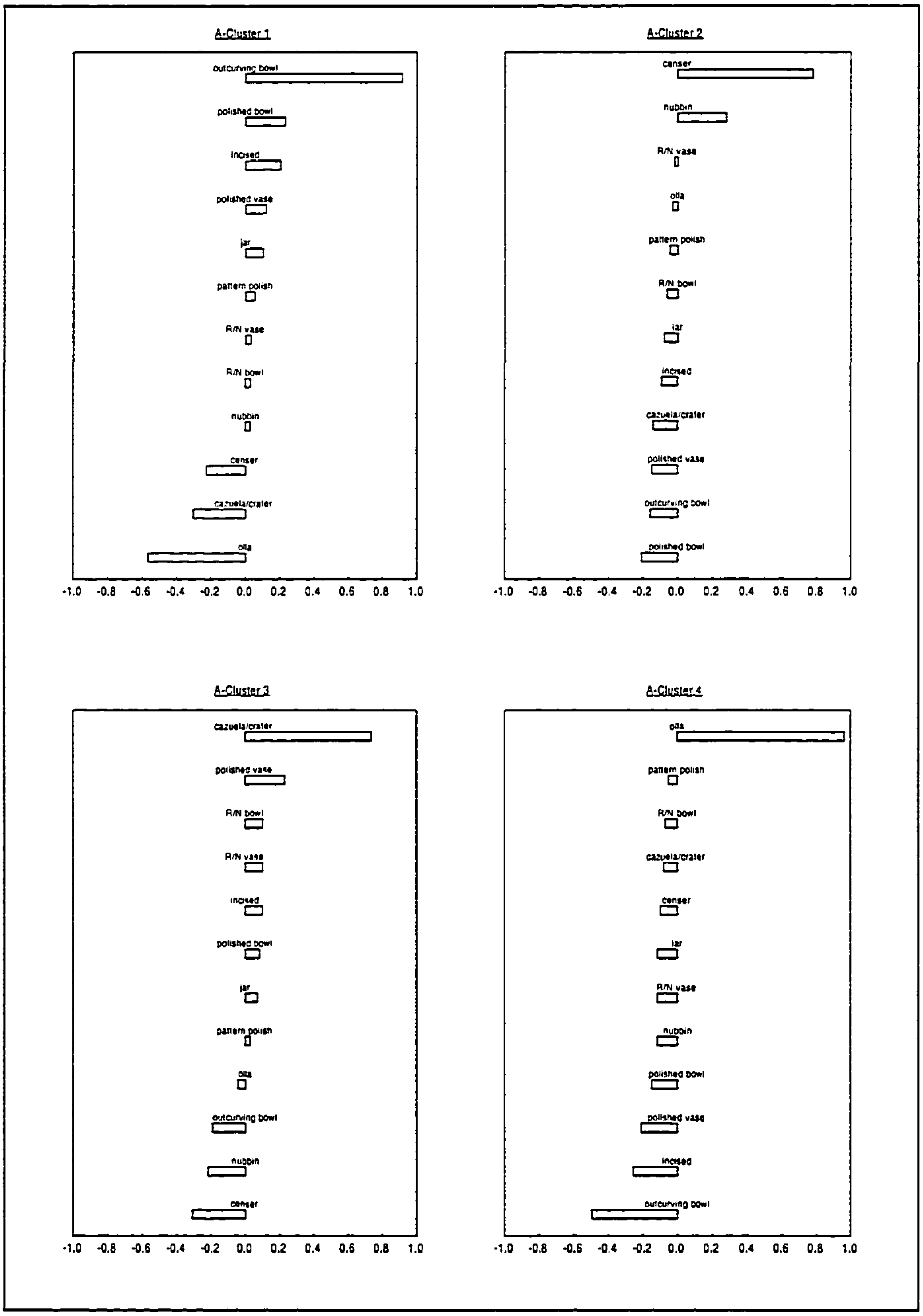

Figure 6.17: Factor structure coefficients generated by four separate DFA analyses using binary grouping variables derived from Tlamimilolpa A-cluster memberships. A single discriminant function is associated with each A-cluster.

emphasized by, the results of the first DFA analysis (Figure 6.16a).

While the DFA analyses referred to above draw attention to the variables that have the greatest power to discriminate among cases belonging to the four A-clusters, it is also useful to examine how the central tendencies of all input variables vary according to A-cluster membership. Table 6.10 records median proportions for the Tlamimilolpa data, both unstandardized and row-standardized as z-scores. The standardized values are shown as line plots in Figure 6.18, grouped according to broad similarities in line profile.

Table 6.10: Tlamimilolpa assemblage classification: median posterior proportions, broken down by A-cluster. The final four columns are based on row-standardized z-scores.

category	(non-standardized)				(standardized)			
	A-cluster				A-cluster			
	1	2	3	4	1	2	3	4
R454: Tlamimilolpa olla	0.139	0.299	0.303	0.553	-1.25	-0.16	-0.14	1.55
R474: Tlamimilolpa jar	0.005	0.003	0.004	0.002	1.14	-0.33	0.66	-1.47
R504: Tlamimilolpa cazuela/crater	0.038	0.064	0.127	0.069	-1.12	-0.32	1.62	-0.18
R684: Tlamimilolpa censer	0.034	0.108	0.041	0.047	-0.79	1.71	-0.57	-0.35
R584: Tlamimilolpa R/N bowl	0.003	0.002	0.002	0.001	1.48	-0.52	0.25	-1.21
R614: Tlamimilolpa R/N vase	0.006	0.004	0.006	0.003	0.99	-0.51	0.91	-1.39
R924: Tlamimilolpa outcurving bowl	0.535	0.332	0.329	0.193	1.54	-0.12	-0.15	-1.27
R944: Tlamimilolpa polished bowl	0.022	0.007	0.013	0.005	1.56	-0.71	0.17	-1.02
R914: Tlamimilolpa polished vase	0.027	0.019	0.030	0.011	0.71	-0.40	1.13	-1.44
R744: Tlamimilolpa pattern polished	0.000	0.000	0.000	0.000	1.29	0.00	0.22	-1.51
Tlamimilolpa incised	0.027	0.018	0.023	0.010	1.19	-0.25	0.56	-1.49
R874: Tlamimilolpa nubbin	0.062	0.078	0.050	0.051	0.15	1.58	-0.88	-0.85

As in the Miccaotli analysis, many of the patterns suggested by Table 6.10 and Figure 6.18 have already been discussed in the context of DFA results. The main detail to which I wish to draw attention is that, as was the case with comparable categories from the Miccaotli phase, most of the Tlamimilolpa fine-ware ceramic categories exhibit similar profiles that indicate that they tend to be more common in A-clusters 1 and 3 and least common in A-clusters 2 and 4 (Figure 6.18d).

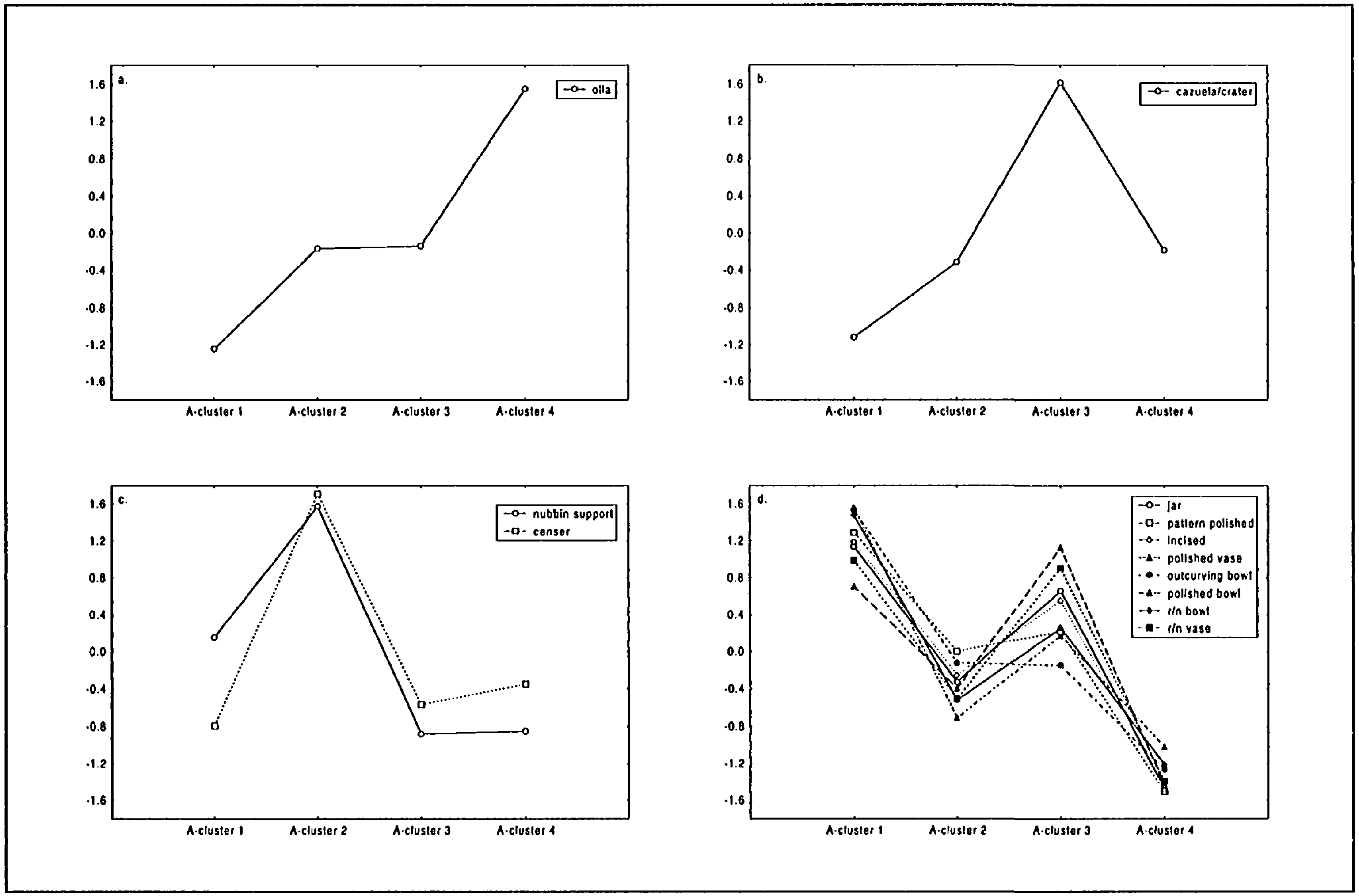

Figure 6.18: Median posterior proportions of Tlamimilolpa ceramic categories, broken down by A-clusters. To facilitate comparison between both rare and common categories, values have been standardized as z-scores, calculated within the set of four proportions associated with individual categories (see Table 6.24).

A-clusters - Summary

Figure 6.19 illustrates the spatial distribution of cases with relatively high and low proportions of the four artifact types that were identified through discriminant function analysis as the most important for discriminating among A-clusters—illustrated are the upper and lower quartiles of the distribution of posterior proportions for ollas, cazuela/craters, censers, and outcurving bowls. Each of these thematic maps exhibits more or less obvious similarities with one of the A-clusters illustrated in Figure 6.14. The spatial distribution of collections with high olla proportions (Figure 6.19a) is essentially the same as that formed by Tlamimilolpa A-cluster 4 cases. Collections with high censer proportions (Figure 6.19c) appear to be a very large subset of the cases assigned to A-cluster 2. The distribution of outcurving bowls is obviously closely related to the distribution of A-cluster 1. Finally, the distribution of cases in the upper percentile of cazuela/crater proportions is very similar to the distribution of A-cluster 3.

Major spatial and compositional differences among the four Tlamimilolpa A-clusters are summarized in Table 6.11. As in Table 6.5, the last two columns list categories that are characterized by high and low proportions within each of the four A-clusters. The categories that were identified by DFA as being most important for discriminating among A-clusters are underlined; other categories that also appear to show patterned variation with respect to A-clusters are listed on subsequent lines.

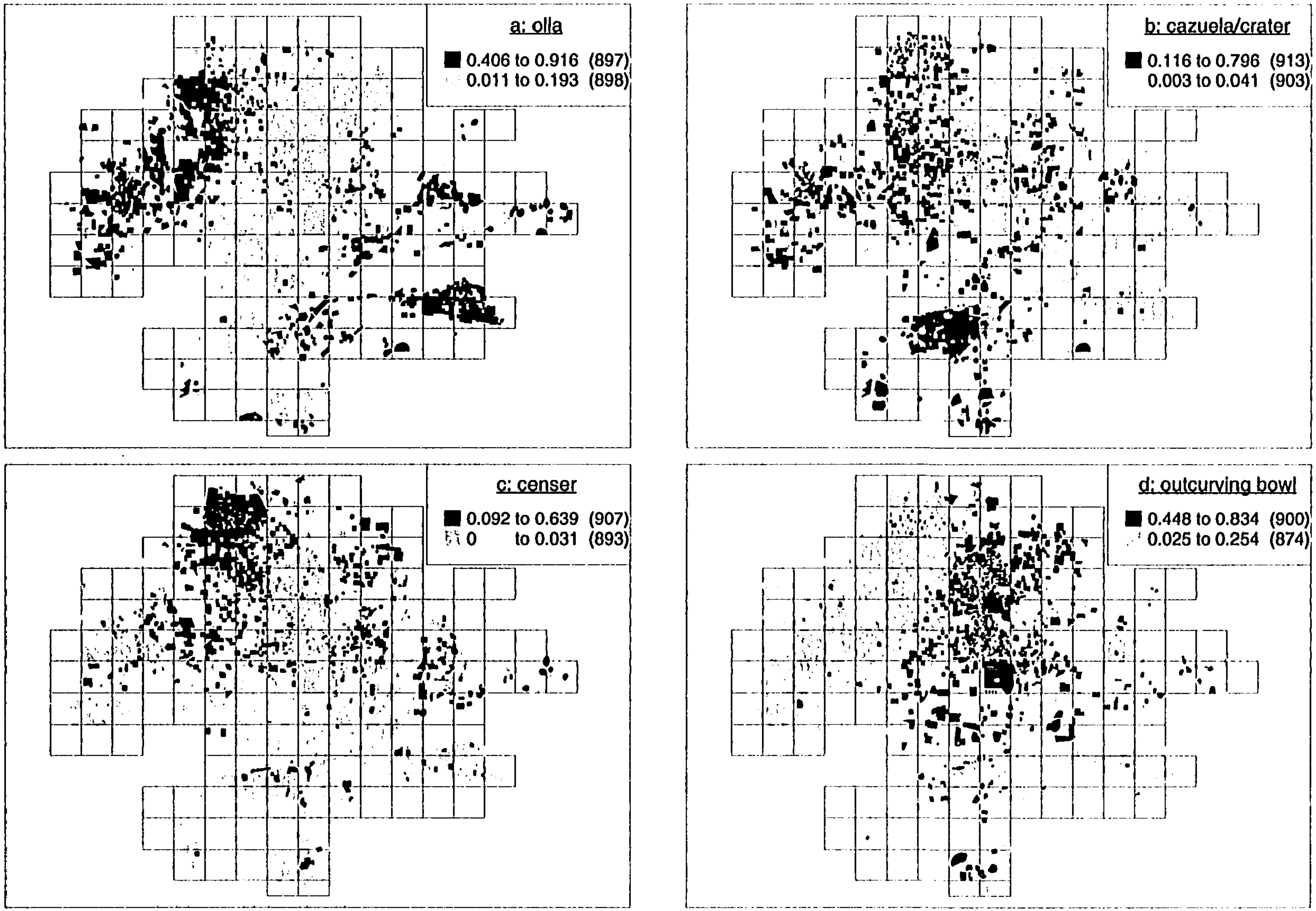

Figure 6.19: Major Tlamimilolpa ceramic categories: Spatial distribution of upper and lower quartiles of posterior proportion estimates.

Table 6.11: Tlamimilolpa assemblage classification: summary of spatial and artifactual patterns associated with A-clusters.

cluster	code	n	spatial parameters	high proportions	low proportions
1	TL:acls4/1	878	• clear concentration in and around the city core, especially the Street of the Dead area	outcurving bowl r/n bowl polished bowl fine-ware jar	olla cazuela/crater censer
2	TL:acls4/2	1094	• most common in the northwest quadrant and along the East Avenue; densely concentrated in the Oztoyahualco district	censer nubbin support	cazuela/crater
3	TL:acls4/3	985	• fairly well dispersed, but rare in parts of the Street of the Dead area and the Oztoyahualco district; strong concentration in the Tlajinga district	cazuela/crater polished vase r/n vase jar incised ware	censer nubbin support
4	TL:acls4/4	617	• strongly concentrated in peripheral areas to the northwest and southeast; rare in most other parts of the city	olla	outcurving bowl incised jar fine-ware r/n bowl r/n vase nubbin-support

Cases assigned to TL:acls4/1 show general similarities to MC:alcs4/1, both in terms of spatial and artifactual patterning. They are characterized by heightened proportions of fine-ware vessels, relatively low olla, cazuela/crater, and censer proportions, and they exhibit a clear tendency to concentrate in and around the geographical core of ancient Teotihuacan. Like its Miccaotli counterpart, this cluster is probably related to behavioural patterns which relate to households associated with the upper end of a wealth/status continuum and frequently engaged in feasting activities involving more elaborate forms of service pottery.

As was the case in the Miccaotli analysis, A-cluster 4 (TL:acls4/4) shows characteristics that are roughly the opposite of what was just described for A-cluster 1. Cases assigned to this cluster exhibit relatively high olla proportions and low outcurving bowl, incised ware, jar, and fine-ware proportions. These cases show strong signs of concentrating along the northwest periphery, and less strikingly, in parts of the southeast periphery of the city. The relatively low counts of elaborate forms of pottery compared to utilitarian olla fragments, as well as their peripheral location, suggests that associated households were of relatively low status, the same interpretation made for MC:acls4/4.

TL:acls4/2 cases are characterized by relatively high proportions of censers and nubbin supports and low proportions of cazuela/craters. The most notable zone of concentration is to the northwest of the ceremonial core, including the Oztoyahualco district and areas immediately to the southeast. There is also a strong concentration toward the end of the East Avenue.

Cases assigned to TL:acls4/3 are characterized by high proportions of cazuela/craters, various fine-ware categories, and burnished jars; categories that are characteristically low are censers and nubbin supports. TL:acls4/3 cases are fairly well dispersed in Teotihuacan, but there are also clear areas of concentration, notably in fairly wide strips flanking both sides of the Street of the Dead area, and in the Tlajinga district.

Having suggested that A-clusters 1 and 4 appear to map onto opposite ends of a wealth/status dimension, I now argue, as I did for the Miccaotli analysis, that the Tlamimilolpa A-clusters 2 and 3 occupy some form of intermediate ground along the same continuum. This is reflected to varying extents in both spatial and artifactual data. Cases assigned to TL:acls4/3, for example, tend to concentrate in parts of the city that are intermediate between the city core and periphery (Figure 6.14c). A similar pattern is less clear for TL:acls4/2, since many of the most striking concentrations of cases assigned to this A-cluster occur on the edge of the city. Nevertheless, compared to TL:acls4/4, many of the TL:acls4/2 cases also occupy locations much closer to the city core. Turning to ceramic materials, median proportions for A-clusters 2 and 3 fall between those of A-clusters 1 and 4 for a number of categories. This is particularly clear for ollas and outcurving bowls, as well as a number of other fine-ware categories (Figure 6.18).

Neighbourhood Classification

As was done for the Miccaotli phase, a second stage of analysis was used in the Tlamimilolpa study to classify localities in Teotihuacan on the basis of differences and similarities in the composition of surrounding neighbourhoods, as characterized by collection tracts classified according to the four A-clusters described above.

Local Density Analysis

Centroids were calculated for each of the 3,574 cases included in the Tlamimilolpa phase analysis, and the point-based local density analysis program LDEN (Kintigh 1993) calculated local density coefficients for all 10 pairs of the four A-clusters, based on 20 radii ranging between 50 and 1,000 m. Local density coefficients were also obtained on a data set in which all cases were assigned to a single category. These values were used, as described in Chapter Five, to calculate a local density coefficient ($D_{ij(r)}$), standardized so as to eliminate boundary effects.

The values of D obtained from these analyses are summarized in Figure 6.20. Compared to local density coefficients obtained from Miccaotli data, the Tlamimilolpa results are notable for varying over a greater range—in rough figures, the range of Miccaotli values is between –0.7 and 1.9 (Figure 6.9), while the Tlamimilolpa values vary between about –1.0 and 3.8 (Figure 6.20).

