Centralized Communities, Population, and Social Complexity After Sedentarization

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Abstract The emergence of centralized supra-local communities followed a number of different pathways, and varied considerably in its pacing in different regions. The establishment of settled agricultural life often set the stage for the emergence of these larger scale and more complex societies by creating the larger, denser populations without which they could not have occurred. The variation observed in the degree and nature of centralization as well as the extremely long time lag between the onset of the Neolithic and the emergence of supra-local centralized communities in some regions, however, make it clear that regional demographic and political centralization is neither a unitary phenomenon nor an automatic consequence of the Neolithic demographic transition. Larger more centralized communities do, nonetheless, owe specific debts to initial Neolithic processes in their regions, since central aspects of their distinctive regional characters are already present in the earliest sedentary agricultural villages that precede them. At least some of these characteristics were quite possibly inherited, in turn, from even earlier hunting and gathering bands.

Keywords Regional settlement study · communities · demographic centralization · chiefdoms

Archeologists long ago grew accustomed to the notion that the initial development of complex social organization sprang quite naturally from early sedentary agricultural village life (e.g., Childe 1950, 1951). Close association with others when mobility has been eliminated from daily living patterns calls for the development of new means of conflict resolution; agricultural surpluses promote population growth; and an abundance of close neighbors encourages economic specialization and interdependence. These processes stimulate the spiraling development of complex societies, which soon expand to encompass more than just single villages and integrate populations on a larger regional scale into centralized supra-local

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communities. The emergence of such communities, organized according to hierarchical principles, is, for some, an essential threshold in human history (e.g., Carneiro 1981). Crossing it leads on to the development of even larger scale and more centralized sociopolitical integration.

This is, of course, a very simple and very general account. These things do not always happen once sedentary agricultural living is established, and at least some of them have happened where populations are not dependent on agriculture or where residence is not fully sedentary. When they occur, they do not always happen in the same way. Comparative study of this variability can be a path toward fuller understanding of the processes involved and of their interrelationships. This chapter takes such a path, focusing on one important feature of emerging complex societies: centralization in early supra-local communities. It complements previous comparative study that has focused on other aspects of early chiefdoms (Drennan and Peterson 2005, 2006), aspects that are consequently not much emphasized here. Recent research on the Neolithic demographic transition (Bocquet-Appel 2002; Bocquet-Appel and Naji 2006) has not altered the traditional recognition that most of the world's prehistoric populations at some point went through a fundamental transition involving plant cultivation and/or animal husbandry, population growth, and more sedentary residence patterns. This recent research does, however, offer deeper understanding of the dynamics of the demographic transition. Our exploration of centralization here similarly seeks deeper understanding of the developmental dynamics of the centralized communities that often emerged in the wake of the Neolithic demographic transition.

In this exploration, we ask several interrelated questions. How varied is the intensity of the regional demographic centralization that often follows the Neolithic demographic transition? How similar is the pacing of the centralization process in different regions? Does regional demographic centralization show a consistent relationship with regional demographic growth? How does centralization relate to local community structure, growth, and conflict resolution? How does centralization relate to regional political integration?

Measuring Centralization

Two analytical tools have been extensively utilized in the archeological study of regional centralization: site size histograms and rank-size graphs. Multimodality in histograms of site areas is often taken to indicate the tiers in a regional settlement hierarchy (e.g., Johnson 1972, 1980b; Fletcher 1986; Kowalewski et al. 1989; Liu 1996). If a single site stands out as much larger than all the rest, then that site is thought to integrate a highly centralized system. A histogram of site areas usually takes the form of a Poisson distribution with a very high peak at a small area value (most sites are small) and a long tail composed of smaller and smaller numbers of increasingly large sites. In such a distribution, a single site will, of course, almost always stand out from the rest as the largest, and purely random processes will create

some bunching among other large site areas. The subjective judgments made about whether the largest site stands out enough to be the dominant center for the whole system or about whether bunches of other site areas really comprise separate modes or tiers, are seldom as unequivocal or reliable as most analysts seem to think. The significance of departures from the "expected" unimodal Poisson pattern is never evaluated, leaving the reader to wonder whether anything more than just the vagaries of sampling is at work. Most important for our purposes here, these histograms do not enable comparisons of just how centralized such systems may be.

Rank-size graphs have been used for precisely such comparative purposes (Blanton 1976; Johnson 1980a, 1981; Paynter 1982, 1983), and means have been suggested for minimizing the subjectivity of comparative judgments and for evaluating the significance of differences (Drennan and Peterson 2004). The units of analysis in rank-size graphs are typically archeological sites (as they are for site size histograms). This raises serious problems if there is no one-to-one correspondence between archeological sites and local human communities, although distance-interaction principles can be used to delineate meaningful units (Peterson and Drennan 2005). In some settlement distributions, however, definable local communities simply do not exist, even though centralized supra-local communities are unquestionably present (Drennan and Peterson 2005; Peterson and Drennan 2005). If there are no genuine local communities, then there are no meaningful units for rank-size analysis, and it cannot be applied. Rank-size graphs have been extremely useful in the analysis of large-scale political formations with extensive territories, well-defined capitals and subsidiary centers, and very large samples of settlements. The early regional communities or polities that concern us here, however, are much smaller; it is common for a single archeological study area to include a number of them. This is, of course, exactly what a convex rank-size pattern has been taken to indicate, and centralization within such small-scale regional communities can be pursued with separate rank-size graphs for each one. These small regional communities, however, may include so few separate local communities that rank-size graphs provide only a crude picture of centralization. Particularly at this small scale, then, other ways of approaching the measurement of centralization are needed.

Distance-interaction principles make it possible to recognize centralized regional organization, since centrally focused patterns of social interaction tend to draw populations toward a center. This creates central peaks of high population density separated by demographic valleys along which boundaries between regional communities can be drawn (Peterson and Drennan 2005). The demographic peaks may be very high and the valleys quite low, or the difference between them may not be so pronounced. Higher peaks presumably reflect stronger centralizing pulls, and this opens the door to a different way of characterizing the strength of centralization for comparison.