The greater range of the Tlamimilolpa local density coefficients is due to the relatively high levels of association exhibited by several of the A-cluster pairs, the 1-1 pair in particular. Within radii of 50 to 150 m, the density of TL:acls4/1 cases in neighbourhoods defined around TL:acls4/1 cases is roughly 250 to 400% higher than the density of cases without regard to A-cluster type ($2.4 < D < 3.8$). Measured over similar distances, the next highest levels of association relate to the 4-4 A-cluster pair, with values of D that peak at approximately 1.7. The levels of association exhibited by the 2-2 pair is only slightly less, with a D value of roughly 1.3.

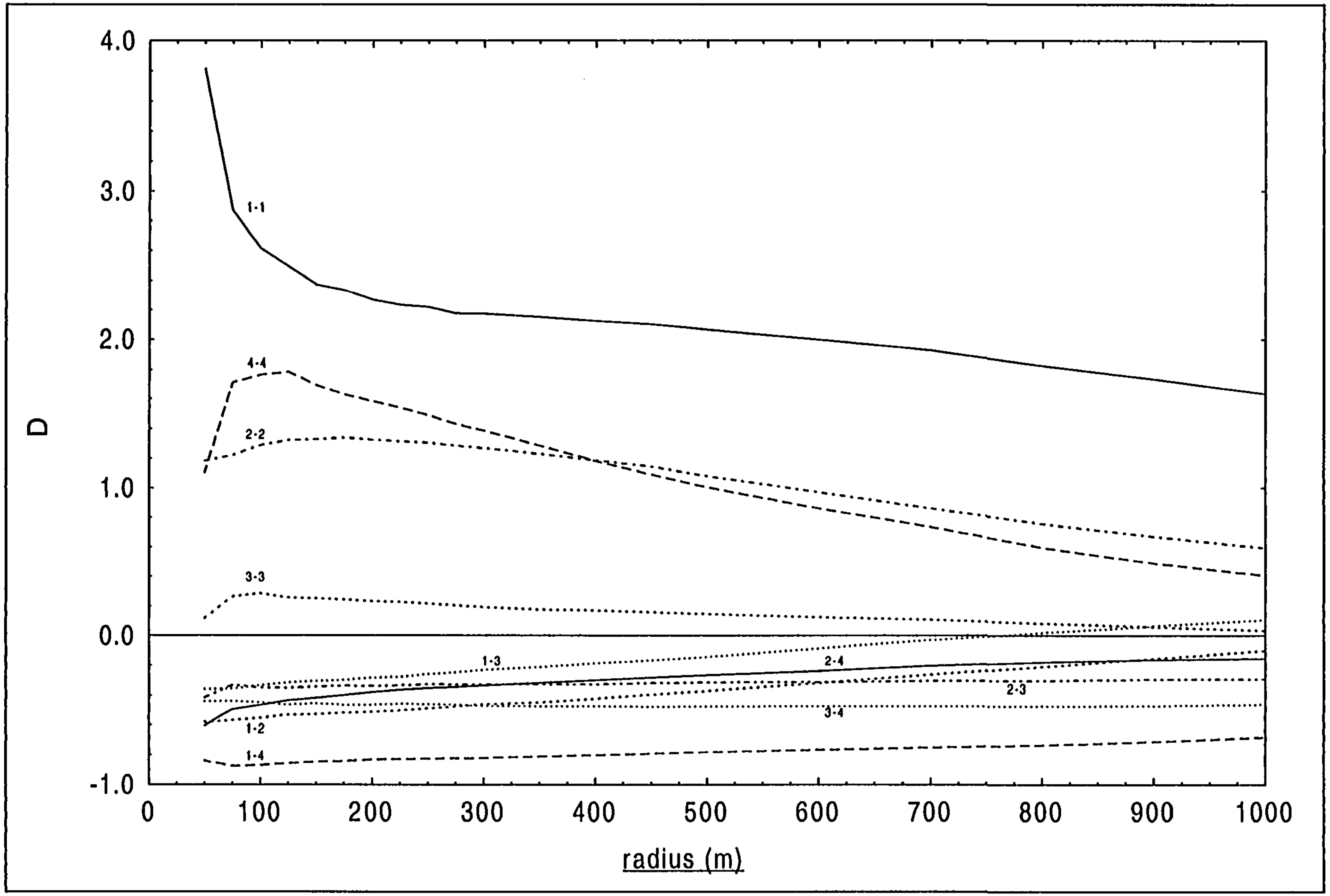

Figure 6.20: Local density coefficient D calculated for Tlamimilolpa phase A-cluster pairs for radii between 50 and 1000 m. Locations above the solid horizontal line ('0.0') indicate spatial association; locations below indicate spatial segregation.

There is a wide gap between the local density coefficients associated with these two pairs and the next highest, exhibited by the 3-3 pair with a peak D value of about 0.25.

All of the pairs pertaining to between-cluster association exhibit values of D that are well under 0, at least over distances of less than about 700 m, suggesting an over-all effect of segregation amongst the various A-clusters. The A-cluster pair exhibiting the strongest evidence for spatial segregation is 1-4, with D values of less than –0.8 over distances of around 100-150 m.

The main points of contrast with patterns revealed by the Miccaotli local density analysis are (1) that the Tlamimilolpa data provide clear evidence for greater spatial association among the same A-clusters, and slightly weaker evidence for the segregation of different A-clusters, and (2) none of the between-A-cluster pairs exhibit local density coefficients that are as high as the within-A-cluster pairs, at least at distances of less than 400 or 500 m. Recall that D values for the Miccaotli 1-3 pair were positive, similar in magnitude to those generated by the 3-3 and 4-4 pairs and exceeding both at certain scales of analysis. In the Tlamimilolpa data set, collection tracts associated with A-clusters 1 and 3 appear to be essentially isolated from one another. Points of similarity between the Miccaotli and Tlamimilolpa local density analyses include the fact that the 1-1 pairs from both phases exhibit the highest LDA coefficients, and 1-4 the lowest.

Neighbourhood Composition Data

In order to enhance comparability with the Miccaotli phase analysis, I generated neighbourhood composition data for the 3,574 Tlamimilolpa cases using the same buffer size of 130 m; this is entirely compatible with results from the Tlamimilolpa LDA work, which indicated that peak levels of association occur at fairly short distances, well under 200 m. The same geographic selection criteria were also used, based simply on the intersection of borders. The results produced a mean neighbourhood size of about 27, and about 9% of all cases have neighbourhoods composed of 10 or fewer collections. Cases for which neighbourhood composition data was based on 5 or more neighbours, 3,518 in total, were retained for neighbourhood classification using cluster analysis.

Cluster Analysis

Counts of the four A-clusters within 3,518 neighbourhoods defined by 130 m buffers were standardized as proportions and used as input in k-means cluster analyses. Solutions for 2 to 10 clusters were obtained.

Figure 6.21 shows %SSE data generated by these analyses. Unlike the similar plot created for the Miccaotli analysis (Figure 6.10), the drop-off in %SSE values for the Tlamimilolpa data shows a strong eversion at 4-clusters—the marked flattening of the line-plot at this point indicates that little improvement in cluster isolation and cohesion is produced by higher level clusters. While data pertaining to all cluster solutions were exported to MapInfo, examination via thematic maps concentrated on two to five clusters. Ultimately, I determined to concentrate descriptive and interpretive work on the 4-cluster solution; as will be shown below, this was associated with a particularly clear zonation of the city.

Tlamimilolpa N-Clusters

Table 6.12 breaks down cases included in the Tlamimilolpa analysis by both N-cluster and A-cluster assignments. A thematic map of the 4 N-clusters created for the Tlamimilolpa data reveals patterns strongly reminiscent of those exhibited by the A-clusters from which they derive (Figure 6.22) but forming much more clearly delimited spatial entities.

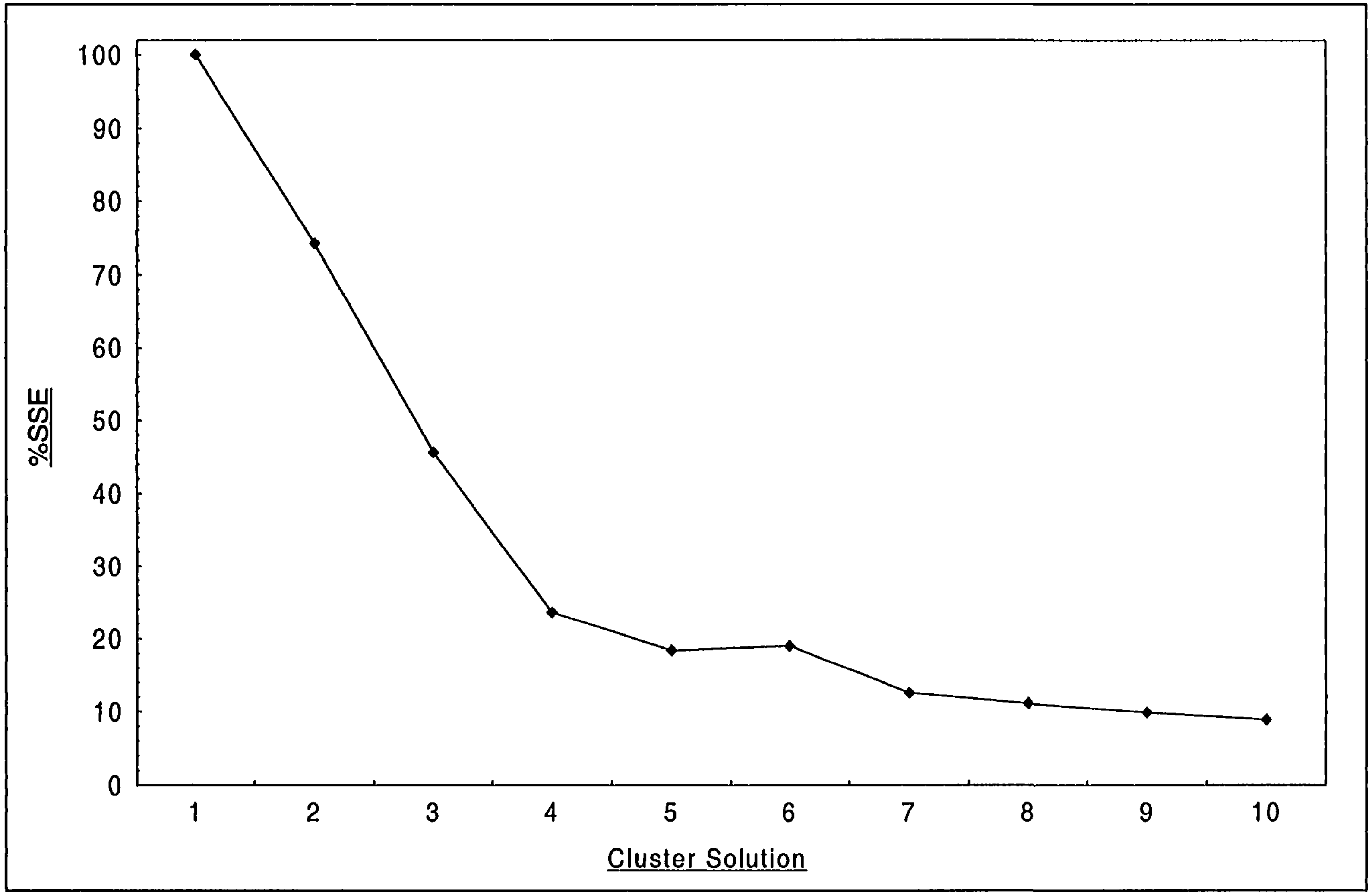

Figure 6.21: Sum-squared error plot associated with k-means analysis of neighbourhood composition data for the Tlamimilolpa phase.

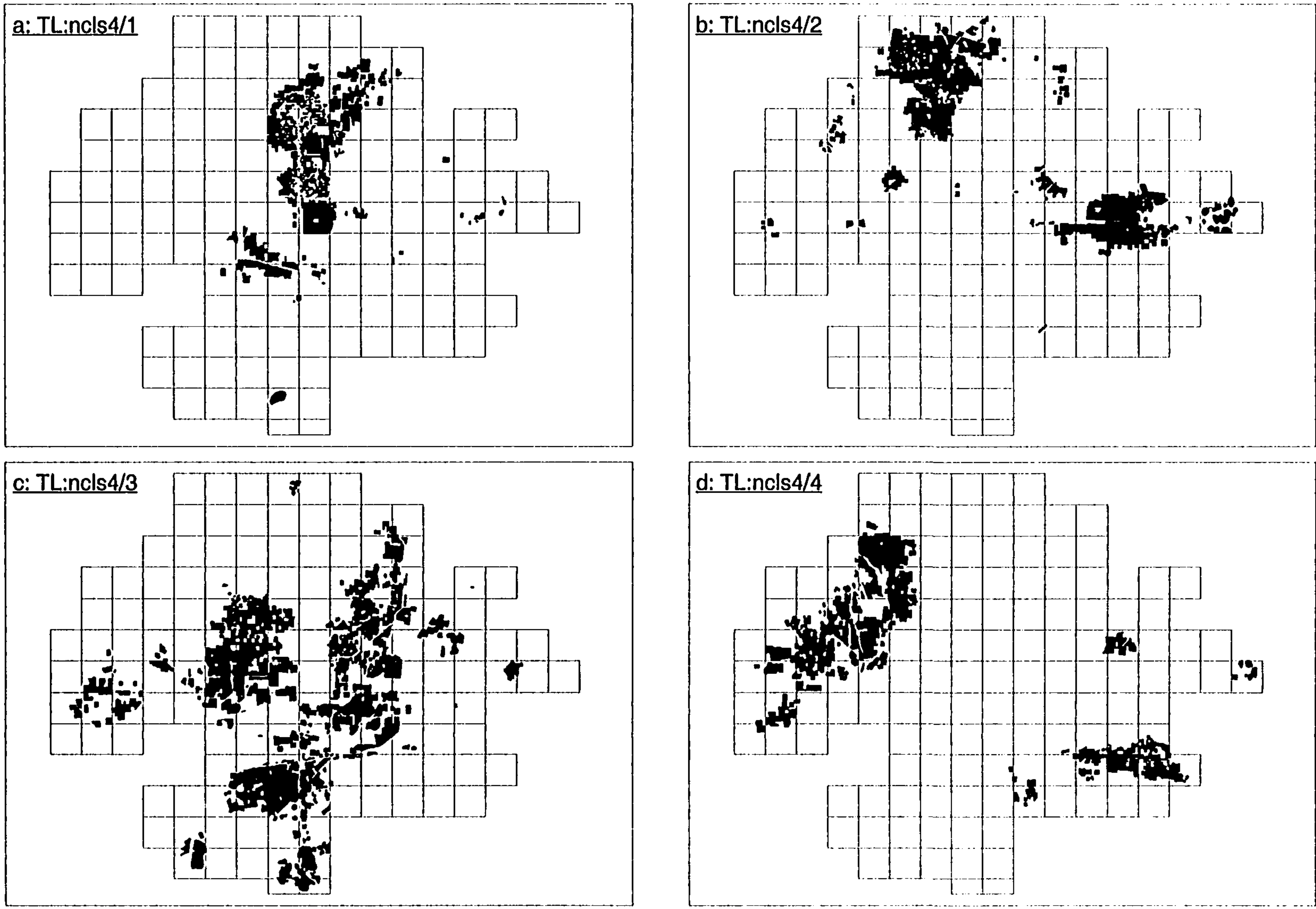

Figure 6.22: Maps illustrating the spatial distribution of Tlamimilolpa N-Clusters.

Table 6.12: Cross-tabulation of A-cluster and N-cluster class memberships for the Tlamimilolpa phase analysis.

A-cluster:	N-cluster: TL:ncls4/1	TL:ncls4/2	TL:ncls4/3	TL:ncls4/4	total
TL:acls4/1	589	64	214	3	870
TL:acls4/2	65	632	250	131	1078
TL:acls4/3	87	94	678	106	965
TL:acls4/4	14	65	78	448	605
total	755	855	1220	688	3518

N-cluster 1 (TL:ncls4/1) consists of 755 cases. Most of these are located in the immediate vicinity of the Street of the Dead, and map very closely onto types of structural remains—temple platforms, 3-mound complexes, room groups, plazas—that, at least in later phases but probably also by Tlamimilolpa, gave a distinct architectural flavour to the ceremonial core of the city (Figure 6.22a). A concentration of N-cluster 1 cases also extends to the northeast of the Street of the Dead in the general area of squares N5E2 and N6E3. This is an area in which mostly apartment compounds were recorded by the TMP survey. A fairly large spatial outlier composed of cases assigned to this cluster also exists in the vicinity the La Ventilla district, around square S1W2. This general area was significantly disturbed by recent leveling activities (Millon et al. 1973:91-92, 104-105), but was interpreted by TMP fieldworkers as having contained mostly residential structures. Excavations in this area have exposed a number of important apartment compounds, some clearly occupied by high status individuals (Cabrera Castro 1996, 1998a; Gómez Chávez 1996, 2000).

The 855 cases assigned to N-cluster 2 (TL:ncls4/2) are mostly found in two areas: to the northwest of the northern end of the Street of the Dead area, extending to the outskirts of the city and including the Oztoyahualco district; and near the eastern end of the East Avenue (Figure 6.22b). Much of the terrain encompassed by both these areas is situated near peripheral parts of the city.

Of all the clusters, N-cluster 3 contains the largest number of members at 1,220 cases. Many of these are found in two broad zones that flank both sides of much of the Street of the Dead area. The eastern zone extends farther south than the western zone and encompasses terrain to the southeast of the Ciudadela. All collection tracts in the Tlajinga district, still further to the south, were also assigned to N-cluster 3 (Figure 6.22c). Smaller, but still clearly discernible concentrations are located at the south end of the Street of the Dead (squares S6W1 and S6E1) and near the western edge of the city, in the vicinity of square S1W7.

N-cluster 4 is the cluster most clearly associated with peripheral parts of Teotihuacan. Most of the 688 cases assigned to this cluster are located in a southwest-northeast trending zone running along the most elevated, western-most parts of the city. A smaller concentration is found on the opposite side of Teotihuacan, south of the Río San Lorenzo, in the vicinity of squares S3E5 and S3E6 (Figure 6.22d).

Diachronic Patterns

I have so far avoided making many direct comparisons between results obtained from the Miccaotli and Tlamimilolpa analyses and have emphasized patterns of spatial variability that are largely specific to one phase or the other. In this section—partly by way of summary—I consider the diachronic implications of these data, discussing in more detail how patterns that have been described for Tlamimilolpa differ from those that characterized the preceding Miccaotli phase. In doing this, I draw on three different lines of comparison, the first having to with differences and similarities in the ceramic assemblage composition of A-clusters. The second is concerned with the A-cluster composition of larger spatial entities, specifically neighbourhoods, and the regionalities defined by N-clusters. The third line of comparison deals with the form of the spatial/regional entities delimited by N-cluster concentrations.

Ceramic Assemblage Patterns – Miccaotli and Tlamimilolpa A-clusters

In previous sections, I pointed out that each of the four Miccaotli A-clusters shares at least broadly similar patterns of spatial concentration, and/or ceramic assemblage characteristics, with one of the Tlamimilolpa A-clusters (compare Table 6.5 and Table 6.11); the numeric suffixes used in naming A-clusters from the two phases were deliberately assigned to highlight these general similarities and to facilitate comparison. Both MC:acls4/1 and TL:acls4/1, for example, concentrate near the city core and exhibit high outcurving bowl proportions and low olla and censer proportions. A-clusters MC:acls4/4 and TL:acls4/4 concentrate on the edge of the city, and both have high olla and low outcurving bowl proportions. Parallels between the Miccaotli and Tlamimilolpa versions of A-clusters 2 and 3 are less obvious and are largely expressed in spatial patterns: MC:acls4/2 and TL:acls4/2 cases both tend to concentrate in the northwest quadrant, while large numbers of MC:acls4/3 and TL:acls4/3 cases are found in areas more or less adjacent to the Street of the Dead area, flanking concentrations of A-cluster 1 cases.

These parallels in results obtained from the Miccaotli and Tlamimilolpa analyses are compatible with the interesting idea that, at a fundamental level, behaviours associated with ceramic consumption and discard at Teotihuacan were fairly conservative, at least during these periods of occupation. Nevertheless, it might also be argued that some degree of similarity should be expected from analyses carried out on materials from two temporally adjacent phases, if only because of the nature of ceramic change. As noted in Chapter Four, ceramic change at Teotihuacan appears mostly to have been a fairly gradual process, and divisions between phases are not usually very clear-cut in terms of ceramic typology. If the attribution of sherds to Miccaotli and Tlamimilolpa were based on criteria so uncertain as to be an essentially random process, the results generated by the analyses I carried out could be expected to be essentially the same for both phases. Of course, the phasing of Teotihuacan ceramics is not nearly this uncertain—if it were, it would make no sense to attempt diachronic analyses of the type that I am describing. Nevertheless, it is prudent to recognize that some, probably minor, portion of what appears to be diachronic stability could reasonably be attributed to errors in assigning sherds to the correct phase.

On the other hand, there are also clear differences between results obtained for the Miccaotli and Tlamimilolpa phase analyses; these are working against whatever homogenizing effect may be attributable to typological imprecision and therefore of greater inherent interest than similarities. MC:acls4/1, for example, is characterized by somewhat elevated proportions of two ceramic categories—cazuela/craters and comales—that were used for utilitarian tasks involved in storing and preparing food stuffs destined to be served in fine ware vessels such as outcurving bowls, perhaps quite often as part of feasting events. Comales were not included in the Tlamimilolpa analysis, but it is notable that TL:acls4/1 cases exhibit low proportions of cazuela/craters. In fact, the only utilitarian ceramic category that appears to show relatively high proportions in TL:acls4/1 collections is the fairly uncommon, somewhat enigmatic, burnished jar. This suggests that the intensity of food preparation activities may have been decreasing over time in high–status households. Compared to their Miccaotli predecessors, the ceramic-consuming activities of Tlamimilolpa elites were probably more focussed on serving and consuming food than cooking it.

An important implication of this idea is that neighbourhoods in which high levels of the comparatively mundane activities of cooking and food storage took place may have shifted away from those dominated by high-status households; given the relative homogeneity that has been described for ceramic consumption patterns in the Street of the Dead area, it makes sense to consider evidence for food preparation in other parts of the city. Of particular interest are proximal zones that were assigned in the neighbourhood composition analysis to class

TL:ncls4/3. These areas are dominated by ceramic assemblages that were assigned to TL:acls4/3 and which are characterized by highly elevated proportions of cazuela/craters—a ceramic signature entirely compatible with high levels of cooking and storage activities.

The implication is that elite households living in the city core might regularly have obtained cooked food from lower-ranked households living in separate, but relatively nearby neighbourhoods, perhaps as some form of patron-client relationship, based on lineage or other ties of kinship. A good analogy for this kind of economic tie has been documented among Late Postclassic Mixtec society in Oaxaca (Spores 1984), where the needs of ruling elites for cooked foodstuffs were mostly fulfilled by lower-ranking retainers, and the archaeological signature is very similar (Lind 1987). If similar relationships existed in Teotihuacan society, they probably date back in some form to the Miccaotli phase and perhaps earlier periods as well. However, the greater heterogeneity of elite-dominated neighbourhoods in Miccaotli (below) and the prominence of cazuela/crater and comal sherds in MC:acls4/1 assemblages suggest that such relationships may, prior to Tlamimilolpa, have been less pervasive, had less to do with the transfer of cooked food, and involved households that were less spatially segregated from one another.

It should be noted that these patterns are confounded by the fact that many of the TL:acls4/3 cases are in the Tlajinga district, an area that, during the Xolalpan and Metepec phases, contained numerous workshops engaged in specialized production of utilitarian vessels made of San Martín Orange Ware. Specialized production in this area, particularly of comales, may have begun earlier (Hopkins 1996:145). If such production included cazuela/craters (as seems likely, given the repertoire of the later San Martín Orange potters) this would inflate the proportion of cazuela/craters in TL:acls4/3 cases for reasons that, at least in Tlajinga, might connect indirectly or not at all with local ceramic consumption.

Censers also provide an interesting contrast between the Miccaotli and Tlamimilolpa phases. Censer proportions are not very high in any Miccaotli A-cluster, but tend to be slightly elevated among A-cluster 2 cases. Censers are more common in Tlamimilolpa in general, but the proportion of censers among Tlamimilolpa A-cluster 2 (TL:acls4/2) cases is clearly elevated relative to other A-clusters, particularly A-cluster 1.

The relatively low proportion of censers among cases that concentrate in the city core is particularly interesting. Ritual activities involving this type of vessel appear to have been relatively less important within the residential and religious structures that dominated the ceremonial precincts of Teotihuacan, compared to other parts of the city. This general pattern appears to accentuate over time, even as the use of ceramic censers was becoming more common in the city as a whole. Many of the rituals activities routinely carried out in the city core would have been public in nature, designed for viewing by relatively large numbers of individuals, perhaps involving larger, more visible ritual objects or facilities than ceramic censers. Censers probably played a more prominent role in rituals carried out at the level of the household, or perhaps the corporate group housed by the apartment compound. The diachronic pattern suggests greater segregation of public and private ritual over time.

Changes in Neighbourhood Composition

Much of what I have to say in this section derives from simultaneously examining how cases were assigned to A-clusters and N-clusters. To reiterate ideas presented elsewhere, classifying cases according to ceramic assemblage characteristics clearly reveals patterns of spatial importance, but A-clusters are essentially aspatial in that they are defined in a way that makes no use of locational information. N-clusters differ from A-clusters because they incorporate a fundamentally spatial meaning—they are defined partly on the basis of patterns of spatial association among variously classified cases, and with the aim of delimiting spatial analytical units. Nevertheless, N-clusters build directly on A-clusters, and the two sets of classes are nested. Individual cases that were included in the two classification stages (i.e., those not eliminated on the basis of collection or neighbourhood size thresholds, or a lack of a corresponding record in the digital map file MF2) can be characterized both in terms of ceramic assemblage content and the composition of surrounding neighbourhoods; these are inherent in A-cluster and N-cluster memberships, respectively. Similarly, the larger spatial entities that emerged from classifying cases into N-clusters can be usefully described in terms of A-cluster content.

For both the Miccaotli and Tlamimilolpa phases, the majority of cases assigned to a given N-cluster are drawn from a single A-cluster, the other three represented by much smaller numbers. This is shown in Figure 6.23, which uses bar plots to describe the composition of N-clusters expressed in terms of A-cluster counts. For each N-cluster, one of the A-clusters is clearly dominant—even in the case of MC:ncls4/3, where this effect is the least pronounced, the count of A-cluster 3 members is more than twice that of the next-most-numerous A-cluster. This general pattern holds for the Tlamimilolpa phase as well, but in this later phase the domination of each N-cluster by one of the A-clusters is even greater (Figure 6.23b). The general form of the regional/spatial entities created by the definition of Tlamimilolpa N-clusters is quite similar to that which emerged for Miccaotli. However, during Tlamimilolpa, the neighbourhoods on which N-clusters are based are much less variable internally and much more clearly dominated by ceramic assemblages that are generally similar to one another and which were therefore assigned to the same A-cluster.

Not surprizingly, a temporal trajectory leading toward decreased variability within spatial units, described above in terms of the A-cluster composition of the whole set of cases assigned to each of the N-clusters, is also reflected in the internal composition of the overlapping

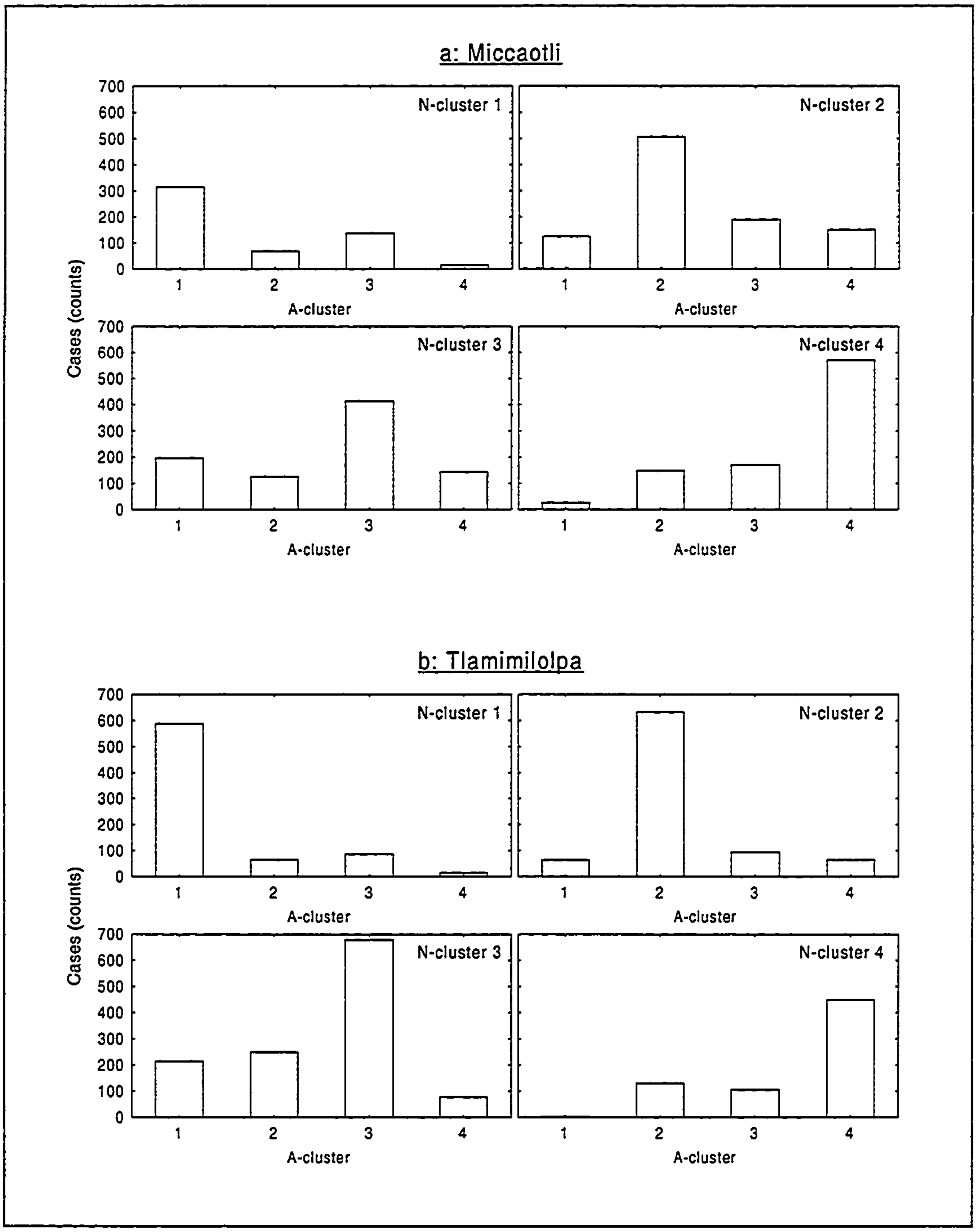

Figure 6.23: N-cluster composition, expressed in terms of A-cluster counts and broken down by phase (Miccaotli and Tlamimilolpa).

neighbourhoods that were used to define N-clusters. This can be seen in Figure 6.24, which uses box plots to show the distribution of A-cluster proportions within neighbourhoods defined on the basis of 130 m buffers, broken down by N-cluster and phase. The most dramatic contrast between Miccaotli and Tlamimilolpa is exhibited by neighbourhoods that encompass collection tracts assigned to N-cluster 1, mostly located in the ceremonial core of the city. In Miccaotli, the median proportion of A-cluster 1 cases within such neighbourhoods is around 0.5. This means that the central tendency for neighbourhoods located in the city core is to encompass a set of collection tracts of which roughly half belong to A-cluster 1—other types of collection tract are most likely to belong to A-cluster 3 and least likely to belong to A-cluster 4. In the Tlamimilolpa data, the median value for A-cluster 1 cases in the same general part of the city has shifted to slightly under 0.8—in other words, a much greater domination of city core neighbourhoods by households that I have argued were located toward the upper end of a wealth/status dimension. Very similar observations hold for the distribution of A-cluster proportions in N-cluster 2—parts of Teotihuacan that were already dominated by A-cluster 2 in Miccaotli are much more strikingly so in Tlamimilolpa. On the other hand, it is not obvious from Figure 6.24 that the same trend exists among the cases assigned to N-clusters 3 and 4, and the distribution of A-cluster proportions appears quite similar for both phases.

A more compact way to examine the issue of neighbourhood composition is by measuring the diversity of A-cluster memberships within individual neighbourhoods. Figure 6.25 shows the distribution of a specific measure of diversity, “evenness,” broken down according to the four N-clusters and by phase. In this particular case, the evenness statistic H/H_{max} (Kintigh 1989) is used to assess the uniformity with which the various A-clusters are represented within neighbourhoods. This measure ranges between 0.0 (where only one A-cluster is present) to 1.0 (where all four A-clusters are present and represented by the same number of cases); lower values

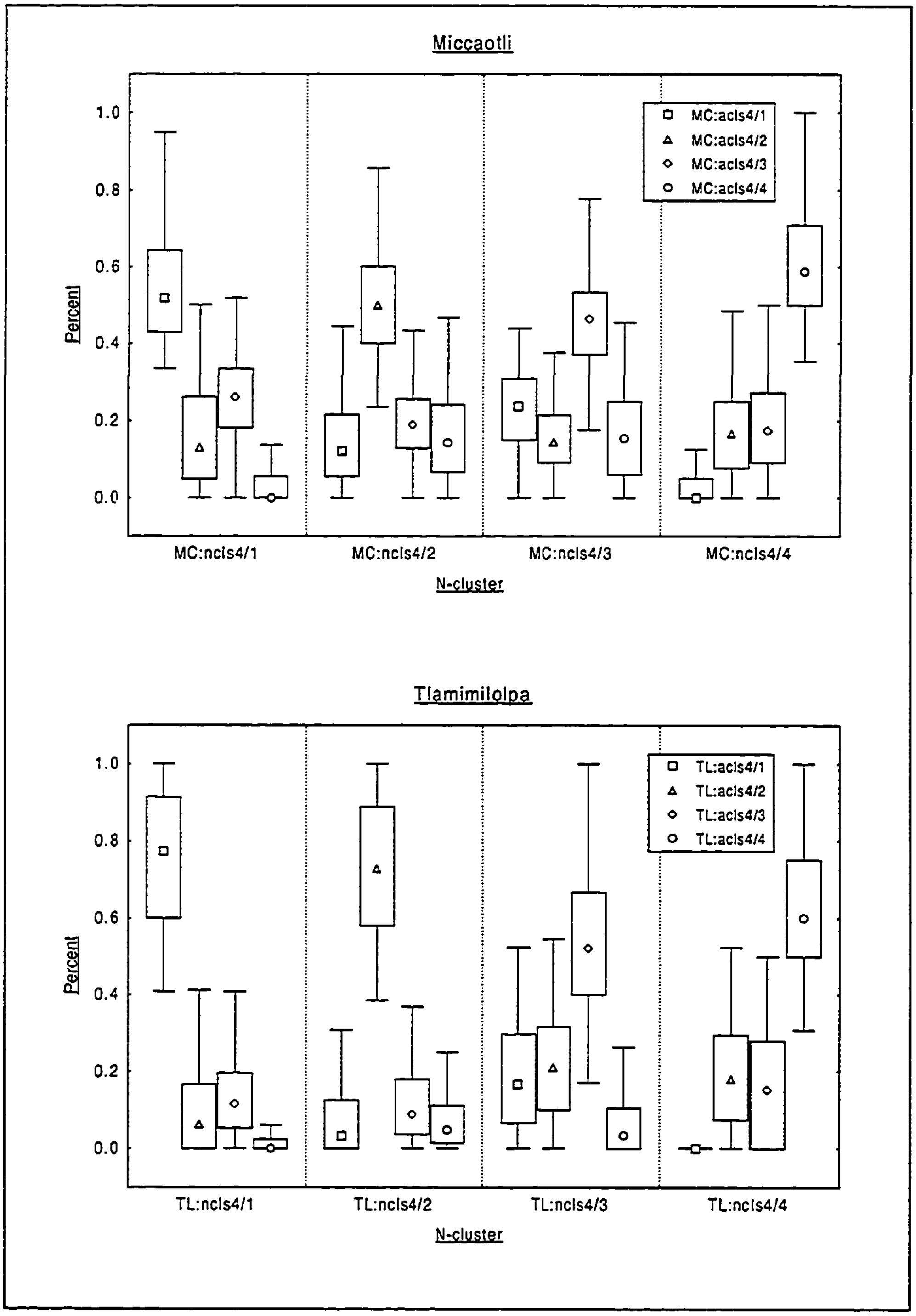

Figure 6.24: Composition of neighbourhoods used to define N-clusters, expressed in A-clusters (percent-standardized), broken down by N-cluster and phase. [Boxes encompass the midspread; symbols inside boxes indicate the median, while whiskers show the range of cases that fall within 1.5-times the midspread, above and below the limits of the box.]

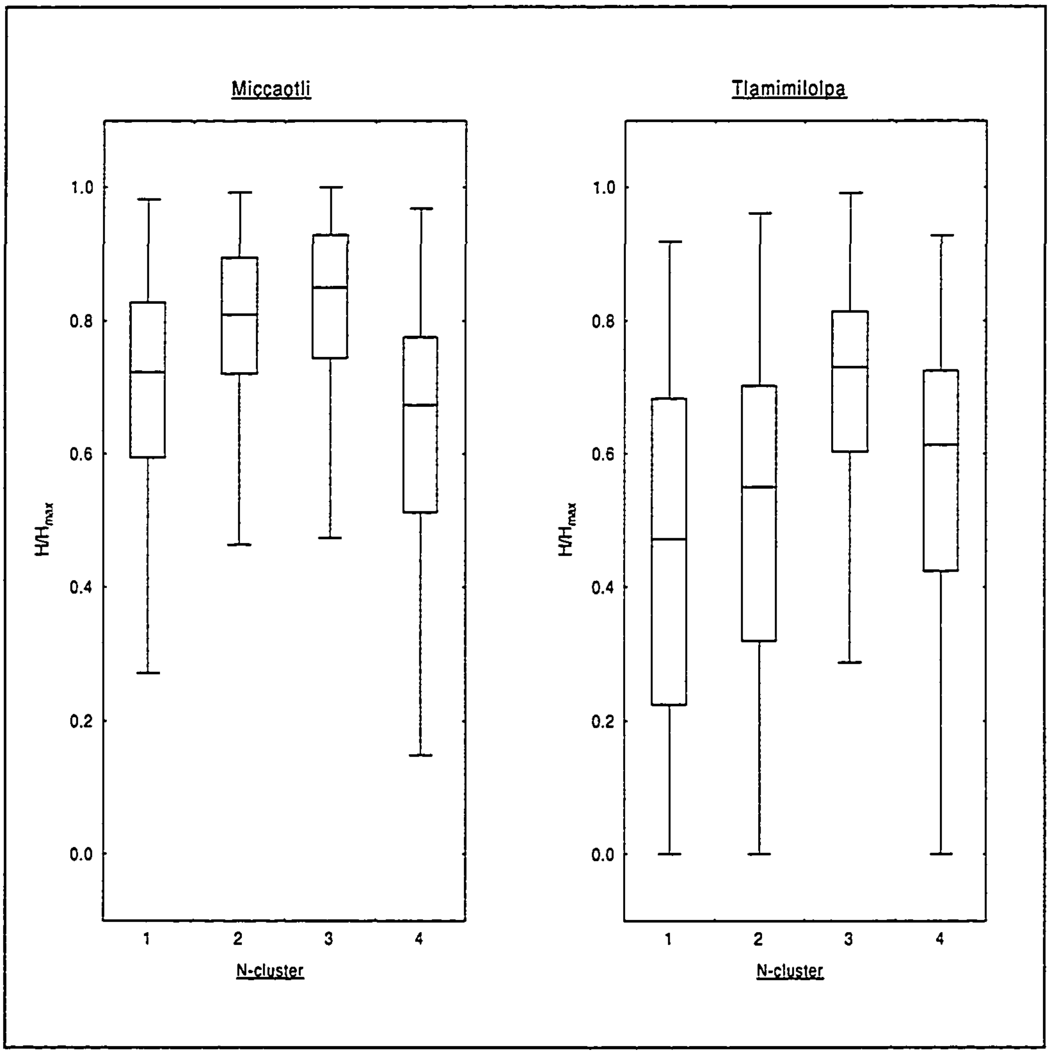

Figure 6.25: Internal diversity of neighbourhoods used to define N-clusters, measured by the 'evenness' statistic H/Hmax on the basis of counts of various A-clusters, and broken down by N-cluster and phase. [Boxes encompass the midspread; lines inside boxes indicate the median, while whiskers show the range of cases that fall within 1.5-times the midspread, above or below the limits of the box.]

indicate greater homogeneity of neighbourhoods, while higher values indicate greater heterogeneity. The distributions of H/H_{max} shown in Figure 6.25 corroborate observations that were made on the basis of the box plots in Figure 6.24—they make it clear, for example, that the central tendency for evenness is lower in Tlamimilolpa than in Miccaotli, particularly in neighbourhoods surrounding collection tracts assigned to N-clusters 1 and 2. They also suggest, however, that the same general diachronic trend holds for N-clusters 3 and 4, although in a much less pronounced fashion. The median value of H/H_{max} for N-cluster 4, for example, drops only slightly, from just under 0.8 in Miccaotli to slightly more than 0.7 in Tlamimilolpa. The downward shift in the distribution of H/H_{max} is somewhat greater for A-cluster 3. Overall, the downward shift in the evenness statistic measured across the two phases signals a general increase in neighbourhood homogeneity over time.