The Valley of Oaxaca (Mexico) provides a much studied and thoroughly described example of the emergence of an early centralized regional community (Flannery and Marcus, eds., 1983; Kowalewski et al. 1989; Marcus and Flannery 1996). By the Rosario phase (700–500 BC) this chiefly polity, with its center at San José Mogote, appears to have dominated other local communities in a substantial

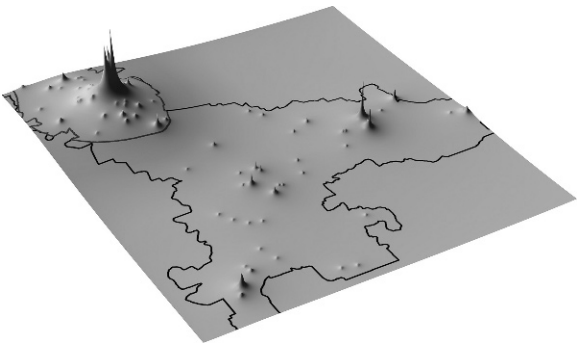

Fig. 1 A smoothed surface representing the demographic density across the Valley of Oaxaca during the Rosario phase (cf. Peterson and Drennan 2005). The survey area and the San José Mogote chiefdom within it are outlined

portion of the valley, forming the kind of demographic peak discussed above (Fig. 1), on the basis of which its limits have been delineated (Peterson and Drennan 2005). The degree of demographic centralization in the polity can be represented by a graph of the proportions of its population in a series of concentric rings radiating from this central peak. Figure 2 shows the division of the territory of the San José Mogote polity into 12 rings, each containing one-twelfth of the total area of the polity. Using Kowalewski et al.'s (1989) population estimates for each site, the estimated population of each ring is determined (Table 1) and expressed as a proportion of the total polity population. These proportions are graphed in Fig. 3. Not surprisingly, the central ring has by far the largest proportion of the polity's

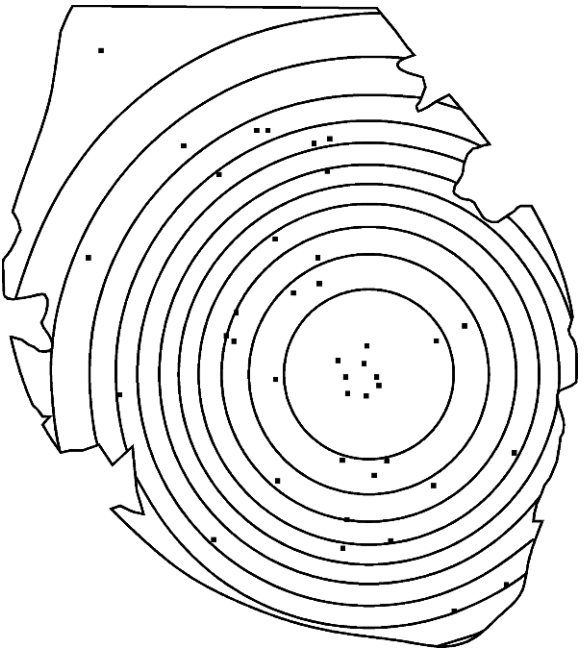

Fig. 2 The distribution of sites across the San José Mogote chiefdom's Rosario phase territory divided into 12 equal-area rings

Table 1 Calculation of *B* value for Rosario phase San José Mogote chiefdom in the Valley of Oaxaca

Ring	Estimated population	Population proportion	Cumulative proportion
1	707	57%	57%
2	117	9%	66%
3	97	8%	74%
4	38	3%	77%
5	0	0%	77%
6	8	1%	77%
7	8	1%	78%
8	177	14%	92%
9	54	4%	96%
10	31	2%	99%
11	0	0%	99%
12	14	1%	100%
Total	1251	100%	991%
B value			0.6196

population; successive rings have decreasing proportions out to about the seventh ring, where the proportion increases before trailing off to near zero values in the outer rings. The 90% confidence zone in Fig. 3 is produced from the 90% error ranges of the estimates of proportions for each of the 12 rings. In doing this we have taken the estimated number of households in the region as the sample size upon which the proportions are based. This seems a plausible idea of the number of observations on which the estimates rely, since the household is probably the fundamental decision-making unit in residential location. If the estimated number of households is inaccurate or the assumption about decision making invalid, the shape of the graph is not affected, only the breadth of the confidence zone.

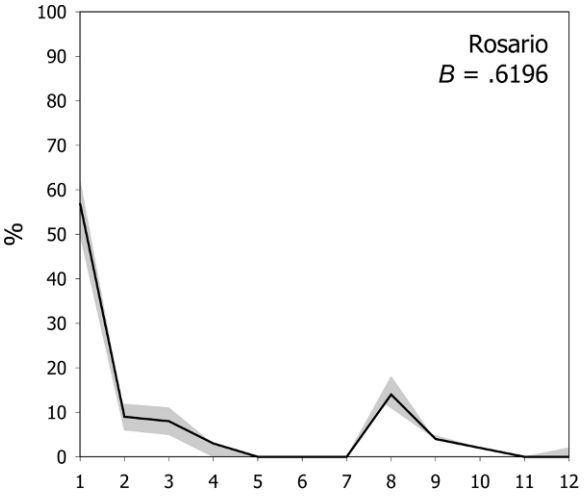

Fig. 3 Graph of the distribution of Rosario phase population across 12 concentric rings within the San José Mogote chiefdom in the Valley of Oaxaca. The rings are ordered from innermost to outermost (left to right), and a 90% confidence zone is shaded