Social Areas – Formal Changes in N-cluster Concentrations

Just as pairs of A-clusters from Miccaotli and Tlamimilolpa can be identified on the basis of general similarities in spatial concentration and content, so too can pairs of similar Miccaotli and Tlamimilolpa N-clusters be identified and used as a basis for diachronic comparison. As with A-clusters, the naming conventions I have used to refer to N-clusters reflect these similarities, so that Miccaotli A-cluster 1 (MC:ncls4/1) is most similar to the Tlamimilolpa A-cluster 1 (TL:ncls4/1), and so on.

At perhaps the most general level of comparison, it is clear that the regional entities that emerge from classifying collection tracts according to Miccaotli N-clusters are somewhat less compact, more dispersed, and less clearly delimited than those associated with the Tlamimilolpa phase (compare Figure 6.11 and Figure 6.22). This is more obvious for some N-clusters than others, and the best example comes from comparing MC:ncls4/1 and TL:ncls4/1—the N-clusters that for both phases are most clearly associated with the civic-ceremonial core of Teotihuacan. In Miccaotli, even ignoring spatial 'outliers' that consist of only one or two more or less isolated cases, N-cluster 1 is made up of around five or six discrete, unconnected concentrations of cases (Figure 6.11a). In Tlamimilolpa (Figure 6.22a), N-cluster 1 appears to be composed of only two major groups, the largest mapping closely onto the Street of the Dead area. In Miccaotli, this latter area was divided into two discrete parts, separated by a 'gap' largely filled with N-cluster 2 cases. In Tlamimilolpa, these two spatial entities merge into a single, clearly delimited, tightly integrated unit, with both sides of the entire length of the Street of the Dead clearly dominated by a single A-cluster that is indicative of the activities of high-status residents. Interestingly, the Miccaotli 'gap' that was filled in during the Tlamimilolpa phase is centered around the Calle de los Muertos Complex, a large architectural macrocomplex that is thought to have been built largely during Tlamimilolpa. As I noted in Chapter Three, Cowgill argued that this area may have become the seat of administrative power in Teotihuacan at the same time (Cowgill 1983). This complex may have been built on land obtained—likely expropriated—by Teotihuacan's rulers from neighbourhoods mostly occupied by much less wealthy and powerful residents. Judging from the distribution of N-cluster 1 cases in Miccaotli, this zone, and perhaps in the vicinity of the Xalla compound (north of the Pyramid of the Sun, square N4E1), may have been the last parts of the Street of the Dead area not already firmly established as elite-dominated neighbourhoods. By Tlamimilolpa at least, both of these areas had clearly been integrated into the elite character of the Street of the Dead area.

Similar observations can made on the basis of comparisons between other N-cluster pairs from Miccaotli and Tlamimilolpa. Compared to MC:ncls4/4, for example, TL:ncls4/4 appears substantially less dispersed, consisting of something in the order of half as many, more or less discrete, concentrations. The same general trend appears to hold for the remaining two N-clusters, although the differences between phases are much less striking.

Finally, there is an ambiguous but noteworthy change involving the Tlajinga district, west of the Street of the Dead. This area was mostly assigned to N-cluster 4 in the Miccaotli phase analysis and almost entirely classified as N-cluster 3 in the Tlamimilolpa phase analysis. This means that, in the earlier phase, the neighbourhoods that make up this district were dominated by structures yielding ceramic assemblages that I have described as impoverished, dominated by ollas, and characteristic of the most peripheral parts of the city. By Tlamimilolpa, this area appears to have more in common with the spatially intermediate zones of the city that flank the Street of the Dead area. The fact that Tlajinga may have already become a center of ceramic craft production during the Tlamimilolpa phase makes it difficult to interpret this pattern. It is possible that, after the Miccaotli phase, the residents of this area were beginning to occupy a more moderate position on a wealth/status continuum, at least as measured by pottery consumption patterns. It is also possible, however, that patterns of ceramic consumption in the Tlajinga district were already swamped by production behaviour, as was clearly the case later in the city's history.

Notes for Chapter Six:

[1] The codes occasionally used to describe various cluster solutions are designed to facilitate comparison among cluster analyses and are composed of three fundamental parts. Taking "MC:acls4/1" as an example, the prefix "MC" refers to the phase to which the analysis pertains, in this case Miccaotli. The next part of the code ("acls") refers to an "A-cluster" (a product of assemblage classification work) while the last part of the code ("4/1") refers to cluster 1 from a 4-cluster solution. Similarly, "TL:ncls3/2" refers to cluster 2 of a 3 cluster solution, an "N-cluster" produced during the neighbourhood classification stage of the Tlamimilolpa analysis.

[2] Note that results from discriminant function analyses carried out on N-clusters are not reported here, either for the Miccaotli or Tlamimilolpa Phase analyses. In second stage analyses aimed at assemblage classification, discriminant functions provided important insights into the relatively complex relationship between A-clusters and ceramic input variables. Interpreting N-clusters in terms of input variables (i.e., A-cluster proportions) was straightforward, and discriminant analysis provided no new insights.

Chapter Seven

RESIDENTIAL VARIABILITY IN THE CAPITAL OF AN EARLY STATE: SUMMARY AND CONCLUSIONS

This chapter is organized around several themes and sections. The first offers a brief recapitulation of the analytical procedures that underlie this study and reviews its main conclusions. Subsequent sections relate these conclusions to broader issues concerning the nature of Teotihuacan history and society and discuss more general implications for early cities.

Methods and Procedures

This study of socio-spatial patterning in the ancient city of Teotihuacan is notable for its reliance on quantitative analytical procedures, some of which are innovative and not yet part of the standard archaeological toolkit. In the following section, I summarize in general terms the flow of the analyses that underlie this research, and then highlight what I regard as its most important methodological contributions.

Parallel analyses carried out on Miccaotli and Tlamimilolpa phase ceramic data were organized around three fundamental stages. In the first stage, ceramic collections from about 5,000 individual tracts mapped during a full-coverage survey of Teotihuacan were characterized in terms of the proportions of various kinds of pottery contained within them. Correlation analysis was employed as a means of screening ceramic categories for systematic phasing problems that would preclude their use in phase-specific analyses. An empirical Bayesian procedure was used to dampen deleterious effects of sampling error on estimates of ceramic category proportions within ceramic assemblages.

In the second stage of analysis, the artifact collection tracts from Teotihuacan were classified using cluster analysis, assigned to one of four groups on the basis of broad patterns of variation inherent in the ceramic proportion data. The groups that emerged from this stage of analysis (described as 'A-clusters') reveal patterns of association among pottery categories that relate to differences in the general categories of household activities—principally food storage and preparation, food service, and ritual—emphasized at the localities sampled by collection tracts. These activities, the kinds of pottery involved, and associated spatial patterns suggest that the A-clusters are related to broad differences in the wealth/status levels occupied by the individuals and households whose activities generated the discarded pottery.

In the third stage of analysis, patterns of spatial association among the different A-clusters were assessed using local density analysis. A series of overlapping analytical units was defined by creating 130 m 'buffers' around each of the original collection tract boundaries. These units were used to tally proportions of A-cluster types within neighbourhoods surrounding collection tracts, data which were then used to fuel a second classification stage based on cluster analysis. The four groups that emerged from the classification procedure (termed 'N-clusters') divide the city into a number of more or less distinct 'social areas.' Differences in the internal composition of these social areas (i.e., as expressed by A-cluster counts and proportions) allowed socio-economic variability within neighbourhoods to be compared and contrasted spatially, across social areas, and temporally, between phases of occupation. Among other things, a diachronic trend toward reduced social diversity within most social areas was documented, particularly in that most closely linked to the elite occupation of Teotihuacan, in and around the city's ceremonial core.

The basic goal of the first stage of analysis—characterizing collections according to proportions of different artifact types—is standard and unremarkable, a basic task that has served as the foundation of countless archaeological analyses. In this study, however, two methodological refinements were employed in an attempt to generate better descriptions of ceramic variability at this level. The first of these, the use of various measures of statistical correlation as a means of screening ceramic categories for potential phasing problems, proved to be very useful as 'red-flag' procedures that prevented me from incorporating categories into the phase-specific analyses that may not, in fact, have been reliably phased under TMP sorting procedures. Nevertheless, as discussed in Chapter Five, there is plenty of room here for methodological improvement. Experiments that I did calculating 'bootstrapped' confidence intervals for correlation coefficients were promising and should be pursued further; such confidence intervals will allow more meaningful comparisons to be made between a series of correlation coefficients derived from a given category and a number of phase totals. Equally promising were my experiments with Monte Carlo-based estimations of the effect of sampling error on the 'reliability' of sherd counts. The ability to quantify a measure of reliability for specific ceramic categories will allow partial corrections to be made for the effects of statistical attenuation, and this should also improve comparisons among correlation coefficients calculated in order to assess the possibility of systematic phasing errors. Statistical attenuation effects have been almost wholly neglected in the archaeological literature, so this will be an important methodological advance.

A second refinement imposed on the description of ceramic variability was the use of Bayesian statistical methods as a means of reducing the noise-effects of sampling error, thereby improving the estimates of ceramic category proportions within collections that formed the basis for subsequent stages of analysis. These methods, while no panacea for the 'small sample' problem, had a highly beneficial effect, particularly with regard to the information supplied to this study by 'intermediate-sized' samples. In fact, I feel that one of the reasons that strong, robust patterns were revealed by this work is the Bayesian pretreatment imposed on all input data. The use of spatially restricted information to generate more meaningful ‘local priors’ is a significant refinement of the general approach described in Robertson (1999). The general ideas that underlie the empirical Bayesian approach described both in Robertson (1999) and in the present study are quite simple mathematically, and, unlike many other Bayesian methods, could be widely and usefully employed by archaeologists. One application (Ortman 2000) inspired by the 1999 article has already appeared in the archaeological literature.

Another significant methodological and conceptual innovation was the use of buffers defined around the original collection tracts as an analytical tool for describing socio-spatial patterning at the level of the neighbourhood. The examination of social variability within neighbourhoods taps into a level of socio-spatial patterning that has important implications for understanding the day-to-day life of the ancient inhabitants of Teotihuacan. The social texture of urban neighbourhoods matters from a sociological perspective because it is the primary context through which most social actors experience their cities and interact with others. From a purely methodological perspective, however, extending the analysis to the level of the neighbourhood offered important practical advantages. Above all, the definition of N-clusters permitted a clear delineation of broad divisions within the city that proved both useful and meaningful, but were only vaguely suggested by the distribution of A-clusters. Spatial units reflected in spatially contiguous N-cluster assignments are significant features of the socio-spatial landscape of Teotihuacan and they form the empirical basis for many of the substantive conclusions of this study.

As was discussed in Chapter Five, using buffers around collection tracts in order to assemble data about neighbourhood composition was suggested to me by Kintigh’s (1990) observation that a by-product of local density analysis (i.e., a vector of artifact type densities within a set distance of each artifact) could be usefully employed as input data for analyses of artifact distribution patterns using unconstrained clustering. This is essentially the approach that was taken in this study, but at a higher scale of analysis; the distributional patterns of interest concerned ceramic sherd assemblages from collection tracts, rather than individual artifacts.

In addition to fueling neighbourhood-level cluster analysis, lattice-based local density analysis was also used to summarize site-wide patterns of association between A-clusters defined in the second stage of analysis. The results were highly informative about varying levels of association and segregation that existed between the various A-clusters, and were instrumental in interpreting locational aspects of both A-clusters and N-clusters. Particularly useful was the ability to compare directly results from what were essentially separate analyses carried out on Miccaotli and Tlamimilolpa data. This was made possible by the development of the standardized local density coefficient D. Converting relative measures of local density based on the coefficient C to the absolute measure D is a refinement that should become a standard option for describing output from local density analysis.

In a subsequent studies of this type it would probably be a good idea to augment a single site-wide local density analysis with a series of analyses carried out separately for sets of cases defined on the basis of N-cluster membership, thus stratifying the assessment of A-cluster association according to major spatial subdivisions. Associational patterns among the status levels represented by A-clusters may show meaningful variation across social areas. Assessing this possibility using stratified local density analyses has the potential to add significant detail to what was learned from the site-wide analysis.

Ceramic Consumption and Socio-spatial Patterns at Teotihuacan

The research methodology outlined above resulted in a rather detailed account of the spatial patterns generated by ceramic consumption practices in early Teotihuacan, especially as they relate to social-economic variability within the ancient city. Parallel analyses carried out for the

Miccaotli (ca. AD 150-200) and Tlamimilolpa (ca. AD 200-350) phases made it possible to identify features of the social landscape at Teotihuacan that were persistent over time, and which may therefore be regarded as characteristic of internal settlement patterns for this period. These can be contrasted with other features that varied diachronically. Perhaps not surprisingly, the aspects of settlement that appear to be stable and persistent are also fairly general ones; evidence for settlement features that changed over time emerge from more detailed results of the analysis.

On the basis of preliminary, unpublished evidence concerning the spatial distribution of mural paintings and variation in the quality of architectural construction, Cowgill (1992a:215-216) characterized Teotihuacan's neighbourhoods as relatively heterogenous, emphasizing that there was only a tendency for the proportion of high-status households to decrease away from the city core. Somewhat earlier, Millon (1976:220) expressed similar opinions, probably based largely on evidence obtained from the excavation of apartment compounds.

Although adding much more detail about the degree of social heterogeneity within Teotihuacan's neighbourhoods, particularly as it varied over time, the results of this study are in general accord with these earlier interpretations. Results of analyses described above show that, during both the Miccaotli and Tlamimilolpa phases, most neighbourhoods were relatively diverse in socio-economic terms, encompassing a mixture of the wealth/status levels measured in this study by different kinds of A-clusters. In fact, the vast majority of neighbourhoods contain representatives of three, and often, all four types of A-clusters. The conclusion that Teotihuacan's neighbourhoods were internally organized as relatively heterogenous entities during the Miccaotli and Tlamimilolpa phases also helps explain why Altschul's (1981) earlier studies of social districts in Teotihuacan largely failed to identify barrios that conformed to a model based on the idea of 'homogenous organizations' (see also Sload 1982:310).

Nevertheless, it is important not to imagine that Teotihuacan's neighbourhoods exhibited a random assortment of status levels, and one of the contributions of this study has been to provide much detail about specific patterns that underlay the intermingling of different socio-economic statuses within the city. During both the Miccaotli and Tlamimilolpa phases, most neighbourhoods in Teotihuacan were numerically dominated by households of relatively similar socio-economic status. In other words, local expressions of social diversity in the city were balanced by a clear tendency for the spatial self-association of households from similar status levels. In fact, in the majority of neighbourhoods, the total count of one of the A-clusters exceeds the total count for all three of the other A-clusters combined, and this is true for both the Miccaotli and Tlamimilolpa occupations.

The tendency for spatial self-association of wealth/status levels is reflected in the fact that each A-cluster tends to be more common in some parts of the city than in others. During both the Miccaotli and Tlamimilolpa phases, neighbourhoods composed of high proportions of wealthy and presumably high-status individuals were mostly located around the civic-ceremonial core area, along the sides of the Street of the Dead. Households from the opposite end of the socio-economic spectrum tended to concentrate near the periphery of Teotihuacan. Neighbourhoods dominated by intermediate wealth/status levels were most often located in parts of the city that were spatially intermediate as well.

These observations encapsulate the most general patterns revealed by this study and naturally invite questions as to the degree to which socio-spatial patterning at Teotihuacan fits with the classic models of urbanism discussed in Chapter Two. In brief, the shapes of the social areas that emerge from these analyses in the form of N-clusters do not conform very closely to either the zonal model of Burgess (1925) or the sectoral model of Hoyt (1939). This is particularly the case for the Miccaotli phase, which exhibits an irregular, almost haphazard, arrangement of N-clusters that is difficult to relate to any idealized geometric pattern. Nevertheless, as noted above, the Miccaotli N-cluster most closely associated with high-status residents does occupy much of Teotihuacan's core, while that most closely associated with low-status residents is mostly found elsewhere, including large parts of the city's periphery. This observation is at least reminiscent of a zonal pattern, although it reverses the classic formulation of Burgess (1925) in which high-status residential areas are located around the city's periphery. As was noted in Chapter Two, Burgess's description of the zonal pattern derives from industrial cities equipped with modern transportation technologies that facilitate movement between periphery and core. Tendencies toward zonal patterns are observed in many pre-industrial cities, in Mesoamerica and elsewhere, but with a reversal of the direction of trends in the socio-economic status of residential areas. An elite association with early city cores is quite typical.

Because the Tlamimilolpa N-clusters are much more consolidated than those of the Miccaotli phase, it is easier to assess possible levels of conformity to idealized settlement models. Arguably, some elements of both sectoral and zonal patterns are present. If so, a zonal pattern is more clearly expressed; the core, dominated by high-status occupants, is more or less encircled by a ring of neighbourhoods in which intermediate-status levels predominate. The N-cluster most associated with low-status residents is almost entirely found in parts of the city's periphery, again reversing Burgess's formulation of the zonal pattern. Sectoral elements are less clear, but may possibly be reflected in the way in which intermediate-status social areas extend along parts of the East Avenue and the Street of the Dead south of the Great Compound/Ciudadela area. The somewhat isolated "satellite" of neighbourhoods dominated by high-status households a short distance to the southwest of the Great Compound, in the La Ventilla district, could conceivably be attributed to a 'multiple-nuclei' model of urban development.

Nevertheless, these observations seem only moderately illuminating. Beyond a very general approximation of a zonal model, I think the social areas distilled from the Miccaotli and Tlamimilolpa phase ceramic data suggest a complex history of growth and settlement that is difficult to reduce to simple geometric models of uncertain explanatory value. The exploratory approach taken in this study, to some degree modelled after methods of factorial ecology, made it possible to describe contours and boundaries for the social areas of Teotihuacan in ways that were guided by empirical data and unconfined by arbitrary models.

It is interesting that a principal dimension of variability identified by the exploratory analysis of the Miccaotli and Tlamimilolpa phase ceramic data was related to variation in wealth/status levels. As noted in Chapter Two, socio-economic status is one of the dimensions of variability that frequently emerges from factorial ecologic studies of modern industrial cities, along with family composition, ethnicity, and mobility. We know that ethnicity was a determining factor of settlement in some parts of Teotihuacan, since at least two enclaves of ethnically distinct residents are known to have existed. The ceramic data available for this study (lacking counts of different kinds of 'foreign' sherds, for example) were unlikely to identify spatial or any other kinds of variability that could be convincingly related to ethnicity. Similarly, material correlates for 'family composition' and 'mobility' are unlikely to be readily identified in the kind of data available for this study, although both factors may have been significant in determining the nature of social areas at Teotihuacan.

Differential distribution of the various A-clusters defined in this study and the effect that this had on the form and location of N-clusters raises the question as to whether free-standing walls and other barriers to movement in Teotihuacan constrained social actions and higher level groups. As was described in Chapter Three, the TMP survey recorded the remains of a number of large, free-standing walls in Teotihuacan, particularly to the north and northwest of the Street of the

Dead area (Figure 3.3). None of these walls map convincingly onto any of the N-cluster boundaries defined for either the Miccaotli or Tlamimilolpa phases. While it is possible that these walls had no appreciable effect on the formation of social areas at Teotihuacan, it is more likely that they simply post-date the Tlamimilolpa phase occupation at Teotihuacan. I am unaware of any direct evidence regarding when these walls were constructed. It remains to be seen if they appear to have had a structuring effect on the Xolalpan or Metepec phase occupations.

Temporal Trends in Neighbourhood Composition

The most important diachronic pattern revealed in my analysis is the clear reduction in neighbourhood diversity over time. Compared to their Miccaotli predecessors, most Tlamimilolpa neighbourhoods were, in socio-economic terms, more homogenous entities exhibiting much stronger domination by specific components of the wealth/status continuum. This is particularly so in the Street of the Dead area. By the Tlamimilolpa phase, this zone was overwhelmingly dominated by ceramic assemblages assigned to A-cluster 1 and associated with households of high wealth. Less drastic changes in internal social diversity were exhibited by neighbourhoods dominated by intermediate-status households. Peripheral parts of the city showed the least change in this regard; neighbourhoods dominated by low-status households, mostly near the edge of the city, were only slightly less diverse in the Tlamimilolpa than in the Miccaotli phase.

Ongoing processes of socio-economic aggregation and segregation meant that social areas were becoming more consolidated in most areas, and the boundaries between them were becoming more sharply delimited. This was most evident around the geographic and symbolic core of the city. Compared to the previous phase, the Street of the Dead area during the Tlamimilolpa phase appears to exhibit much greater cohesion, and probably tighter social integration. The N-cluster boundary delimiting this zone maps closely onto architectural discontinuities clearly visible in architectural interpretations of the TMP map, and gaps that had existed in this area in the Miccaotli phase are no longer visible in the Tlamimilolpa phase.

Analytical procedures used to divide intermediate status households into two analytical categories, based on the composition of associated ceramic assemblages, highlight both temporal and spatial differences. Comparative evidence from the Miccaotli and Tlamimilolpa phases suggests that one of the two types of intermediate status household—that associated with high proportions of cooking vessels—was, over time, becoming more closely tied economically to high-status households and assuming greater amounts of the labour costs involved in preparing food consumed by elites. High-status households show a corresponding decline in the proportions of food preparation vessels. Interestingly, but perhaps paradoxically, the spatial connections between these two classes of household appear to have been weakening, with intermediate-status households characterized by high proportions of cooking vessels becoming more concentrated in neighbourhoods that largely ring the city core, an area increasingly dominated by the households and activities of elite residents of Teotihuacan. The change in economic ties between portions of Teotihuacan's elite and intermediate-status population was part of the larger trend toward increasingly homogeneous neighbourhoods throughout most of the city. It may also have been part of a general change in how social relations were structured in Teotihuacan, as will be discussed more fully below.

Teotihuacan in the Mesoamerican Urban Tradition

The main ways in which this investigation has contributed to previous understandings of life within the ancient neighbourhoods of Teotihuacan were touched on above. While providing a greater level of detail and implementing several new conceptual and methodological tools, this study fits nicely within a tradition of research that has examined the internal organization of Teotihuacan in a variety of mostly fine-grained ways (cf. Altschul 1981, 1987; Cowgill 1967, 1968, 1974, 1982; Cowgill et al. 1984; Gottscho [Sload] 1977; Robertson 1999; Sload 1982; Sload 1987). This kind of research has largely been possible because of the unusually extensive and intensive data recording methods implemented by the Teotihuacan Mapping Project. One of the difficulties in framing this study in a broader context of research into Mesoamerican urbanism is that few other urban centers in Mesoamerica have been subjected to the level of fieldwork needed to support very comparable kinds of interpretive analyses.

Two sites that have much in common with Teotihuacan in terms of fieldwork methodology are Monte Albán and Xochicalco. Archaeological survey carried out at Monte Albán in the 1970s under the direction of Richard Blanton shared the basic aims of the Teotihuacan Mapping Project, and field procedures were designed to record information that would be as compatible as possible with data collected at Teotihuacan (Blanton 1978:16-17). Mapping was essentially full-coverage, with relatively detailed field observations recorded for each of the roughly 2,000 terraces on which Monte Albán's residential structures were built. Sherd collections were recovered from about 1,700 terraces, and these have been tabulated using categories that capture important chronological and functional differences.

Similarly systematic field investigations were conducted at the site of Xochicalco by Kenneth Hirth, also during the 1970s (Hirth 2000a, 2000b). Like the TMP, the Xochicalco Mapping Project sought both to define the boundary of the Epiclassic urban center and to create a comprehensive inventory of existing architectural remains. Artifactual materials were recovered using several different sampling strategies, but most of the almost 1400 collections were recovered from tracts that, as at Teotihuacan and Monte Albán, were defined around prehispanic (and mostly very well preserved) architectural features (Hirth 2000a:56-58).

In the context of this particular discussion, the most interesting and relevant results from these two projects have to do with the internal divisions that have been identified at these sites—for Monte Albán during the IIIb phase and for Xochicalco throughout the Epiclassic (Blanton 1978:44-46; Hirth 2000a:234-243, see also Chapter Two). These divisions contrast with the social areas that I have documented for Teotihuacan both with regard to how they were identified and their probable meaning as socio-spatial units.

At both Monte Albán and Xochicalco, internal divisions were defined using architectural and/or topographic data and not on the basis of discontinuities or other patterns in artifactual remains. In the case of Monte Albán, where divisions were created by defining Thiessen polygons around prominent mound-group clusters, boundaries between divisions are essentially arbitrary. The divisions themselves remain largely hypothetical constructs, although auxiliary evidence for the veracity of some has been identified in distributional patterns of artifactual remains. At Xochicalco, division boundaries are mostly based on linear, man-made topographic features that divide and cross-cut terraces. In this sense, internal boundaries at Xochicalco can be regarded as less arbitrary than those at Monte Albán, but the spatial units that they define are no less hypothetical.

While recognizing a need for further testing and analysis, however, I suspect that the internal divisions that have been posited for both Monte Albán and Xochicalco do relate to a level of spatial organization that was important in these two cities. The probable size of these divisions, and the fact that they tend to isolate recurring architectural complexes with likely civic-ceremonial functions, suggests that they represent some form of urban ward. These wards might have been administrative units under the centralized control of urban administrators, but they might also have been much more autonomous organizations with interests that were not necessarily aligned with those of the state, or with each other.

Either way, it is reasonable to assume that they existed largely because of relatively high-level plans or policies, and in this regard they differ from the social areas that I have documented in this study for Teotihuacan. I discuss the social and historical processes that might have given rise to patterned variability in the neighbourhoods of Miccaotli and Tlamimilolpa phase Teotihuacan in another section of this chapter (below). Suffice it to state here that the social areas revealed by contiguous N-cluster assignments at Teotihuacan are mostly larger and probably more 'organic' spatial units. By describing them as organic I mean to suggest that they mostly grew out of relatively natural, ongoing processes, more social than political in nature, that resulted from large numbers of low-level and localized decisions about residential location. While it is possible, perhaps even likely, that urban administrators had an effect on how such decisions played out as action, the fairly irregular boundaries between social areas (particularly for the Miccaotli phase) suggests little in the way of top-down planning.

It is also important to emphasize that there is no incompatibility between the possibility that urban wards existed at Monte Albán and Xochicalco, and the identification of social areas, based on patterned variability in wealth/status differences, at Teotihuacan. These represent different levels of spatial organization that can be expected to coexist in the same settlements, often cross-cutting one another spatially, and likely to be identified in different kinds of material remains. It is significant that the present study, based on an analysis of surface ceramic remains, generated evidence of relatively low-level socio-spatial patterning, while investigations of patterns in the built environment of Monte Albán and Xochicalco suggest higher-level political entities that originate in more deliberate kinds of action.

It is quite likely that social areas analogous to those of Teotihuacan existed at Monte Albán and could be discovered if appropriate, artifact-based analyses were conducted. There are potential problems with the survey data available for Monte Albán, however, that might make it difficult to generate convincing evidence for internal socio-spatial patterning (see Blanton 1978:11, 16-17). While the presence and absence of a variety of artifact types on individual terraces was recorded, constraints of time and funding meant that only ceramic artifacts were collected by the Monte Albán survey, mostly in small numbers. Emphasis was placed on sherds with clear chronological meaning and frequently no collections were made when pottery observed on a terrace appeared to represent a single-phase occupation. The mean collection size was only about 35 sherds (compared to around 170 sherds at Teotihuacan). Somewhat more than half of the total collection is said to have provided no chronological information, so the published data must be based on an effective mean sample size of only around 15 to 20 sherds per terrace, with phase-specific assemblages even smaller. The effects of sampling error on estimates of type proportions in such small samples would probably be very large, and, if so, evidence for only the most robust behavioural patterns is likely to be discerned. This may be one of the reasons why relatively little of the type of exploratory analysis that Cowgill and colleagues have carried out for Teotihuacan, and that I have described here, has been reported for Monte Albán. Nevertheless, I know of no *a priori* way to assess the potential effects of sampling error on existing behavioural patterns, and the lack of larger artifact samples from Monte Albán does not mean that they contain no useful information. In fact, attempts at this kind of research might make a highly significant contribution to comparative studies of urbanism in Mesoamerica—perhaps allowing us to start to consider, for example, if neighbourhoods in other early, prototype cities were more or less diverse than those at Teotihuacan and if trajectories of urbanization also led toward more socially segregated internal divisions.

The field data collected from Xochicalco probably have the potential to make a similar contribution to our knowledge of socio-spatial variability in Mesoamerican urban centers. Analyses reported by Hirth and associates (Cyphers and Hirth 2000) focus on evaluating differences in the composition of ceramic assemblages collected from a variety of different kinds of contexts, such as elite vs. non-elite structures, and domestic vs. precinct areas. Although almost none of these comparisons reveal differences of very high statistical significance, it would be unfortunate if this discouraged a deeper exploration of these data, particularly with a view to characterizing patterns of socio-spatial variation. Even if a surprizing degree of homogeneity is granted to ceramic consumption practices at Xochicalco (Cyphers and Hirth 2000:133), it does not follow that the kinds of social areas that I have documented for Teotihuacan might not also exist in the datasets of the Xochicalco Mapping Project.

Early Settlement, Residential Mobility, and the Adoption of the Apartment Compound

The relative heterogeneity of neighbourhoods at Teotihuacan during the Miccaotli phase (and presumably earlier) could be reasonably explained in terms of a wide range of factors, some possibly having to do with the nature of the city's foundation and early rapid growth, and others with the nature of social relationships that existed among immigrant groups. As discussed elsewhere, early demographic growth at Teotihuacan appears to have been relatively rapid, but given its eventual size and the probable health-status of its residents (Storey 1992), high levels of immigration must have continued over a long span of time, including much of the period addressed by this study. As pointed out in Chapter Three, the earliest dense occupations at Teotihuacan were to the north and west of what was to become the city core. From quite early on, however—at least after massive, symbolically charged monuments began to be constructed there—the Street of the Dead area would have been a magnet for wealthy, high-status families, presumably including those of the city's rulers. Although aspects of the early city show evidence for centralized planning, we have no way of knowing if specific residential choices were controlled by administrators of the early state. At some level, attempts may well have been made to direct how building sites were allocated to at least some of the new residents. For example, pressure to occupy and/or avoid certain parts of the city conceivably may have been stratified by wealth levels—differentially directed at wealthier or poorer households, for example, or both. I reiterate, however, that the form of social areas, particularly for the Miccaotli phase, provides no clear empirical evidence for administrative planning of this kind. It is perhaps more likely that top-down pressure on residential choices was directed at incoming residents possessing particular ethnic and political affiliations. This is consistent, for example, with the presence of at least two fairly-well delimited ethnic enclaves at Teotihuacan. Regardless of the details of how residential choices were determined, evidence from the Miccaotli phase shows that the immediate Street of the Dead area was, by a relatively early time, largely dominated by elite members of Teotihuacan society. This may have been true during the Tzacualli phase as well.

As settlement continued throughout the early stages of occupation, the prestige that accrued from living in close proximity to the ceremonial core of the city would have increased, reinforced by its growing monumentality of the area and by the persistent ability of high-status households to reside there. However, wealthy, powerful families need not have been and do not appear to have been the exclusive residents of this part of the city. Poorer households—perhaps members of a lower-ranked portion of a lineage or other kin-based unit—likely accompanied more wealthy households in their initial occupation of the city core, remaining attached as retainers and living in close proximity in order to facilitate economic and social interaction. Kin-based relations have been cited in various cultural contexts as an explanation for social diversity within urban neighbourhoods [see Stone (1987:3-4) for a discussion of Islamic examples, and Perring (1991) for observations based on Roman cities]. Similar kin-based connections at Teotihuacan may underlie examples of spatial juxtaposition of households from quite different parts of the socio-economic spectrum.

This spatial pattern may have originated in a more characteristically 'rural' form of social relationship that was common in the smaller settlements that pervaded the Basin of Mexico prior to the growth of the primate urban center at Teotihuacan. In spite of the likelihood that kin-based, patron-client relationships persisted in early Teotihuacan, although becoming less common and less important over time, it is also probable that a number of relatively low-status households succeeded in occupying parts of the city core without elite sponsorship, at least for a while. These ideas are consistent both with the internal heterogeneity seen in the A-cluster composition of Miccaotli phase N-cluster 1 (MC:ncls4/1) and its discontinuous spatial association with the Street of the Dead area.

Although there could well have been some element of *nouveaux riches* in early Teotihuacan, most of the individuals with high levels of status, wealth, and power were probably those (and/or their descendants) who enjoyed similar levels of status, wealth, and power in the pre-Teotihuacan Basin of Mexico. These may have been the people targeted for early resettlement at Teotihuacan by early administrators—particularly if one of the reasons for the rapid growth of the city and its status as a primate center for the entire Teotihuacan Period was the desire to maintain control over potential political rivals. Similar scenarios have been suggested for Mayapan, for example, where families that amounted to elite hostages were prominent among the center's early residents (Hammond 2000:243; Roys 1962). Nevertheless, we cannot assume that all of the elite individuals residing in the Basin of Mexico, or their immediate and extended families, were included in the earliest waves of immigration to the city—in fact, those with the strongest political and resource bases in other parts of the basin might have been exactly those most reluctant to come to Teotihuacan, resisting for as long as possible whatever persuasions, coercions, and other measures brought about its phenomenal rate of growth.

As noted in Chapter Three, however, most of the residents of the Basin of Mexico did eventually migrate to Teotihuacan. As immigration continued, less and less land would have remained unclaimed near the most prestigious parts of the city core, and wealthy and powerful households that might otherwise have settled there would have been forced to occupy parts of the city away from its core, perhaps forming neighbourhoods that included households of significantly lower wealth or status levels. Not everyone, even wealthy, potential elites in the new city, would necessarily have wished to join those already living in proximity to the ceremonial core, however, even if building space was available. Issues of political competition may have made it prudent or even obligatory for some newcomers to settle in intermediate or peripheral parts of the city.

To summarize, the early phases of settlement of Teotihuacan (i.e., the period in which the city attained near-maximum spatial extent and levels of internal density) resulted in residential areas which were usually internally diverse but also numerically dominated by one part of the socio-economic continuum. A degree of top-down planning may have contributed to some part of this pattern, such as the concentration of wealthy households near the city core. Nevertheless, there is no reason to assume this, and it is likely that the composition of Teotihuacan's neighbourhoods and the form of its social areas emerged from a context of rapid immigration that may have been only partially controlled (or controllable) by city administrators. Most residential choices were likely made at low levels, emerging from preferences held by household leaders for specific residential locations and/or the socio-economic status of potential neighbours, played off against whatever building sites happened to remain available at a given point in time.

It is intriguing to consider a probable connection between two striking changes in the residential system at Teotihuacan that were associated with the Tlamimilolpa phase—i.e., a massive reorientation in housing style and a major shift in the internal composition of neighbourhoods. As discussed in Chapter Three, during the Tlamimilolpa phase residential structures previously in use began to be systematically replaced by new, highly distinctive, apartment compounds. The length of time over which the adoption of apartment compounds was carried out is not clear. What is clear is that this was a massive undertaking, one certainly sanctioned, and possibly to some extent sponsored, by the administrators of Teotihuacan. The changes in neighbourhood composition documented by this study occurred during the same general period of occupation, and it is entirely possible that these two processes are related to one another, although not necessarily through direct causality. Specifically, I suggest that the extensive razing of existing dwellings and their replacement with apartment compounds—with all of the disruption that this implies for existing settlement patterns—resulted in a phase of occupation characterized by markedly higher levels of residential mobility than could have existed previously.

By the Tlamimilolpa phase, many of Teotihuacan's households would have been living on residential sites that had been determined generations earlier, perhaps by ancestral families using different selection criteria or facing different pressures and circumstances. Such sites may have come to be regarded by their current residents as less than optimal in terms of location, or the composition of the surrounding neighbourhood. For such families, the wholesale move to apartment compounds may have provided new opportunities to try to bring residential locations more into line with current needs and preferences. Even if carried out across multiple generations, the adoption of apartment compounds must have seriously disrupted existing rhythms of social life. Dwellings were demolished, and former occupants may sometimes have had to vacate building sites to find at least temporary shelter elsewhere. As newly constructed apartment compounds became sufficiently habitable, households moved back in, but perhaps in some cases after recombining with other households to form new residential units. The level of confusion associated with demolition and construction work, and the shifting and reorganization of households would probably have made this a strategic time for household leaders seeking to claim more desirable residential locations. Not only might there have been greater opportunities for relatively congenial kinds of adjustments, but residential shifts that involved an element of expropriation would have attracted less attention and therefore have met with less resistance. As increasing numbers of households began to move, potential building sites would have been made available by the shuffling effect of relocating households. Heightened levels of residential mobility thus merged with locally perceived ideas about preferred residential sites to effect wide-spread change in existing socio-spatial patterns.

The main impetus for residential movement likely came from relatively high-status households wishing to live in greater proximity to the city core; movements by less wealthy and less powerful households would often have been reactive—and as suggested above, elements of coercion and expropriation may well have been involved. It also seems reasonable to assume that newcomers constructing new residential structures near the ceremonial core usually required a fairly high degree of approval from the elite households that already lived there—even though the families displaced by such movement may sometimes have been their own low-ranking kinsmen. In fact, considering the city as a whole, it would seem that elite residents of the Street of the Dead area would have been in the best position to influence the socio-economic composition of their own neighbourhoods. A desire on the part of such households to reduce the social diversity represented by their neighbours—and perhaps, to distance themselves from poor relatives—may have been an important factor in initiating the entire process of residential shuffling.

The adoption of apartment compounds is good evidence for a fundamental rethinking of the residential style of Teotihuacan, a change that may have been motivated in part by an ideology that placed high value on a social world that was compartmentalized and orderly. As noted elsewhere in this study, other realms of material culture at Teotihuacan—particularly mural paintings and certain features of architectural style—have been interpreted as expressing this same general concern. If the adoption of the apartment compound itself represents a conscious attempt to modify the social landscape at Teotihuacan, it is not difficult to imagine that a degree of concomitant residential relocation was tolerated, or even actively encouraged by central authorities. A state that could somehow compel and/or attract the regional population of the Basin of Mexico to move into a single urban center could certainly effect the levels of socio-spatial change that my study has documented. Given the general disruption associated with the adoption of apartment compounds, the locational shifts required to concentrate elites in the city core, and homogenize neighbourhoods in general, could have been carried out without causing a great deal of additional inconvenience to the households of those involved. Nevertheless, it would be a mistake to assume that the organized force of central authorities would have been required to bring about the changes in neighbourhood composition that I have documented in this study. As I have stressed elsewhere, cumulative decisions made at the level of individual residential units on the basis of local preferences account for these changes parsimoniously.

Neighourhoods, Social Interaction and Civic Integration

The places in which social interaction occurs affects the assessments that individuals make of available options and, ultimately, the decisions that translate into action. In this sense, all social processes are to at least some extent spatial processes. In dense urban centers, a high proportion of social interaction is relatively localized, taking place among individuals who reside relatively close to one another. The social constitution of neighbourhoods is therefore a matter of practical and theoretical importance, having implications both for the daily life of urban residents and for outside observers seeking to understand urban behaviour.

A significant proportion of social interaction that takes place within cities is unplanned and often accidental, built around chance encounters on the street or in the market. This does not mean, however, that this level of interaction is of little consequence in creating an urban structure. The social life of a city is fundamentally constructed around the intersection of paths, defined in both space and time, that residents move through on a routine, daily basis (Giddens 1984:112, 132-135). From these nodes of intersection emerge recurring social relationships that, along with patterns in the built environment (Penn and Dalton 1994), make social interaction more predictable, particularly among strangers, and reduce much of the chaos of living in a dense urban center. More concretely, the social constitution of neighbourhoods has a clear effect on the frequency with which face-to-face contact occurs among people of similar and/or different wealth/status levels. A neighbourhood that is entirely filled with one's social peers is perceived as offering quite different opportunities for social strategizing than one in which socio-economic variability is relatively even, or at the other extreme, dominated by households from the other end of the socio-economic scale. This is an important part of what lends cultural meaning—a sense of place—to the localities in which people live and engage one another.

I suggested in the previous section that the diachronic changes in neighbourhood composition that have been documented at Teotihuacan may have been tied to a reduction in the importance of kin-based relationships. If so, this had important and practical implications for how the ancient residents of Teotihuacan organized their day-to-day affairs. At a higher level, however, such changes must also have both modified the ideational meanings attached to different parts of Teotihuacan and strengthened the conceptual distinction between wealthy and poor residents of the city. In modern urban societies, spatial segregation is an important component of class differentiation; an increase in physical distance between members of different classes modifies the opportunities and constraints placed on individual and collective action. This helps to build and reproduce regionalized class cultures that become closely identified with different parts of an urban center. In the case of Tlamimilolpa phase Teotihuacan, archaeological evidence for heightened levels of socio-economic segregation and, importantly, a stronger association of wealthy individuals with the civic-ceremonial core, speaks to increasing reification of social distinctions that were probably already in place earlier. It is worth pointing out that rigid and often hereditary distinctions of class or estate had become a salient feature of a number of Postclassic societies (notably the Mixtec, Aztec and Maya—see Chase and Chase 1992) by the time of the Spanish Conquest. I am not suggesting that such a wide-spread characteristic of Mesoamerican society had its origin at Teotihuacan. The Postclassic emergence of such institutions in Central Mexico is, however, consistent with the trend toward reifying wealth/status differences that I am suggesting did occur at Teotihuacan.