Any regionally centralized community would produce the general pattern of a line higher on the left than on the right. The stronger the centralization, the higher the line would be at the left side of the graph, and, correspondingly, the lower it would have to be toward the right (since the proportions must total 100%). A measure of the strength of such centralization could be calculated by converting these proportions into cumulative proportions, as in the third column of Table 1, and summing them. The stronger the centralization, the greater the proportions of population in the inner rings will be and thus the higher the sum of the cumulative proportions will be. The ultimate in strong centralization would place 100% of the population in the innermost ring, and the sum of the cumulative proportions would be 1200% (Table 2). A perfectly even (entirely uncentralized) population distribution would place 8.3% of the polity's population in each of the 12 rings, and the sum of the cumulative proportions would be 650% (Table 2). The cumulative proportion sum, then, could range from as little as 650% for no centralization to 1200% for the strongest possible centralization. This sum could be expressed as a measure of centralization with the useful property of varying from 0 for no centralization to 1 for maximum centralization by subtracting 650 and dividing the remainder by 550 (Table 2). The value of this coefficient, which we will call B, for the Rosario phase San José Mogote chiefdom is 0.6196, suggesting strong centralization – exactly what we have already seen in Fig. 3. This is not news for the San José Mogote polity; a more familiar rank-size graph (Fig. 4) shows the primate pattern taken to indicate a strongly integrated system. Sociopolitical integration and demographic centralization are, of course, not exactly the same thing, although in this instance (as is quite often the case) they represent two sides of the same coin. The very strong integration of the San José Mogote chiefdom in the Rosario phase is effected through heavy dominance by San José Mogote, in its role as regional central place – central

Table 2 Example calculation of B value for maximum centralization and for no centralization

Ring	Maximum centralization		No centralization	
	Population proportion	Cumulative proportion	Population proportion	Cumulative proportion
1	100%	100%	8.3%	8%
2	0%	100%	8.3%	17%
3	0%	100%	8.3%	25%
4	0%	100%	8.3%	33%
5	0%	100%	8.3%	42%
6	0%	100%	8.3%	50%
7	0%	100%	8.3%	58%
8	0%	100%	8.3%	67%
9	0%	100%	8.3%	75%
10	0%	100%	8.3%	83%
11	0%	100%	8.3%	92%
12	0%	100%	8.3%	100%
Total	100%	1200%	100%	650%
B value	$(1200 - 650)/550 = 1.0000$		$(650 - 650)/550 = 0.0000$	

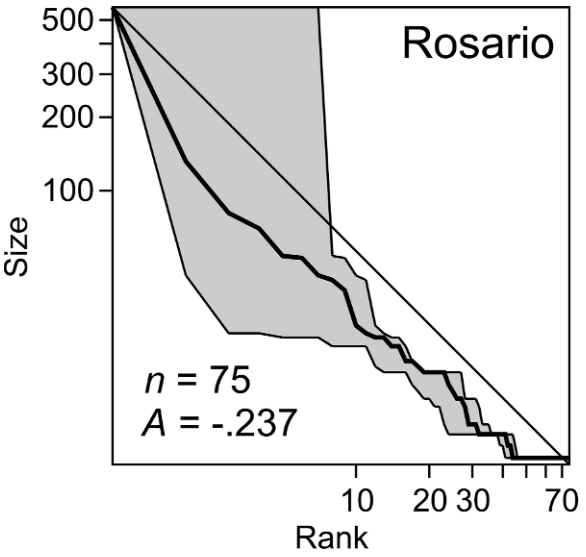

Fig. 4 Rank-size graph for the San José Mogote chiefdom in Rosario phase Oaxaca (Drennan and Peterson 2005). A 90% confidence zone is shaded

spatially and functionally. It is entirely conceivable that a primate "center" as revealed by a rank-size analysis might not be in an even remotely central location in its region. There are archeological cases in which this has actually occurred, underscoring the extent to which the impression given by rank-size analysis may diverge from spatial reality (Johnson 1981:177; Drennan and Peterson 2004:544). The ring graphs used here along with the *B* coefficient truly are an indication of regional demographic centralization, since spatial centrality is their foundation.

Regional Centralization and Village Life

Regional-scale demographic centralization also emerged in the Alto Magdalena of the Colombian Andes (Drennan 2000; Peterson and Drennan 2005; Drennan, ed., 2006), as can be seen in Fig. 5. The pattern is not exactly like the single dramatic demographic peak of Rosario phase Oaxaca, but by the Regional Classic period (1–900 AD) several broad demographic hills are separated by deep valleys where population density was lower. Each hill represents a population drawn toward a center of ritual and mortuary activities. One of these, Cerro Guacas, is the central place in the polity the analysis below will focus particularly on. The pattern of centralization at the regional scale is clear, although the structure of population distribution at the local scale is very different from that of Oaxaca. Instead of compact nucleated villages, the inhabitants of the Alto Magdalena lived in widely dispersed farmsteads or small groups of nearby farmsteads directly on the land that they cultivated, forming a virtually continuous distribution of occupation across the landscape. Although continuous, this distribution is of highly variable density, allowing for the formation of the hills and valleys seen in Fig. 5. Both the Regional Classic Alto Magdalena and

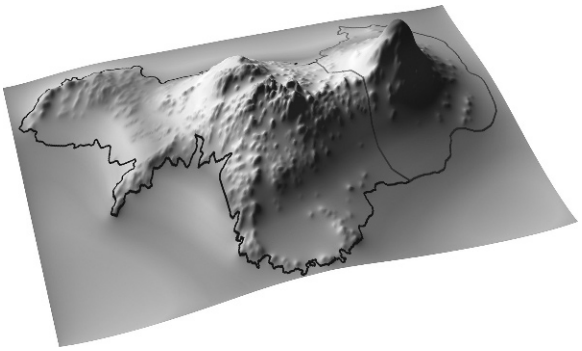

Fig. 5 A smoothed surface representing the demographic density across the western survey zone of the Valle de la Plata in the Alto Magdalena during the Regional Classic period (cf. Peterson and Drennan 2005). The survey area and the Cerro Guacas chiefdom within it are outlined

Rosario phase Oaxaca represent chiefly polities dating to some 1000 years following the establishment of sedentary agricultural life ($dt \approx 1000$). It is interesting to explore how the degree of regional demographic centralization might differ between these two cases. In strictly mechanical terms, rank-size analysis could be performed on the Alto Magdalena dataset; the delineation of archeological "sites" was part of the data collection procedure. These sites are not, however, villages; they are arbitrary partitions created for convenience in a continuous distribution of occupation. The pattern of discrete small local communities, so often taken for granted in regional settlement study, simply does not exist in the Alto Magdalena. There are thus no meaningful units of analysis upon which to base a rank-size graph. Regional centralization can, however, be characterized with a ring graph like the one for Rosario phase Oaxaca in Fig. 3 and its strength measured with the *B* coefficient. The ring graph for the Cerro Guacas polity (Fig. 6) is very similar to the one in Fig. 3. The proportion of the polity's population in the innermost ring is slightly lower, but the next several rings have higher values than for San José Mogote, and

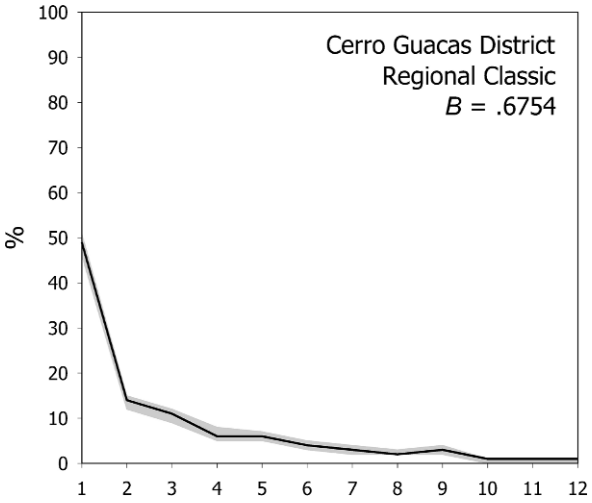

Fig. 6 Ring graph for the Regional Classic Cerro Guacas chiefdom in the Alto Magdelena in the western survey zone of the Valle de la Plata (90% confidence zone)

there is nothing resembling the largish community that creates a bump in the eighth ring in the San José Mogote graph. The *B* value of 0.6754 is somewhat higher than that for Rosario phase San José Mogote.

These two early chiefly polities, thus, appear to have created roughly similar degrees of regional demographic centralization within about a millennium after the beginning of agriculture and sedentism. Both show some of the commonly observed archeological indicators of early chiefdoms, such as public monuments, elaborate elite burials, etc. (Drennan and Peterson 2005, 2006). The San José Mogote chiefdom arose in the context of agricultural village life and poses no immediately obvious challenge to the simple general account of the emergence of complex social organization referred to at the beginning of this chapter (in some sense a "natural" outcome of the Neolithic demographic transition). In the Alto Magdalena, however, despite the presence of sedentary agricultural living, the absence of villages or any form of compact local community calls into question the intensity of several of the processes upon which that account relies.

Much has been made of the tendency of very early villages in several parts of the world to fission before they grow beyond a few hundred inhabitants (Johnson 1982; Marcus and Flannery 1996:71–73; Bandy 2004). This has been attributed to the incidence of conflict arising from interaction among growing numbers of closely spaced neighbors in the absence of established organizational means of resolving such conflict. The pattern of dispersed farmsteads in the Alto Magdalena reflects substantially lower levels of interaction between households; so, by the widely imagined dynamics of early village living, the incidence of conflict would be substantially less in dispersed farmsteads than in a compact nucleated village. In similar fashion, household dispersion does not encourage the economic specialization and interdependence often fostered in compact villages, and direct evidence of economic specialization is quite scarce for the Alto Magdalena compared, for example, to the Valley of Oaxaca (Drennan and Peterson 2006:3962). Regional demographic centralization in the Alto Magdalena by 1000 years after the onset of agricultural life was nonetheless quite strong (even stronger than in the Valley of Oaxaca), and, as in Oaxaca, it revolved around hierarchical social organization. Unlike Oaxaca, regional centralization in the Alto Magdalena did not take the form of very large villages as central places, and it could not have emerged as the automatic unfolding of life in farming villages.

The western Liao Valley of northern China contrasts strongly with the Alto Magdalena in that, at 1000 years after the onset of sedentary agricultural living, village life was highly developed (Zhongguo 1997; Shelach 2000; Chifeng 2003; Linduff et al. 2004; Neimenggu 2004). Some early villages were small, but the very earliest from around 6000 BC (Xinglongwa and Zhaobaogou times) include ones with populations over 200. These villages were as compact as those in Oaxaca (around 50 people per ha within the village), and substantially larger on average. Despite the vigorous development of substantial agricultural villages, there are at this point in the western Liao sequence none of the signs of regional centralization that we have been discussing. The large villages were not central places in integrated regional systems; they and their smaller contemporaries were separated by very large

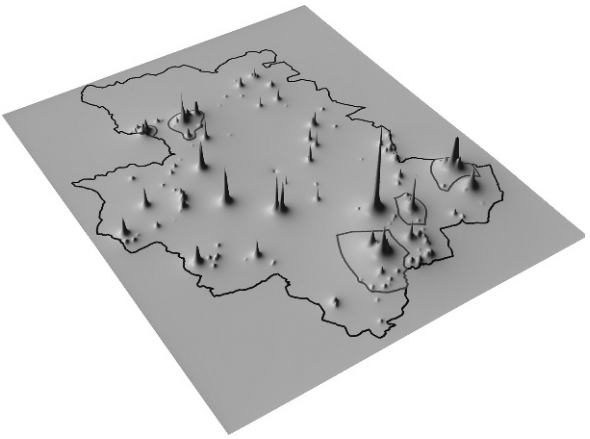

Fig. 7 A smoothed surface representing the demographic density across the Chifeng region of the western Liao valley during Hongshan times (cf. Peterson and Drennan 2005). The survey area and five of the Hongshan times (cf. Peterson and Drennan 2005). The survey area and five of the Hongshan chiefdoms within it are outlined

distances. Nor is there evidence of chiefly or hierarchical social organization. Public monuments were not being constructed. Such regionally centralized complex societies do not put in their appearance in the western Liao Valley until fully 2000 years after the beginning of sedentary life.