Within the various social areas of Teotihuacan documented by this study, social integration was probably enhanced by these changes, although at the expense of the broader integration of Teotihuacan society. Increasing socio-economic homogenization within neighbourhoods meant that the interests of individuals residing close to one another were becoming more aligned with one another, but less aligned with those held by people living in different social areas. Obviously, any weakening of relationships between relatively wealthy and poor households based on ties of kinship would have contributed to this reduction in 'vertical' integration.

As suggested earlier, elite residents are the most likely to have triggered changes in neighbourhood composition at Teotihuacan by pressuring households of relatively lower status residing in and around the city core to relocate to more outlying areas at the time apartment compounds were adopted. Maintaining social distance between high-ranking individuals and social inferiors appears to have been important at Teotihuacan, reflected in distancing mechanisms that included the use of elaborate headdresses and clothing, and, the example *par* *excellence*, large nose pendants that at least in certain contexts hid much of the wearer's face from view. Presumably, Teotihuacan's elites would have welcomed the increase in physical distance between their households and those of lower wealth/status levels—particularly if, as I have suggested, they were nevertheless able to draw on the latter for labour and food.

The systemic cost, however, may have been the effective loss of important lines of city-level integration and an increase in social tension between wealthy and poor residents. Given the current lack of comparable studies for post-Tlamimilolpa phase Teotihuacan, it is difficult to do more than speculate about the long term effects of such changes. As noted in Chapter Three, mortuary data indicates that the gap between the wealthy and poor may have been widening over the Xolalpan and Metepec phases (Sempowski 1992); there is weak evidence for other kinds of internal instability and perhaps overall decline (Millon 1988a:142-149). Certainly the results of my investigation make sense as an early expression of the same general trajectory.

Reasons underlying the deliberate burning of the city core at the end of the Metepec phase and the collapse of Teotihuacan as a viable political entity are still unknown. Whether or not the city's own residents instigated this final phase of destruction may never be satisfactorily determined—and if they were responsible, they may well have had help from outsiders. If the changes that I have documented for the Miccaotli and Tlamimilolpa phases can be shown to continue into subsequent periods of occupation, it will be reasonable to regard the city core as having become increasingly distinct and disconnected from other parts of Teotihuacan. The final phase of destruction, focussed as it was on this particular part of the ancient city, may then be seen in a new light.

From: "Calum" <u38cg@abdn.ac.uk>
Newsgroups: rec.music.makers.bagpipe
Sent: Monday, December 10, 2001 7:54 AM
Subject: Re: Donald MacLeod Piobaireachd CD's

ronteague@aol.com (RonTeague) wrote in
news:20011207215618.12733.00001463@mb-cp.aol.com:

> John you dog, you beat me to it. Who is the publisher and who is
> stocking these besties. Cheers Ron Teague the extreamly cheesy
> piobaireachd player.

I believe they are being published by Lismor, though I may be wrong. They are available on the www.music(-?)scotland.com website - you have to search for 'donald macleod' to find them.

I will add my own thoughts on these CDs.

These recordings have been circulating for a number of years. I own fifteen cassettes of the recordings myself. They all follow the same basic system, of Donald singing the ground (sometimes just the first line, sometimes the whole urlar), then playing it over. For some tunes, that are commonly used for a first piobaireachd (eg Glengarry's Lament), he describes in detail embellishments like the crunluath and the a mach movements. For others he just plays through some of the more difficult to express areas and leaves it at that.

There is one point to note about these recordings. Donald assumes you have a score in front of you, and I assume he is normally working from the PS scores or Kilberry. He then procedes to make changes to these scores without citing traditional authority for these changes. Sometimes they are logical reflections of the way the tunes are commonly played (IIRC, he suggests that Lament for Donald Ban should be read in 6/8, as it is commonly played), in some, he makes changes that appear sensible, but do not appear in the written record (for example, he replaces the F doublings in the ground of the Desperate Battle with throws on F, which does sound better, but throws judges for a loop, in my experience), and sometimes he makes changes that seem to have no rhyme or reason to them (Again, in the Desperate Battle, instead of returning to the ground after the final a mach, he plays the doubling of Var II at an increased speed from its first play-through, without explanation).

These recordings are superb and of immense value, not just because of their scope but because they contain such a large number of modern piobaireachd. They are an invaluable resource for the isolated player, and a real opportunity to own the comprehensive legacy of one of the twentieth century's finest piobaireachd players.

Cheers,
Calum

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APPENDIX A

TEOTIHUACAN CERAMIC VARIABILITY

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This summary of Teotihuacan pottery supplements the briefer description in Chapter Four of the specific ceramic categories employed in this study. It provides a more detailed account of the TMP ceramic reanalysis categories pertaining to the Miccaotli and Tlamimilolpa phases, including information on their status in the current version of the electronic REANS database (see Chapter Four). Information on a number of categories pertaining to the Xolalpan and Metepec phases is also included.

In this section, familiarity with vocabulary presented in Chapter Four—*ware*, *form*, *mode*, *phase-variant*, and *category*—is assumed. The presentation is organized around the principal Teotihuacan Period wares and modes recognized in the TMP ceramic reanalysis typology, especially Burnished, Matte, San Martin Orange, Painted, and Polished Wares; where appropriate, subsections describe specific forms in more detail. In some cases, however, for the sake of clarity and logic, I have grouped categories in ways that deviate from the typological organization reflected in reanalysis tabulation sheets. All Appendix A tables are located at the end of the text summary.

Burnished Ware

A number of different types of vessel were finished simply by having their external surfaces rubbed by a hard or semi-hard object, such as a pebble, before they were completely dry. This removed the most prominent surface irregularities produced during manufacture and flattened and smoothed the surface. While burnishing tended to produce somewhat lustrous streaks, no great effort was made to create a very refined finish; linear gaps between burnish streaks are usually visible, and under TMP ceramic analysis procedures this is one of the attributes used to separate Burnished from Polished Ware (Hopkins 1996:162).

The categories included within Burnished Ware largely represent utilitarian food-preparation and storage tools. In the REANS file, six different forms are distinguished: ollas, red-rimmed ollas, jars, comales, basin/bowls, and cazuela/craters. Burnished Ware persists throughout the Teotihuacan Period but becomes relatively less common after the Tzacualli phase, with a concomitant increase in Polished Ware (Rattray 1981b:179).

Table A.1 summarizes basic information about the 22 Burnished Ware categories that pertain to the Miccaotli to Metepec phases. It is intended primarily as an indicator of how common a particular category is within individual collections, and within the TMP collections as a whole. For each category, the Valid N column indicates how many cases in the REANS database have non-missing data. Roughly 200 cases are excluded because they pertain to sites for which no collection could be taken, usually because they were excavated and restored before the TMP survey was carried out. Roughly 150 other cases are absent because relevant ceramic reanalysis tabulation sheets incorporate problems (lost, unrecorded, or possibly misidentified collections, errors in merging, etc.) that currently prevent them from being coded and integrated with the REANS database. For various reasons, data on specific categories are missing from some other cases. Sum indicates the total number of sherds of that type recorded in REANS. The next two columns show the mean and standard deviation of counts of each category within individual collections. The final two columns show the same statistics, calculated for the proportion of each category within individual collections; this proportion is count/total, where total is based on the sum of all prehispanic sherds. The same general format will be used for all of the other tables presented in Appendix A. Category names are occasionally abbreviated, as are all references to phase-variants, hopefully in obvious ways (i.e., Mic=Miccaotli, Tla=Tlamimilolpa); the codes used for fields in REANS (e.g. R453) are also provided.

Olla

Ollas are fairly large, general-purpose vessels with a globular body, a relatively open mouth and a somewhat restricted neck. Hand-made ceramic ollas are still in common use in modern Mexico and ubiquitous in archaeological deposits at Teotihuacan. Sherds, especially from the base of the vessel, frequently show evidence of exposure to fire, and ollas were likely used in prehispanic times for the same range of domestic tasks that they serve today, principally cooking beans and stewing other commonly consumed food stuffs. Other likely functions include the transportation and storage of water, pulque, and dry foods (Hopkins 1996:131).

The top and bottom halves of ollas were sometimes made separately using molds. Strap handles sometimes occur, but are uncommon. Olla dimensions vary widely. Rattray illustrates several examples (Rattray 1981b:Figs. 146, 196, 241) which range between about 50 and 75 cm in height, and 50 and 60 cm in width. Hopkins's examination of rim sherds from the Miccaotli to Metepec phases indicates a range of outside-rim diameters between about 15 and 50 cm, with phase-specific modes that vary between 20 and 30 cm (Hopkins 1996:525-554). Very large ollas were sometimes deliberately buried in the floors of apartment compounds with rims exposed at ground level (Rattray 1981b:234, 382) and were likely used to store and cool drinking water.

Ollas—both the form of the rim and the overall shape of the vessel—are regarded as being useful chronological indicators (Rattray 1981b:110, 237, 333).

Red-Rimmed Olla

This category was recognized at least as early as 1963 (George Cowgill, personal communication 2000), but it was not coded separately in DF8 and does not appear to have been distinguished in reanalysis sorting procedures until around 1977. Defined on the basis of often quite thin red paint on the lip or rim, red-rimmed ollas are thought by Rattray to appear during Late Tlamimilolpa, becoming more popular in Early Xolalpan (Rattray 1981b:235, 278-279).

Although a Tlamimilolpa phase-variant was sometimes recorded on reanalysis recording sheets, only Xolalpan and Metepec versions carry through to REANS. It is worth pointing out that the TMP policy of collecting only rim and feature sherds means that the distinction between red-rimmed and ordinary ollas is probably quite solid, although distinguishing the two categories on the basis of body sherds would often have been impossible.

Jar

Artifacts attributed to the burnished jar category are not very common (Table A.1). Recorded during the reanalysis project and carried over into REANS, burnished jars are treated only in passing in Rattray's manuscript, where they are described as being essentially small ollas that exhibit similar types of rim treatment (1981b:185). *Polished* jars, frequently mentioned in Rattray (1981b), were not recognized as a reanalysis category. Schematic line-drawings suggest that jars in general may differ from ollas in having flat bases and a sharp, well-defined eversion between the neck and body section (see Rattray 1981b:Figure 2B). Rattray's illustrations, however, are drawn largely from Polished and/or Painted Ware examples, and it is uncertain whether these observations apply to Burnished Ware jars.

Comal

Found only in Burnished Ware, comales are relatively thin, shallow griddles that on the basis of ethnographic analogy are thought to have been used to cook and reheat tortillas and toast other kinds of non-liquid foodstuffs. Throughout the Teotihuacan period, comales become thinner and flatter, and there is some suggestion that comal diameters may have decreased over time (cf. Rattray 1981b:187, 206, 280). While the upper surfaces of comal sherds are smooth, the bottom surfaces are roughened, perhaps deliberately to improve heat conduction. The thinnest part of the comal is at the center, which may sometimes be slightly depressed.

Compared to later times of occupation, comales were not very common during the Teotihuacan Period. Table A.1 suggests a possible Xolalpan peak both in raw numbers and as a proportion of individual collections. It has been argued that the adoption of comales by prehispanic populations of the Valley of Oaxaca at around 500 BC relates to shifts in time-budgeting of farming households (Blanton et al. 1993:75), in turn a response to increased demands on the part of leaders for agricultural surplus. At Teotihuacan, the relative scarcity of comales compared to other kinds of cooking vessels, such as ollas, suggests that food preparation activities continued to emphasize boiling and stewing, rather than toasting.

My phase affiliation work with correlation coefficients suggests that many of the comales attributed to Tlamimilolpa may actually have been made in the Miccaotli phase (see Chapter Five).

Basin/Bowl

The reanalysis "burnished basin/bowl" category receives little treatment in Rattray's manuscript (1981b), and what she does say is only in the context of describing Miccaotli and Tlamimilolpa-phase ceramics. "Miccaotli bowl" is briefly described as a poorly defined category consisting of "medium-sized" vessels with flared or rounded walls, flat bases, and simple direct rims. This suggests that they are morphologically fairly similar to basins; schematic line drawings included in Rattray (1981b:Fig. 2B) indicate that burnished bowls may also have been somewhat smaller, perhaps with more convex walls and a less angular juncture between the base and walls. Basins are large, shallow vessels with well-defined angles between flat bases and outsloping walls, direct rims, and are often equipped with three large, globular supports.

Rattray states that burnished basins are rare until Tlamimilolpa. Reanalysis procedures combined basins with burnished bowls, recognizing phase-variants for all phases between

Miccaotli and Metepec. About 86% of all examples were attributed to Tlamimilolpa, although correlation studies suggest that many or perhaps most of these were actually made in the Miccaotli phase.

Four basins attributed to Late Tlamimilolpa and illustrated by Rattray show outside-rim diameters that range between about 25 and 34 cm and heights that range between 6 and 11 cm (not including supports). Some show resist paint decoration (Rattray 1981b:236, Fig. 116, 117). Presumably, the basin/bowl category subsumes vessels that were used for a variety of purposes such as cooking, storage, and food service.

Cazuela/Crater

The "burnished cazuela/crater" category subsumes two similar kinds of open, bowl-shaped vessels with wide, flaring rims (Hopkins 1996:96, 528-532, 537-541). The cazuela is the earlier form. Hopkins (1996:537, 544) states that the burnished crater, which has more upright walls and a narrower rim, starts to replace the cazuela during the Tlamimilolpa phase and is in turn largely replaced in Xolalpan by craters made of San Martín Orange ware. A precipitous drop in REANS burnished cazuela/crater counts after Tlamimilolpa is in accord with this contention (Table A.1). Both are utilitarian vessels, probably used for domestic cooking and storage purposes. The outer rim diameter of these vessels varies between about 20 and 60 cm; Tlamimilolpa craters appear to show two modes at about 25 and 40 cm (Hopkins 1996:538), perhaps reflecting the existence of types that served different purposes.

San Martín Orange Ware

San Martín Orange is a ware characterized by a distinctive bright orange to tan-orange colour produced by a relatively high firing temperature (Sheehy 1992:688-697). The exterior surfaces of San Martín Orange sherds usually exhibit a finish produced by vertical or horizontal scraping, overlain by uneven, predominantly horizontal burnish. Thought to have been made mostly in the Xolalpan and Metepec phases, San Martín Orange vessels are found in three utilitarian forms: craters, amphorae and scraped basins. Craters and basins have roughly the same shape as their counterpart forms in Burnished Ware; the amphora is a more distinctive vessel that resembles an olla with a restricted mouth, a high neck, a somewhat pointed base, and three strap-handles arranged to facilitate transport using a tumpline.

Table A.2 shows that San Martín Orange craters are very common in the Xolalpan phase and nearly absent in Metepec. Cowgill (personal communication 1999), however, doubts whether this phasing is accurate. Amphorae appear never to have been very common (contra Manzanilla 1997:23), and scraped basins are rare.

Most of the San Martín Orange Ware vessels consumed at Teotihuacan were produced in a well delineated and somewhat peripheral part of the city south of the Barranca San Lorenzo, a district known today as Tlajinga (S3W1 and parts of adjacent squares). Some San Martín Orange also may have been produced in the Oztoyahualco district in the northwest part of the city and at more scattered locations elsewhere (Cowgill 1987:168; Krotser and Rattray 1980). The evidence for this is not very conclusive, however, and it is clear that the vast majority of San Martín Orange vessels were made in the Tlajinga district.

Painted Ware (Red and Red-on-Natural)

Various broad classes of pottery used during the Teotihuacan Period were decorated with paint before firing, although only two post-Tzacualli varieties of Painted Ware—termed Red and Red-on-Natural Ware—were regularly recorded by the ceramic reanalysis. Red Ware refers to vessels that have at least one surface entirely covered with red slip and is sometimes referred to as "monochrome red ware." Red-on-Natural (R/N) vessels exhibit significant amounts of unpainted surface area and are often described by Rattray (1981b) as "bichrome." Several of the categories that receive these types of surface decoration (various kinds of painted vases, jars, and bowls) are similar in form to certain Polished Ware categories, and they probably can be regarded as variants of each other. Similarly two other Painted Ware forms (basins and craters) share forms with categories that belong to Burnished Ware. There is some indication that Tlamimilolpa red and red-on-natural vessels may be more common in burials than in ordinary midden contexts (Rattray 1981b:115, 199), and they may therefore have been regarded as more valuable or significant than other types of pottery. The only vessel form that appears to be unique to Painted Ware is the so-called red-on-natural ridged dish, a shallow, plate-like form with a slightly raised encircling ridge on the external surface, running parallel to and well below the rim. Notably, the highly polished interior surface was the locus for painted decoration on ridged dishes, while exterior surfaces were left matte and unpainted (Rattray 1981b:354).

Rattray claims that Painted Ware, which was quite common and varied during the Tzacualli phase, all but disappears during Miccaotli and was resurrected during the Tlamimilolpa phase (Rattray 1981b:114-115, 198-199)—as a consequence, none of the REANS Painted Ware categories have phase-variants earlier than Tlamimilolpa. This opinion is not widely shared (George Cowgill and Mary Hopkins, personal communications 2000), however, and statistical work that I have done evaluating phase affiliations of REANS categories suggests that some of the Painted Ware (especially Xolalpan Red Ware categories) contain significant numbers of sherds that were actually used in earlier phases, not implausibly including Miccaotli.

Rattray says that the use of "specular red" (a paint variant containing specular hematite) becomes more common during Tlamimilolpa and Xolalpan (compared to the Tzacualli phase, presumably) and that monochrome red vessels are almost always decorated with brilliant, specular paints (Rattray 1981b:115). Tlamimilolpa and Xolalpan designs appear to be largely simple geometric patterns, often outlined by incising (Rattray 1981b:214, 255, 306, 353). The Metepec phase is characterized by a return to greater use of "thin" non-specular paints.

Decorative motifs described for the Metepec phase may be somewhat more elaborate than in earlier periods and include the *xicalcoliuhqui* step-fret, serpent eye, feathered serpent, and "Tlaloc" symbols (Rattray 1981b:401).

Matte Ware

Matte Ware includes a variety of ceramic categories for which vessel surfaces were smoothed but not burnished. A distinction can be made between Coarse and Fine Matte Ware, based partly on formal differences and partly on differences in the texture of the temper used to make the paste. Categories included in Fine Matte Ware are 'handled covers,' censer *adornos* (appliqué ornaments), and matte miniatures. Censers, three-prong burners, and fist-size, usually two-chambered censers known as *candeleros* belong to Coarse Matte Ware. While most of these ceramic objects appear to have functioned principally in a ritual context, handled covers and three-prong burners may also have served fairly utilitarian purposes. Only censers have recognized phase-variants in the REANS file (Table A.4).

Rattray (1981b:109) claims that vessel types belonging to both Coarse and Fine Matte Ware were made in the same workshops, many of which were located in the Oztoyahualco district; earlier workshops (pre-Xolalpan) were generally located in square N7W2, with later workshops tending to concentrate in squares N7W3 and N6W3. A workshop specializing in censer adorno production has been excavated in the northwest part of square N1E1, within a large walled enclosure attached to the north side of the Ciudadela (see "Censer Adorno" section, below).

Burner

The three-prong burner is an unusual kind of brazier that begins to be used at Teotihuacan during the Tlamimilolpa phase. They are low, flat-bottomed basins with three evenly-spaced "prongs" attached to the interior rim, slanting upward and inward over the interior of the vessel. The prongs are typically hollow with openings both at the top and the lower exterior surface, and, at least during the Metepec phase (Rattray in Berrin and Pasztory 1993:248), they were sometimes decorated with the molded heads of deities, humans or monkeys (Séjourné 1966a:Lám. 8). Burners appear to have been designed to support a cooking pot or griddle, although they seldom if ever show evidence of the wear that one would expect from this kind of use (George Cowgill, personal communication 2000). They probably also served as a kind of portable space heater; the ability to flexibly shift the location of heating and cooking facilities to different activity areas in a multiroom apartment compound with plastered floors would have made life more comfortable, without necessarily increasing fuel consumption. The climate of the Teotihuacan Valley makes indoor heating very desirable, especially in winter.