In the western Liao Valley, settlement study in the Chifeng region shows the emergence by around 4000 BC, during Hongshan times, of more than a dozen small regional polities, often separated by a considerable amount of open space (Fig. 7). *B* values can be reliably measured for five of these supra-local communities; they range from 0.3671 to 0.8812, with a mean of 0.6485. The ring graph in Fig. 8 is for a polity with a *B* value very close to this mean. As in both Oaxaca and the Alto Magdalena, centralized regional systems emerged in the western Liao Valley concurrently with hierarchical social organization, as evidenced in elaborate elite

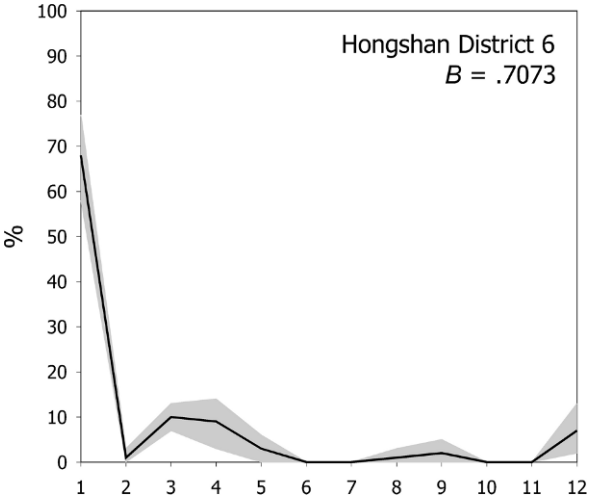

Fig. 8 Ring graph for a Hongshan period chiefdom in the chifeng region with a *B* value near the mean for five supra-local communities (90% confidence zone)

burials, public monuments, and domestic remains (Guo 2005; Drennan and Peterson 2006). In both spatial and demographic terms, the Hongshan polities of Chifeng were substantially smaller than those we have looked at in the Valley of Oaxaca and the Alto Magdalena. On average they show slightly weaker regional demographic centralization. And despite the rapid formation of sometimes quite large villages at the very beginning of sedentary agricultural life, these chiefly polities were extremely slow to develop, compared to those of the Alto Magdalena and the Valley of Oaxaca. Unexpectedly, as regional centralization first emerged in the Chifeng region, the degree of village nucleation relaxed in at least some cases. Fushanzhuang (Peterson 2006), the central place of one regional community, was a dispersed 40 ha village of some 200 people (or around 5 persons per ha within the village).

Regional Centralization and Demographic Growth

Demographic growth is often seen as a major force behind the development of regional centralization or at least as an important part of the picture. From such a perspective, one might attempt to account for the slow pace of social change in Chifeng by reference to overall regional population levels. As mentioned above, the earliest agricultural villages in the western Liao Valley were separated by large distances, and this, of course, is the accompaniment to very low regional population densities. Chronological resolution for the western Liao Valley is poor; it is possible to estimate regional population levels roughly for these long periods, but we cannot yet talk about population growth rates very meaningfully. The first two periods of settled agricultural living are each 750 years long. By the end of the first (Xinglongwa [6000–5250 BC]), population density in the Chifeng region can be estimated at about 0.3 persons per km^2. By the end of Zhaobaogou (5250–4500 BC), this had grown to about 1.5 persons per km^2. This amounts to an annual population growth rate of 0.25%, averaged over the period between 750 and 1500 years following the establishment of sedentary agricultural life. Given the length of the period, there were almost certainly one or more shorter episodes of more rapid growth interspersed with long periods of remarkable demographic stability. Along with supra-local community organization and social hierarchy come higher population levels. By the end of the Hongshan period (4500–3000 BC), regional population density had risen to about 8 persons per km^2 (an annual growth rate of 0.10%, again averaged over a very long period). Again, it seems much more likely that this very low rate of average population growth reflects a generally high degree of population stability punctuated by episodes of more rapid growth. It is certainly possible (though by no means certain) that Hongshan regional demographic centralization occurred in the context of such a growth spurt.

The extremely long time required for the development of social hierarchy and centralized regional communities in the western Liao Valley (some 3000 years after settled agricultural life began) was, then, characterized by very low rates of long-term average population growth. It is not the case, however, that regional

populations finally arrived in Hongshan times at levels sufficient to produce crowding or resource competition, leading to more complex social organization. At around 8 persons per km^2, there would still have been abundant unoccupied territory and unclaimed resources in the wide spaces that often separated Hongshan polities. Crowding and resource competition might well have led to conflict in the Chifeng region, but only in later times. It was not until sometime during the Lower Xiajiadian period (2200–1000 BC) that regional population arrived at such levels. The Xiaoheyan period (3000–2200 BC) between Hongshan and Lower Xiajiadian is very poorly known, but it is certain that population density was no higher than during Hongshan times, and might have been substantially lower. Population growth accelerated considerably during Lower Xiajiadian, reaching an annual rate of 1.07%, averaged over the entire period. If, as seems likely, much of this growth occurred in a shorter span of time, then it would have been a much more dramatic growth episode than any that had occurred previously in the region. By the end of Lower Xiajiadian, population densities had reached some 100 persons per km^2; there were twice as many small polities in the Chifeng region; and there were no longer tracts of unoccupied prime territory between them (Fig. 9). Like the earlier Hongshan supralocal communities, the Lower Xiajiadian polities were usually less than 5 km across, although their populations numbered a few thousand each (compared to a few hundred apiece in Hongshan). Heavily fortified hilltop redoubts are conspicuous Lower Xiajiadian remains. It is plausible to postulate crowding, resource competition, and conflict as causes of Lower Xiajiadian demographic and political centralizations. B values for regional centralization within these polities are more consistent than for Hongshan and consistently higher. For eight polities with reasonably complete data, B ranges from 0.6274 to 0.9088, with a mean of 0.7648 (Fig. 10). This is not, however, a new pattern in Lower Xiajiadian but an intensification of a pre-existing

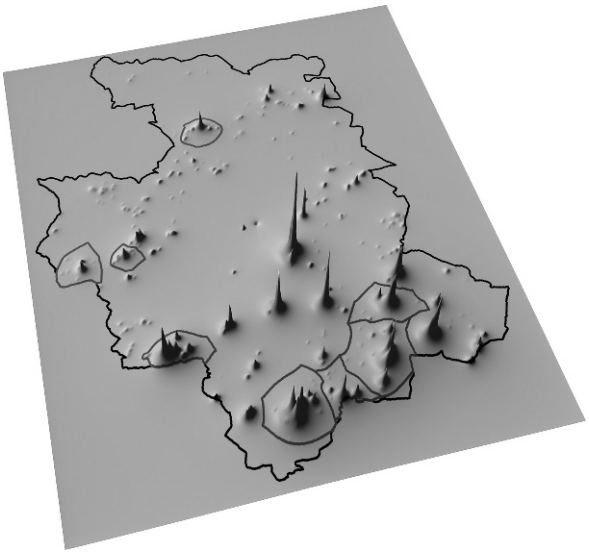

Fig. 9 A smoothed surface representing the demographic density across the Chifeng region of the western Liao valley during Lower Xiajiadian times. The survey area and eight Lower Xiajiadian districts within it are outlined

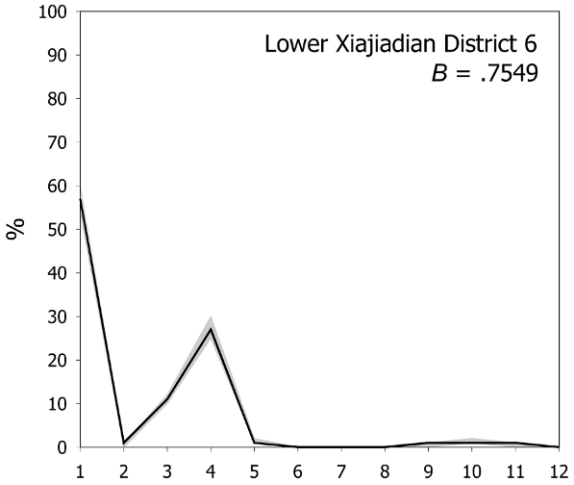

Fig. 10 Ring graph for a Lower Xiajiadian period district in the Chifeng region with a *B* value near the mean for eight supra-local communities (90% confidence zone)

one. Regional demographic crowding was not behind the initial emergence of regional centralization (Fig. 11), and both initial emergence in Hongshan times and intensification in Lower Xiajiadian were so many millennia after the establishment of sedentary agricultural life that they cannot be understood as simply the automatic unfolding of this transformation's demographic potential.

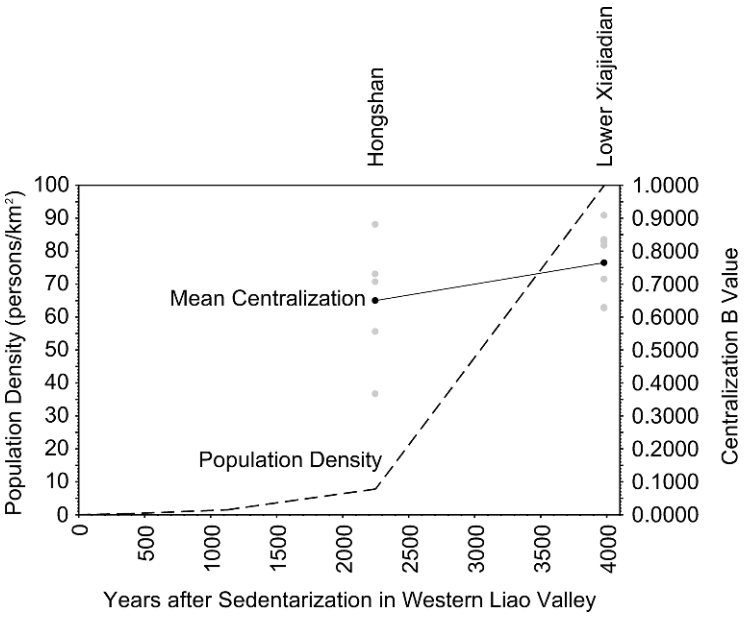

Fig. 11 Summary of changes in population density and centralization in Chifeng

More precise control of chronology would make a welcome contribution to the study of the western Liao trajectory, but it would not change the observation that centralized supra-local communities did not appear until more than 1500 years after the establishment of sedentary agriculture. A number of New World trajectories show much more rapid emergence of complex supra-local communities. The Rosario phase chiefdom in the Valley of Oaxaca discussed earlier had emerged before the end of the first millennium of settled agricultural living, and its antecedent regionally centralized communities go back to no more than 200 years after the first villages. These thousand years can be divided into four periods, providing a more detailed picture of a trajectory of more rapid social change than the western Liao Valley. Initial farming villages of the Tierras Largas phase (1500–1200 BC) in Oaxaca, like those of the western Liao Valley, were compact and nucleated, although most had quite small populations (50 people or fewer). From the very first, however, San José Mogote's population of about 200, while no larger than those of some Xinglongwa and Zhaobaogou villages in the western Liao Valley, was by far the largest in the Valley of Oaxaca. Moreover, San José Mogote served as the central place in a supra-local community composed of a number of nearby smaller neighbors (cf. Bandy, Global Patterns of Early Village Development). No such clusters of smaller neighbors are known for any large Xinglongwa or Zhaobaogou village; these do not form until Hongshan times. The Tierras Largas regional community appears to cover an area nearly 20 km across, much larger than the territories of Hongshan chiefdoms in the Chifeng region, although at about 350 inhabitants, it is demographically of similar size to Hongshan polities and of roughly similar regional centralization with a B value of 0.6422 (Fig. 12). The San José Mogote regional community in the Tierras Largas phase does not include all of the Valley of Oaxaca's early villages. There is a scatter of small villages elsewhere in the valley that do not seem part of this cluster, or of any other cluster. In contrast to the situation in Chifeng, San José Mogote heads the only supra-local community in Oaxaca. In even sharper contrast to the Chifeng region, the development of supra-local community organization in Oaxaca is almost instantaneous with the emergence of sedentary village life.