Although three-prong burners appear to exhibit changes in shape and proportion throughout the Teotihuacan period (Rattray 1981b:109), the ceramic reanalysis procedures did not attempt to divide the fragments collected in the TMP survey according to specific phase-variants.

Censer

Censers were used at Teotihuacan during rituals as a container for burning incense. The simplest censers are Matte Ware vessels shaped like a modern terra-cotta flower pot (i.e., a truncated cone with straight sides and a flat base). More complex censers were constructed by stacking two similar pots in an "hour-glass" form, one inverted to form a base for the other. The upper vessel often has a flanged rim, and variant rim forms are useful chronological markers. Distinctive lids were sometimes added, the most elaborate equipped with a clay "chimney" to which was attached an elaborate superstructure of clay panels and decorative "adornos," and often a mask depicting a human face. These "composite" (also "theater") censers may have been abstract representations of mortuary bundles inside stylized temples, and the incense burned within them, offerings to dead ancestors (Headrick 1995). They are sometimes found disassembled in association with human burials, especially involving important individuals (Rattray 1992; Sempowski and Spence 1994).

According to reanalysis procedures, the censer category refers specifically to the base, body, and lid portions of censers. The decorative elements added to composite censer lids and bodies were recorded under the censer adorno (R700) category, while chimney fragments were probably counted as "tubes" and mixed with a small number of unrelated artifacts such as flutes. The tube category was not included in REANS.

Burner/Censer

Because of similarities in general shape, finishing, and material, it is sometimes difficult to differentiate censer fragments from three-prong burner fragments. The composite category Burner/Censer records counts of ambiguous specimens.

Candelero

"Candeleros" are small, typically two-chambered, censers (Kolb 1988a) that were probably used in some form of personal ritual to burn very small quantities of incense, wax, and/or bark paper. The name used for these artifacts stems from their resemblance to modern candle holders. Two basic categories exist in the reanalysis: "common" candeleros are decorated by crescent-shaped punctate impressions and are usually fairly crude; "other" or "non-common" candeleros subsume all other varieties. The latter are usually more carefully finished, may be burnished or partially polished, and frequently show some kind of incised or modelled decorative work.

Candeleros are rare before Xolalpan, although they begin to appear in stratigraphic contexts pertaining to the Late Tlamimilolpa phase. The earliest examples are single chambered (Rattray 1981b:229-231).

Candelero counts are recorded on reanalysis tabulation forms with Tlamimilolpa, Xolalpan, and Metepec phase-variants; these data were not transferred to the REANS files because of doubts about the veracity of phasing criteria and because it seemed unlikely that they would improve on basic counts, available through DF8, of "common" and "non-common" candeleros (George Cowgill, personal communication 2000).

Censer Adorno

Conceptually related to the censer category (but made of Fine rather than Coarse Matte paste) are "adornos", decorative appliqué objects that were fastened to the more elaborate censers. These largely mold-made artifacts exhibit a wide variety of forms and motifs. Some are naturalistic shapes that can be readily identified, such as shells, butterflies, birds, and parts of plants. Others are more cryptic, sometimes reproducing symbols also seen in painted murals, and/or decorated ceramic vessels, some of which may have been elements in a poorly understood notational system (Langley 1992).

A specialized workshop for the manufacture of censer adornos was discovered by the Proyecto Arqueológico Teotihuacan 1980-82, just outside of the Ciudadela (in 2C and 2D:N1E1). Its period of use appears to span the Late Tlamimilolpa to Metepec phases (Langley 1992; Múnera Bermúdez 1985). While the location of this workshop suggests that the manufacture of censer adornos was sometimes subject to the control of high-level authorities, they may also have been made in other locations and outside of such controls.

Censer adornos were not identified very often in the TMP collections—the REANS total for the category is less than 1000. Nevertheless, two areas in the city show notable concentrations: Oztoyahualco (where censers are also very abundant), and square N1E5. These artifacts appear to be more common in collections from areas somewhat to either side of the Street of the Dead, rather than directly on the Street of the Dead itself.

While REANS procedures distinguished censer adornos from what I am calling "form" adornos (adornos attached to ceramic vessels, particularly cylinder tripods [below]) it is possible that the two categories were sometimes confused during the reanalysis; the censer adorno counts may occasionally include "form" adorno counts, and vice versa (Mary Hopkins, personal communication 1998).

Miniature

As noted above, ceramic vessels classified as "miniatures" are made of Fine Matte Ware. These artifacts mimic the form of larger vessels, especially utilitarian pots such as ollas, and are sometimes about the size of a human fist but often much smaller (Rattray 1981b:Figures 58, 144-145). Miniatures are frequently found in burials (Rattray 1981b:108); their association with adult interments suggests they are probably not toys and had a primarily ritual function. Criteria for determining the phase affiliation of miniatures have not yet been identified, at least for periods prior to Late Tlamimilolpa (Rattray 1981b:108), and they were recorded in the reanalysis as a single category without phase-variants.

Handled Cover

Handled covers, or "tapaplatos," are somewhat enigmatic vessels for which an unambiguous function has not yet been demonstrated. Their form resembles a shallow plate, with three loop supports or handles symmetrically arranged on the convex surface. Some have shallow mold-impressed designs on the convex surface. Occasional signs of burning on one or both surfaces indicate that they must sometimes have been used around fire, perhaps to cook or heat food, although not implausibly as part of ritual activity, including incense burning. The loops often show wear or abrasion facets that suggest a partial role as a conventional support, but handled covers may also have been inverted and the loops used to fasten them over the mouth of some other, perhaps non-ceramic, kind of container. Cowgill et al. (1984:168) have raised the possibility that this vessel may often have been used to cover freshly prepared foods being transported in some other kind of container for consumption in another location; handled covers may then have been used to facilitate reheating and serving. As noted above, however, some evidence suggests that they were used also or instead as censers. Relatively high proportions of handled covers often characterize high-status residential structures. Expressed as a proportion of total Xolalpan-Metepec counts within individual collections, handled covers are particularly common in the northern Street of the Dead area and in the vicinity of the Ciudadela and the Great Compound (Cowgill et al. 1984:179, Fig. 6).

Handled covers have been found in excavations at least as early as Early Tlamimilolpa (Cowgill and Cabrera 1991:41), but become more common later (Rattray 1981b:233). Statistical analyses consistently suggest a strong peak in the Metepec phase (Cowgill 1996). Handled covers probably coexisted to some extent with a version, more common in earlier phases, that lacked the loop additions. It is probable that both types of covers were combined in the reanalysis "handled cover" category, which has no phase-variants. There is no separate category under reanalysis procedures for ordinary, handle-less covers, which can only be recognized from relatively large fragments.

Polished Ware

On the reanalysis tabulation forms, the headings "Special Ware or Finish" and "Forms" were used to designate two somewhat diverse sets of categories, some characterized by unusually careful or elaborate forms of surface finish. Several categories from both sets belong to Rattray's "Polished Ware," a term which is adopted here. Table A.5 provides summary statistics for these categories, which include outcurving bowls, polished bowls, polished vases, form adornos, lids, floreros, and Tlaloc vessels.

Outcurving Bowl

As both Table A.5 and Rattray's assessment of TMP test excavation results (Rattray 1981b:111-112, 280, 336) indicate, outcurving bowls are the most common Polished Ware category for all phases from Miccaotli to Metepec. The basic shape of these vessels in profile is that of a truncated cone that exhibits a sharp angle between a flat base and outcurving walls, direct or somewhat everted rims, and often (especially in earlier phases) nubbin-shaped tripod supports. Like vessels assigned to the more general category of Polished Bowl, outcurving bowls were probably used for a wide variety of purposes, but probably most typically as food containers and service vessels.

Polished Bowl

The Polished Bowl category includes various forms, most or all of which were probably small to medium-size food containers and service vessels. Rattray illustrates the basic concept of bowl ("unrestricted vessel with height approximately one-half or equal the diameter") with various shapes that include bowls with upright and rather straight walls, hemispherical forms, and bowls with various kinds of outflaring and outcurving walls (Rattray 1981b:99, Figure 2B). It appears that the difference between outflaring and outcurving walls may sometimes be subtle, and both variants are likely often subsumed by the Outcurving Bowl category of the ceramic reanalysis; other bowl forms were probably recorded as Polished Bowls. This category probably also includes polished, low-wall plates that are characteristic of the Miccaotli phase (Rattray 1981b:190).

Miccaotli polished bowls sometimes had carefully fluted external walls, a type of decoration also exhibited by some of the floreros made in the same period (Rattray 1981b:190, Fig. 61).

"Simple bowls" from Late Tlamimilolpa are said to be well polished on the interiors, with exteriors showing significantly less care in finishing (Rattray 1981b:243). Metepec examples are said often to lack uniformity and attention to careful finish. They are usually decorated by pattern polish, and gouge and groove incising (Rattray 1981b:391).

Polished Vase

The full range of formal variation subsumed by the Polished Vase category, or the degree to which it might have overlapped with other categories, is not entirely clear. Rattray's description of basic vessel forms at Teotihuacan characterizes the vase as a "cylindrical, flared or curved wall unrestricted vessel with height greater than diameter" (Rattray 1981b:100). Vertical rather than horizontal polishing streaks on the exterior are regarded as an excellent criterion for distinguishing vase sherds from bowl sherds, and this was the criterion used by the lab technicians who carried out much of the ceramic reanalyses, Pedro Baños and Ceferino Ortega (George Cowgill, personal communication 1999).

Vases range widely in terms of elaboration and quality. At the top end of the scale are "direct-rim cylinder tripods," vessels which have come to be regarded as one of the hallmarks of Teotihuacan culture (Rattray 1981b:260-261). These are finely made and often highly decorated vessels with solid or hollow rectangular or hollow rounded supports (e.g., Berrin and Pasztory 1993:cat. nos. 123, 131-135). The surface decoration of cylinder tripods is quite variable, and not all, strictly speaking, belong to Polished Ware. Painted examples were presumably tabulated under the appropriate Painted Ware category; vase fragments exhibiting design elements in plano-relief should certainly have generated counts in the Plano-Relief category and may routinely have been counted under the Polished Vase categories as well. Cylinder tripods were often decorated with clay appliqué elements that were recorded in the reanalysis under the "Form Adorno" category.

Reanalysis procedures did not distinguish cylinder tripod vases from a much plainer and generally earlier type of vase that usually has nubbin supports, sometimes somewhat flaring walls, and often an everted rim (e.g., Berrin and Pasztory 1993:cat. no. 111). These two forms are mixed in Polished Ware and probably in Painted Ware categories. Such vases were probably used for a range of purposes, especially before the introduction of cylinder tripod vases. On the other hand, cylinder tripods (primarily a Late Tlamimilolpa to Metepec phenomenon) were probably most often used in rituals and, especially late in the Teotihuacan Period, are strongly associated with burials (Rattray 1981b:113, 114, 244).

Form Adorno

The "Form Adorno" category presumably records counts of the various kinds of clay appliqué elements that were used to decorate high-quality ceramic vessels and their lids. These were particularly common on cylinder tripods, where numbers of mold-made heads of monkeys and various deities were sometimes attached in a concentric row just above the base of the vessel. Less elaborate, and probably more common, examples are small discs of impressed clay that resemble coffee beans, and were attached in much the same manner as other forms.

As has already been noted, "form adornos" are theoretically distinct from Matte Ware "censer adornos" (above) although they may have sometimes been mixed during analysis.

Lid

The reanalysis "lid" category pertains to a distinctive and often elaborate type of cover mostly used with cylinder tripod vases and not to other forms such as handled covers and censer lids. Such covers are sometimes called "apron lids" because of the way in which they overlap the exterior surface of the vase rim. Handles consist of a knob or modelled effigy at the center of the lid top. Some lids have appliqué decorations similar to those found on the vases they were paired with. Vase lids frequently exhibit incised and plano-relief decoration.

Florero

The "Florero" is a rare category in the reanalysis, with Miccaotli to Xolalpan phase-variants recorded in REANS. The vessel form (very rare outside Teotihuacan) is that of a small, elegant jar with a globular body, a long cylindrical constricted neck, and a strongly everted, broad rim. The most distinctive forms are Miccaotli and show highly polished black or brown surfaces, frequently with fluted body walls (Rattray 1981b:191). Floreros likely had an important ritual meaning to the Teotihuacanos and are sometimes found in burials (Rattray 1981b:288).

Tlaloc Vessel

The Tlaloc vessel is a fascinating type of ritual artifact, a jar with modelled and appliqué facial and body elements that identify it with the Teotihuacan Storm God. Trilobed tabs often extend above the rim. These are suggestive of hills or mountains, and may be a reference to a sacred mountain immediately north of the city, today known as Cerro Gordo. Similar, and probably conceptually related vessels were used by contemporary Maya peoples, as well as the more recent Aztecs of Central Mexico. Their primary role was clearly in the symbolic realm, and they may have been used in rituals for invoking rainfall. They were rarely found in the TMP stratigraphic test excavations and were more commonly recovered from burials (Rattray 1981b:111). It is one of the rarest of the reanalysis categories (Table A.5).

The Tlaloc Vessel category has no phase-variants in the reanalysis, but examples may go back to Tzacualli (Rattray 1981b:169). Work in progress by Sonia Bracamontes has identified variants with probable chronological significance (Bracamontes and Plunket 2001).

Dense Ware

Dense Ware consists mostly of small, well-fashioned bowls made of a usually distinctive, compact paste with little or no temper (Rattray 1981b:194-5, 216-7, 251-2). Although the Dense Ware category in the reanalysis is not broken down by phase, Rattray cites stratigraphic data from an excavation in the Oztoyahualco area (Millon and Bennyhoff 1961) that suggests that vessels of this type began to be made in the Tzacualli phase and increased in popularity through Miccaotli and Tlamimilolpa (Rattray 1981b:119-120); there is no mention of Dense Ware in descriptions of post-Tlamimilolpa ceramic inventories. My attempts to assess the phase-affiliation of Dense Ware counts in the REANS files using correlation coefficients produced results quite consistent with Rattray's assertions: a peak affiliation with Tlamimilolpa, and a secondary affiliation with Miccaotli. By Late Tlamimilolpa, Dense Ware bowls are said to be less distinctive and to "overlap" with Polished Ware bowls (Rattray 1981b:251), and it is possible that reanalysis sorting procedures sometimes mixed the Dense Ware with other categories.

Copa Ware

Copa Ware is a potentially confusing designation that includes a small number of rather fine types of vessel made of a compact, fine-grained paste. A highly distinctive, cream pitcher-shaped vessel known as a *copa* lends its name to this ware, but cylinder tripod vases are also made of it. Although Manzanilla et al. (1991) say that Copa Ware is imported, neutron activation analyses indicate that the clay used in Copa Ware probably derives from local sources (Cowgill and Neff 2000). At least one workshop engaged in the manufacture of these vessels may have been identified within the city at the excavated apartment compound known as Teopancaxco, in square S2E2 (Krotser 1987:419-421, 425; Rattray 1981b:118). Rattray (1981b:119) suggests that Copa Ware was primarily used in ceremonial contexts, noting that it commonly occurs in burials.

Copa Ware is a good indicator of post-Tlamimilolpa occupation (Rattray 1981b:118, 296), and the phase-specific categories in REANS pertain to the Xolalpan and Metepec phases only. Neither are broken down by vessel form and presumably they combine counts for both *copas* proper, and vases/cylinder tripods. It is not clear that sherds from the latter types of vessel were cross-counted in the vase category, but it is likely that this was done at least occasionally.

Imported Ware

It has been known since at least the 1930s that at least some "foreign" pottery existed at Teotihuacan (cf. Linné 1934:95-103). One of the most fascinating outcomes of the TMP field work was to amass detailed and systematic information showing that significant quantities of pottery used in the city were made in other regions of Mesoamerica. Identified source areas include Puebla, Oaxaca, the Gulf Lowlands, the Maya area, and perhaps Guerrero. The relative amounts of pottery attributed to these areas varies widely, as does their distribution within the city. In spite of importation costs, some types were distributed widely and can be regarded as part of main-stream ceramic consumption practices. Other types were used in more restricted ways, in some cases, apparently, as part of boundary maintenance strategies engaged in by people holding foreign ethnic identities.

Regular Thin Orange Ware

The best known of the ceramic imports is Thin Orange Ware, a rather fine pottery made of compositionally distinctive paste typically fired at relatively high temperatures. Although conceptually linked to Teotihuacan culture and often regarded as a Teotihuacan export ware (which it may often have been), Thin Orange Ware was actually made in workshops about 150 km to the southeast of the city, in the Tepexi de Rodríguez area of southern Puebla (Rattray 1990b).

In spite of being an import, Thin Orange Ware occurs at Teotihuacan in abundance and in a wide variety of forms (Cowgill et al. 1984:160-165; Rattray 1981a). It appears in tiny amounts as early as the Patlachique phase and persists, at least to some degree, somewhat after the end of the Teotihuacan Period. It is most strongly associated with the Miccaotli to Metepec phases, and is only abundant after Early Tlamimilolpa (Kolb 1986:160-162). Thin Orange probably reached maximum consumption levels during the Xolalpan or Metepec phases. During these phases, the demand may sometimes have exceeded the capacity of the production and/or transport systems that brought Thin Orange into the Basin of Mexico, and copies of certain Thin Orange Ware forms were sometimes made at Teotihuacan using local clays (Millon 1988a:142). After the Metepec phase, Thin Orange ware became very rare and was confined to only a few different forms (Kolb 1986:162).

In the reanalysis, different subwares of Thin Orange were distinguished. Regular Thin Orange, by far the most numerous (Table A.8), is broken down into a number of categories based on shape differences: Hemispherical Bowls made of Regular Thin Orange, the most common form, are medium-size bowls with a hemispherical profile, somewhat thin walls, direct rims, and annular supports ("ring bases"). These vessels were probably used both for food preparation and service. Everted Bowls are much less common. Vessels counted under this category differ from hemispherical bowls in having outcurving walls and everted rims. Some may have nubbin supports (Kolb 1973:Figure 11d), but most lack supports or have annular supports. They vary considerably in size (George Cowgill, personal communication 1998). Both Vase and Jar forms were recognized, as were Regular Thin Orange Miniatures. The Regular Thin Orange Vase category is likely to have included mostly counts of cylinder tripod vases, a form sometimes made of Thin Orange.

Three decorative mode categories were created in the reanalysis specifically for Regular Thin Orange. These categories record sherds decorated by incision, punctate decorations, and impressions formed by molds. Counts in these categories are usually bracketed.

All of the Regular Thin Orange categories described above were included in the REANS database. Other observations made on the reanalysis tabulation forms and on the "specials" file cards pertaining to the ware (Regular Thin Orange adornos, nubbins, slab-supports and lids) were not. I have created an auxiliary database (not yet integrated with REANS) that records this information but have not used it in this study.

Thick Thin Orange and Coarse Thin Orange Ware

The reanalysis includes two other categories related to Regular Thin Ware and made in the same region of Puebla. Thick Thin Orange Ware, as the name suggests, simply contains counts of unusually thick examples of Thin Orange—a thickness of 1 cm is described as the lower threshold for this category in Rattray's discussion of Thin Orange materials in Puebla (Rattray 1990b:191), and a similar cut-off may have been used in the ceramic reanalysis.

Coarse Thin Orange paste has a coarser texture than Regular Thin Orange and was mostly used to make amphorae. Lackey (1986) has suggested that these vessels were used to transport a liquid, possibly pine resin, into Teotihuacan.

While neither the Thick Thin Orange nor the Coarse Thin Orange categories have explicitly recognized phase-variants in REANS, ideas about phase affiliations have inadvertently injected a degree of uncertainty into the relative counts of these two categories. For much of the ceramic reanalysis, Thick Thin Orange (TTO) was regarded by convention as pertaining to the Xolalpan phase, and Coarse Thin Orange (CTO) to the Metepec phase. I suspect that counts for these categories were sometimes mixed because of specific rules followed during certain years of the reanalysis and while data were transferred from reanalysis tabulation sheets to the coding forms used in computer entry. Thick and Coarse Thin Orange share the same row on the tabulation forms, the original intention being that counts could be attributed to the correct category on the basis of their relative height in the row—counts written toward the top of the row were TTO, those written near the bottom were CTO. On many, probably most, tabulation sheets, count figures are written in the middle of the row; this was presumably done while the

TTO=Xolalpan/CTO=Metepec convention was being adhered to; if so, the column containing the count (Xolalpan or Metepec) would make it clear which of the two categories was intended. This over-simplifies the phase affiliations of these two categories, however; excavations show that some CTO is earlier, for example (George Cowgill, personal communication 2001), and the convention was not always followed. Especially in 1977 and 1978, analysts appear to have attempted to deliberately record counts of occasional Xolalpan CTO sherds and/or Metepec TTO sherds, and this led to some inconsistency in the way in which counts were recorded on the coding forms. A count written near the top of the TTO/CTO row in the Metepec column, for example, might be coded as CTO (following the phasing convention) or as TTO (following the height-in-row convention). Some of this sort of inconsistency undoubtedly remains in REANS, although I attempted to standardize ambiguous cases according to the phasing convention. Cases that appear to include deliberate counts of Xolalpan CTO and Metepec TTO have been recorded in the same auxiliary database that contains counts on the various RTO categories not included in REANS.