Regional population density by the end of the Tierras Largas phase was extremely low (at 0.15 persons per km^2 even lower than for Xinglongwa). Regional demographic growth from Tierras Largas to the ensuing San José phase (1200–900 BC) was rapid, averaging 0.59% per year (cf. Bandy 2005), but regional density was still quite low (at 0.90 persons per km^2, lower than that for Zhaobaogou). The San José Mogote regional community remained the only one in the valley, and most of the growth occurred at or near San José Mogote, producing much stronger regional demographic centralization in the San José phase ($B = 0.8308$, Figs. 12 and 13). At this point regional population growth came to a halt (or possibly even reversed slightly): the Guadalupe phase (900–700 BC) population density in the Valley of Oaxaca is estimated at 0.83 persons per km^2. Regional centralization also changed only trivially between San José and Guadalupe: the B value for the Guadalupe phase is 0.8448 (Figs. 12 and 13). Compared to the western Liao Valley, the immediate post-Neolithic trajectory of Oaxaca seems much more compatible with both the

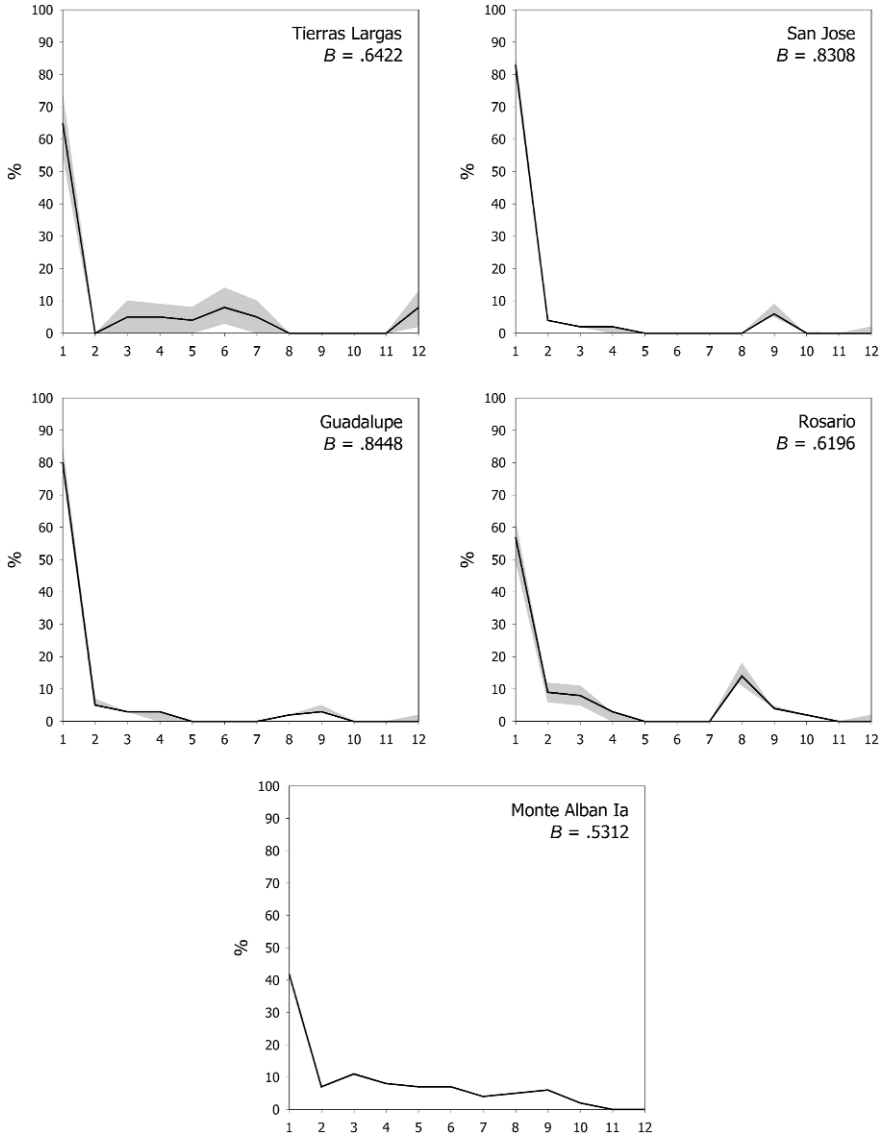

Fig. 12 Ring graphs for the single chiefdom in the Valley of Oaxaca through the sequence discussed in the text (90% confidence zone)

Neolithic demographic transition notion and the idea that early complex societies were an automatic consequence of its unfolding. Bandy (2005) has argued that the Tierras Largas to San José demographic growth was the last portion of the Neolithic population surge, which then leveled off in Guadalupe, as predicted (Bocquet-Appel 2002; Bocquet-Appel and Naji 2006). And it is clear that the initial emergence