Lustrous Ware

The Lustrous Ware category was used to record vessels (usually cylinder tripod vases) with a distinctive composition and a distinctive, highly polished finish, often plain but sometimes decorated with "interlace" or other designs rendered in plano-relief. It has long been regarded as an import from somewhere in the Gulf Lowlands, although Annick Daneels's inspection of the TMP collections suggested that Lustrous Ware is very distinct from chronologically comparable pottery in Central Veracruz (Daneels 1996). Lustrous Ware may be from an as yet unidentified region in Mesoamerica, possibly in northern Veracruz (Cowgill and Neff 2000).

Granular Ware

Granular Ware is readily distinguishable visually by its composition and surface appearance. INAA analyses (Cowgill and Neff 2000) show that it was imported to Teotihuacan, perhaps from Guerrero. The main shape variant is an amphora, although other forms (including ollas and *almena* roof ornaments) occur in smaller numbers (Kolb 1988b). The reanalysis tabulation form was designed to accommodate Granular Ware counts, but as the ware is readily recognizable, and the DF8 tabulations were considered quite accurate, no Granular Ware category was included in REANS. The Granular Ware category in DF8 is unphased, with no shape variants. Excavations at the Feathered Serpent Pyramid show that Granular Ware was imported from at least as early as the early part of the Tlamimilolpa phase. Statistical analyses by Cowgill suggest that it was most popular relatively early in the Teotihuacan Period, although it probably continued in use throughout the sequence (George Cowgill, personal communication 2001).

Other Foreign Ware

In addition to Thin Orange, Granular and Lustrous Ware, a significant amount of pottery recovered from the TMP surface survey was identified as being "non-Teotihuacan" in origin and sometimes attributed to specific extra-regional sources. DF8 contains seven fields based on counts of sherds from specific "foreign" localities—over 2000 sherds in total. Evelyn Rattray claims that these figures underestimate the amount of foreign ceramic materials at Teotihuacan by a factor of five to ten (Cowgill 1993); if so, the DF8 counts are unlikely to be of much use in analysis, in spite of the inherent importance of the categories. While the reanalysis tabulation forms were designed so as to accommodate counts of sherds from three different regions (Oaxaca, the Gulf Lowlands, and the Maya area), these were seldom used, and no corresponding fields were ever created in REANS. Evelyn Rattray (personal communication 1997) reports that she has prepared tabulations of foreign sherds in the TMP collections, but these have not yet been made available for study.

Modes of Decoration

Polished Black

It is unclear exactly what observations were being captured by the "Polished Black" category in the ceramic reanalysis or how consistently it was used. Carefully polished, dark brown and black bowls and vases were particularly common during the Miccaotli phase, and Rattray claims that "lustrous black" was still a prominent finish in Early Tlamimilolpa (Rattray 1981b:111). In the reanalysis, however, only a small number of sherds (191 in 66 collections) were counted as "polished black". Almost all of these were attributed to a Miccaotli phase-variant and only a very few to Tlamimilolpa (Table A.10).

Rattray implies that dark brown may have been more common than black polish during Miccaotli (Rattray 1981b:188), and it is reasonable to assume that the former would have been excluded from the "polished black" category. It seems very unlikely, however, that the less than 200 examples recorded during the reanalysis project as "polished black" reflect a systematic tally of all of the vase and bowl sherds with polished black surfaces that were recovered in surface collections. Nevertheless, Polished Black counts were sporadically recorded throughout the entire period of lab analysis, and it is possible that polished black counts do reflect some kind of meaningful, systematic information—perhaps examples of particularly finely polished black finish (Mary Hopkins, personal communication 1998).

Most tallies of Polished Black sherds were bracketed on the reanalysis sheets. This indicates that these were usually secondary observations tied to other categories, likely a combination of polished bowls, outcurving bowls, and polished vases.

Incision

Beginning well before the Tzacualli phase, various types of ceramic vessel were sometimes decorated by different kinds of incision. Rattray's manuscript (1981b) acknowledges the presence at Teotihuacan of incision done both before and after firing but notes the difficulty of distinguishing incision made on a very dry, but unfired, vessel, from post-fire incision. Both types of incision tend to be lumped together and distinguished as a group from incision that was done when the vessel was still plastic. Post-fire/dry incision is said to occur earliest, eventually to be largely supplanted by the "pre-fire" method (Rattray 1981b:91-92).

The reanalysis datasheets distinguish five different types of incision (regular, cross-hatch, scratch, groove, and gouge) all of which have at least some phase-specific categories. It is difficult to match these categories with the sorts of formal differences described in Rattray's manuscript; there is likely no very systematic relationship. It is also possible (but unlikely) that single examples of incision in the reanalysis may have generated counts in more than one of the five incision categories. Not surprizingly, incised ware counts are mostly "bracketed", since, as a decorative mode, rather than a 'ware' *per se*, incision usually occurs on sherds that would also have been recorded in a ware-based category.

"Regular" incision probably includes examples in which a pointed object was used to scratch designs into the already-hard, polished surface of the vessel, but it probably mainly includes examples of incision produced in clay that was still quite plastic (see below). Incision carried out on hard clay is often imprecise; lines are often crooked or irregular, and cross boundaries meant to contain them. The visual impact of such decoration was sometimes enhanced by powdery red pigment, rubbed into the incision marks after firing (Rattray 1981b:191-2).

As noted above, some of the pottery at Teotihuacan was incised with a broadly pointed object before the surface was dry. Lines incised at this early stage of production tend to have slightly raised edges, a rounded, u-shaped profile, and they form designs that show more control in execution. The "Groove Incised" category of the reanalysis may correspond to some variants of this technique. George Cowgill (personal communication 1999), however, believes that many or most examples of plastic incising were counted under the "Regular Incised" category, and "Groove Incised" counts probably just refer to unusually wide, shallow incisions.

"Gouge Incised" may refer to unusually deep incision made while the clay was still plastic and thus may be something like what Rattray describes as "deep V gouge" incision on Metepec outcurving bowls (Rattray 1981b:386). It is unclear from Rattray how common the latter mode of decoration is, or the degree to which it was used in other phases; Cowgill (personal communication 2001) considers it rather uncommon. The reanalysis category was recorded only 240 times, and most examples were attributed to the Tlamimilolpa phase (Table A.10).

"Scratch Incised" may refer to lines that just break through the polished surface of the vessel, which Rattray describes as characteristic of Early Tlamimilolpa outcurving bowls and other forms of Polished Ware (Rattray 1981b:212). This category was very rarely used in the reanalysis, but, interestingly, the only examples were attributed to the Tlamimilolpa phase.

"Cross-hatch Incised" is a category that describes the configuration of multiple lines, rather than the form of individual incised lines. As the name suggests, it refers to designs created by two series of multiple lines superimposed and intersecting at an angle. There is little doubt that sherds so identified in the ceramic reanalysis display the decorative mode known to be particularly characteristic of Miccaotli (Rattray 1981b:191-192), and this is clear in the phase-variant counts shown in Table A.10.

Plano-relief

Some of the most elaborate vessels used at Teotihuacan, especially cylinder tripod vases of Polished, Copa, and other wares, were decorated by scraping away parts of the vessel surface to create elaborate designs. Some of these designs depict events or scenes, often involving anthropomorphic figures in elaborate clothing (e.g., Berrin and Pasztory 1993:cat. no. 134). More abstract examples of plano-relief include symbols and motifs indigenous to Teotihuacan and the "interlace" or scrollwork designs related to Gulf Lowland styles (e.g., Berrin and Pasztory 1993:cat. nos. 133, 145-146). Plano-relief work was often labour-intensive, and high quality work would have greatly increased the value of pots so decorated.

Pattern Polish

Pattern polish is a kind of surface decoration created by polishing discrete parts of the vessel surface, producing zones that are alternately polished and matte, and often forming more or less standardized design elements such as crosses, parallel lines, and curvilinear motifs such as scallops and flowers (Rattray 1981b:337). Rattray (1981b:113) describes pattern polish as a Xolalpan innovation appearing on polished bowls and jars and becoming more widespread in the Metepec phase. The REANS files show that pattern polish was recorded in relatively small numbers for all phases between Miccaotli and Metepec, with a clear peak in Metepec. This is one of the "bracketed" categories, regularly recorded as a secondary observation on sherds that also contributed to counts of other polished ware categories, including outcurving bowls.

Modes of Support

Vessel supports take a number of different forms at Teotihuacan, and several categories in the reanalysis and REANS were created to accommodate them.

Nubbin

Nubbins provide the most basic form of tripod support, and simply consist of small, solid, roughly conical lumps of clay attached near or at the outer margin of the base of a flat-bottomed vessel. Phase-variants exist for all phases from Miccaotli to Metepec, although the vast majority are attributed to Miccaotli and Tlamimilolpa (Table A.11). Nubbin supports are mostly found on vases and outcurving bowls, although they also occur on flat-bottomed jars.

Round Support

The "Round Support" category includes tripod supports that are cylindrical or globular in shape. Circular attachment scars on bases—a common form of evidence for supports in general—do not allow the two forms to be readily distinguished. Hollow cylindrical supports first appear during Late Tlamimilolpa as appendages on elaborate polished vases. Globular supports probably begin to be used at about the same time, notably on burnished basins (Rattray 1981b:236, 245). The phase-variants recognized in REANS were Tlamimilolpa and Xolalpan.

Slab Support

Slab supports are hollow or solid rectangular supports associated exclusively with polished vases, especially cylinder tripods of better than average quality. Tlamimilolpa and Xolalpan phase variants are recognized in REANS.

Ring Base Support

Ring bases are annular supports, rarely used to support small and medium sized bowls. The very numerous annular supports belonging to Regular Thin Orange hemispherical bowls were not recorded in this category. No phase-variants were recognized in the reanalysis.

Table A.1: Burnished Ware categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R453: Mic olla	4696	47406	10.09	14.31	6.50	5.65
R454: Tla olla	4696	33375	7.11	14.04	3.89	4.23
R455: Xol olla	4696	21982	4.68	8.27	2.56	2.84
R456: Met olla	4696	2572	0.55	1.69	0.25	0.81
R465: Xol red-rimmed olla	4022	8516	2.12	6.27	1.11	2.40
R466: Met red-rimmed olla	4019	122	0.03	0.21	0.01	0.10
R473: Mic jar	4587	1468	0.32	1.31	0.17	0.66
R474: Tla jar	4586	890	0.19	0.84	0.11	0.57
R475: Xol jar	4586	1346	0.29	1.10	0.18	0.62
R476: Met jar	4586	1058	0.23	0.98	0.12	0.50
R483: Mic comal	4696	1663	0.35	1.28	0.23	0.81
R484: Tla comal	4696	2835	0.60	1.43	0.34	0.87
R485: Xol comal	4696	4071	0.87	6.19	0.40	1.31
R486: Met comal	4696	810	0.17	0.70	0.09	0.41
R493: Mic basin/bowl	4696	72	0.02	0.18	0.01	0.20
R494: Tla basin/bowl	4696	4550	0.97	2.10	0.61	1.28
R495: Xol basin/bowl	4696	46	0.01	0.14	0.01	0.11
R496: Met basin/bowl	4696	618	0.13	0.62	0.09	0.46
R503: Mic cazuela/crater	4696	9207	1.96	3.76	1.14	1.77
R504: Tla cazuela/crater	4696	9582	2.04	4.56	1.08	1.90
R505: Xol cazuela/crater	4696	181	0.04	0.54	0.03	0.38
R506: Met cazuela/crater	4696	557	0.12	0.57	0.06	0.32

Table A.2: San Martín Orange Ware categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R515: Xol SMO crater	4696	43720	9.31	21.60	4.92	6.16
R516: Met SMO crater	4696	180	0.04	0.35	0.01	0.14
R525: Xol SMO amphora	4696	3073	0.65	1.88	0.35	0.90
R526: Met SMO amphora	4696	4009	0.85	2.53	0.43	1.01
R535: Xol SMO scraped-basin	4696	51	0.01	0.27	0.00	0.07
R536: Met SMO scraped-basin	4696	707	0.15	0.65	0.08	0.39

Table A.3: Painted Ware categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R545: Xol red crater	4696	10183	2.17	5.03	1.05	1.62
R546: Met red crater	4696	47	0.01	0.16	0.00	0.06
R554: Tla red vase	4694	151	0.03	0.28	0.02	0.17
R555: Xol red vase	4694	1482	0.32	1.52	0.15	0.70
R556: Met red vase	4694	5	0.00	0.03	0.00	0.01
R565: Xol red jar	4694	2352	0.50	2.51	0.24	0.74
R566: Met red jar	4694	41	0.01	0.13	0.00	0.08
R575: Xol red bowl	4694	3066	0.65	2.03	0.34	0.86
R576: Met red bowl	4694	80	0.02	0.20	0.01	0.10
R584: Tla r/n bowl	4695	490	0.10	0.51	0.06	0.35
R585: Xol r/n bowl	4695	1538	0.33	0.89	0.20	0.66
R586: Met r/n bowl	4695	266	0.06	0.39	0.03	0.21
R595: Xol r/n crater	4694	5721	1.22	3.07	0.61	1.27
R596: Met r/n crater	4694	529	0.11	0.85	0.04	0.28
R605: Xol r/n basin	4695	7376	1.57	4.34	0.89	1.84
R606: Met r/n basin	4695	1981	0.42	1.63	0.20	0.72
R614: Tla r/n vase	4694	1145	0.24	0.98	0.11	0.40
R615: Xol r/n vase	4694	309	0.07	0.33	0.04	0.23
R616: Met r/n vase	4694	12	0.00	0.07	0.00	0.02
R625: Xol r/n ridged dish	4694	1587	0.34	1.84	0.16	0.80
R626: Met r/n ridged dish	4694	3159	0.67	2.22	0.29	0.73
R634: Tla r/n jar	4694	202	0.04	0.35	0.03	0.24
R635: Xol r/n jar	4694	2665	0.57	1.87	0.27	0.76
R636: Met r/n jar	4694	825	0.18	0.93	0.08	0.39

Table A.4: Matte Ware categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R670: burner	4691	2946	0.63	2.20	0.29	0.76
R683: Mic censer	4693	1552	0.33	0.93	0.17	0.48
R684: Tla censer	4693	7810	1.66	3.89	0.84	1.29
R685: Xol censer	4693	5237	1.12	5.37	0.48	1.27
R686: Met censer	4693	1547	0.33	1.88	0.13	0.61
R690: burner/censer	4693	2748	0.59	1.89	0.29	0.83
R700: censer adorno	4696	968	0.21	0.74	0.11	0.48
R710: miniature	4696	2844	0.61	2.26	0.25	0.80
R720: handled cover	4696	6145	1.31	4.14	0.71	1.56

Table A.5: Polished Ware categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R923: Mic outcurving bowl	4663	11953	2.56	5.48	1.56	2.35
R924: Tla outcurving bowl	4663	38534	8.26	16.29	4.96	4.99
R925: Xol outcurving bowl	4663	15897	3.41	5.52	2.26	2.90
R926: Met outcurving bowl	4663	9900	2.12	5.09	1.22	2.18
R943: Mic polished bowl	4636	2452	0.53	1.76	0.40	1.26
R944: Tla polished bowl	4637	2636	0.57	1.90	0.37	1.14
R945: Xol polished bowl	4636	1244	0.27	0.84	0.20	0.79
R946: Met polished bowl	4636	2147	0.46	1.50	0.28	0.88
R913: Mic polished vase	4679	1421	0.30	1.16	0.17	0.73
R914: Tla polished vase	4679	3584	0.77	2.20	0.41	1.00
R915: Xol polished vase	4679	6531	1.40	4.08	0.69	1.30
R916: Met polished vase	4679	157	0.03	0.25	0.02	0.18
R934: Tla f/adorno	4318	229	0.05	0.30	0.03	0.17
R935: Xol f/adorno	4318	274	0.06	0.35	0.04	0.26
R800: lid	4694	475	0.10	0.40	0.06	0.31
R953: Mic florero	4693	48	0.01	0.11	0.00	0.09
R954: Tla florero	4693	31	0.01	0.09	0.00	0.10
R955: Xol florero	4693	20	0.00	0.07	0.00	0.04
R960: Tlaloc vessel	4692	81	0.02	0.14	0.01	0.12

Table A.6: Dense Ware.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R770: dense ware	4695	379	0.08	0.56	0.04	0.32

Table A.7: Copa Ware.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R765: Xol copa ware	4687	1321	0.28	1.04	0.13	0.68
R766: Met copa ware	4687	39	0.01	0.10	0.00	0.07

Table A.8: Thin Orange Ware and other imported categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	Mean	sd
R320: RTO hemi bowl	4630	54050	11.67	21.04	6.71	5.76
R330: RTO evert bowl	4630	16757	3.62	6.30	2.11	2.69
R380: RTO vase	4630	2894	0.63	1.28	0.35	0.90
R410: RTO jar	4629	2140	0.46	1.22	0.25	0.69
R390: RTO mini	4629	12	0.00	0.07	0.00	0.03
R360: RTO incised	4633	3024	0.65	1.65	0.33	0.77
R370: RTO punctate	4633	1064	0.23	1.04	0.11	0.48
R400: RTO molded	4631	576	0.12	0.45	0.07	0.33
R340: Thick thin orange	4634	8160	1.76	4.16	1.14	2.44
R350: Coarse thin orange	4634	7377	1.59	3.54	0.97	1.86

Table A.9: Lustrous Ware.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R750: lustrous ware	4695	966	0.21	0.87	0.10	0.49

Table A.10: Decorative mode categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R733: Mic polished black	4694	178	0.04	0.66	0.01	0.18
R734: Tla polished black	4694	12	0.00	0.10	0.00	0.09
R735: Xol polished black	4694	1	0.00	0.01	0.00	0.00
R736: Met polished black	4694	0	0.00	0.00	0.00	0.00
R823: Mic reg. incised	4687	157	0.03	0.30	0.02	0.18
R824: Tla reg. incised	4687	2785	0.59	1.71	0.31	0.79
R825: Xol reg. incised	4687	3836	0.82	2.09	0.44	1.06
R826: Met reg. incised	4687	194	0.04	0.33	0.02	0.13
R854: Tla groove incised	4693	163	0.03	0.25	0.02	0.15
R855: Xol groove incised	4693	372	0.08	0.56	0.03	0.19
R856: Met groove incised	4693	65	0.01	0.13	0.01	0.13
R863: Mic gouge incised	4694	10	0.00	0.05	0.00	0.03
R864: Tla gouge incised	4694	185	0.04	0.32	0.02	0.20
R865: Xol gouge incised	4694	41	0.01	0.12	0.00	0.05
R866: Met gouge incised	4694	4	0.00	0.03	0.00	0.01
R845: Xol scratch incised	4694	13	0.00	0.09	0.00	0.03
R846: Met scratch incised	4694	0	0.00	0.00	0.00	0.00
R833: Mic cross-hatched incised	4590	85	0.02	0.17	0.01	0.12
R834: Tla cross-hatched incised	4590	14	0.00	0.06	0.00	0.05
R835: Xol cross-hatched incised	4590	8	0.00	0.09	0.00	0.02
R810: plano-relief	4694	422	0.09	0.39	0.05	0.38
R743: Mic pattern polished	4668	53	0.01	0.13	0.01	0.18
R744: Tla pattern polished	4668	47	0.01	0.11	0.00	0.06
R745: Xol pattern polished	4668	74	0.02	0.16	0.01	0.11
R746: Met pattern polished	4668	346	0.07	0.59	0.04	0.28

Table A.11: Support mode categories.

category	valid n	sum	count		count/total (%)	
			mean	sd	mean	sd
R873: Mic nubbin	4695	2069	0.44	1.17	0.26	0.65
R874: Tla nubbin	4695	7830	1.67	4.23	0.88	1.42
R875: Xol nubbin	4695	59	0.01	0.14	0.01	0.08
R876: Met nubbin	4695	69	0.01	0.14	0.01	0.23
R884: Tla round support	4591	74	0.02	0.32	0.01	0.08
R885: Xol round support	4591	373	0.08	0.37	0.04	0.25
R894: Tla slab support	4668	77	0.02	0.17	0.01	0.08
R895: Xol slab support	4668	959	0.21	0.83	0.10	0.42
R900: ring base	4670	132	0.03	0.23	0.01	0.17