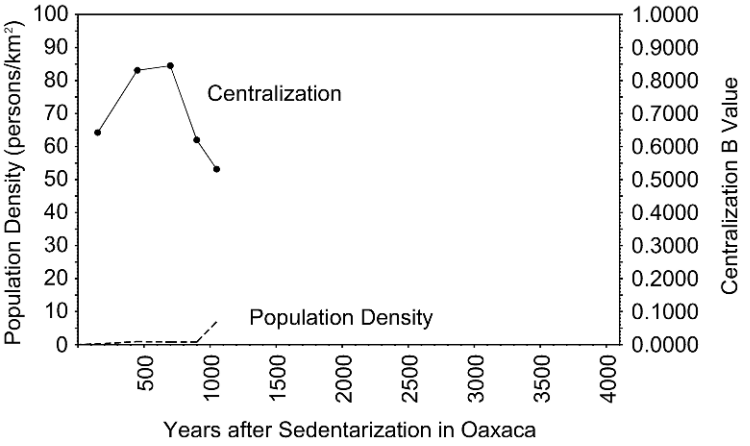

Fig. 13 Summary of changes in population density and centralization in the Valley of Oaxaca

of regional centralization and social hierarchy occurred in the context of an early post-Neolithic population surge. If these two things were connected in the Oaxaca trajectory, however, it cannot have been by way of conflict generated by regional crowding or resource competition because population densities were even lower than those of Chifeng, in a region with resources at least as rich. The compactness of Oaxaca villages and the large size that San José Mogote rapidly grew to, however, might well have generated levels of conflict that would require effective resolution to prevent community fissioning, and this could be the connection between Neolithic population growth and the emergence of social hierarchy.

The Guadalupe phase represents a plateau of stability, in terms of both regional demographic levels and centralization, following immediate post-Neolithic population growth. In terms of regional population levels, the plateau continues through the Rosario phase, but the degree of regional demographic centralization in the San José Mogote chiefdom, as discussed above, actually declined somewhat ($B = 0.6196$, Figs. 12 and 13). Since regional population held steady at this point (at 0.85 persons per km^2), the demographic change consisted of population redistribution within the region. San José Mogote itself shrank to a smaller percentage of the steady regional population, while both nearby and more distant villages grew. This decline in regional demographic centralization, however, does not reflect any decrease in San José Mogote's central place functions. Indeed, the degree of political integration of the polity appears to increase substantially at this time, with the appearance of new forms of elite residential architecture and sculptural evidence of coercive political control (Marcus and Flannery 1996). A major political threshold was crossed during the Rosario phase and it permitted, indeed encouraged, regional demographic *de*centralization. The changing form of the ring graph and the declining B coefficient, thus, should not be taken to indicate any waning of political control. On the contrary, it reflects ever more powerful means of regional political integration – ones that no longer depended on the closeness of dominated populations and made possible a broader and more economically efficient distribution of population across

the regional community. A local community of the size that San José Mogote had grown to by San José and Guadalupe times would require a fairly sizeable catchment area to provide sufficient farmland to feed its population. As population spread more broadly during Rosario times, this catchment could be reduced, making possible shorter commuting distances for San José Mogote's farmers. Outlying communities, however, were clearly under ever more effective political control from a center now actively seeking to expand and in conflict with villages outside the bounds of the chiefdom.

In Monte Albán Ia (500–300 BC) the regional demographic stability came to an abrupt end, with a population explosion whose average annual growth rate of 1.04% exceeds that of the post-Neolithic surge. The political center of the Valley of Oaxaca shifted to the newly founded community of Monte Albán which rapidly came to dominate the entire valley, often through violent means (Spencer and Redmond 2001, 2003; Spencer 2003). As political integration of the growing regional population increased, regional demographic centralization decreased ($B = 0.5312$, Figs. 12 and 13), continuing Rosario phase trends. Essentially this same change has previously been observed in rank-size graphs (Kowalewski et al. 1989; Drennan and Peterson 2004), which show the development of a progressively more log-normal pattern out of the highly primate San José phase one in a regional polity whose population soared from about 2,000 to around 15,000 (some 6.8 persons per km^2). The political changes in this part of the Oaxaca trajectory were clearly well underway during the Rosario phase, but the demographic growth did not begin until Monte Albán Ia, strongly suggesting that the dynamics of political change drove the demographic processes rather than the other way around. To whatever extent initial regional centralization and social hierarchy grew directly from Neolithic demographic expansion, it is clear that by Rosario and Monte Albán Ia, new forces were at work – sociopolitical forces that disrupted the period of demographic stability.

The change from Hongshan to Lower Xiajiadian discussed above for the western Liao Valley involves remarkably similar rates of demographic increase following on the heels of relative stability. While the evidence does not make entirely clear what forces produced this upswing in population growth rates, it may be that their impetus lies in the political dynamics of small regional communities like those known for Hongshan times. The elites of such polities could have furthered their political ambitions by mobilizing more human resources toward such ends, and this would encourage population growth. In the Chifeng region, however, Lower Xiajiadian regional polities had territories no larger than their Hongshan predecessors, even though their populations had grown by an order of magnitude. Demographic centralization within these polities increased substantially, rather than decreasing as occurred in the lone Oaxaca polity, and overall, political fragmentation remained the order of the day. No Lower Xiajiadian polity shows any sign of outstripping any other in size or of dominating neighboring polities. Population densities more than an order of magnitude larger than those of Oaxaca raise the possibility that resource scarcity and competition were a fact of life in Lower Xiajiadian times – conditions that could generate inter-polity conflict and escalating growth and intra-polity demographic centralization. These last features of the Lower Xiajiadian period are not at all similar to Rosario and Monte Albán Ia times in Oaxaca. The politics of

social hierarchy may well have driven demographic change in the western Liao Valley, as in Oaxaca, but the resulting political landscape was very different. The increasingly effective large-scale projection of political authority at the heart of change in Oaxaca was never accomplished in Lower Xiajiadian times. The western Liao and Oaxaca trajectories, then, both show initial development of social hierarchy and regionally centralized communities (very soon after settled farming life in Oaxaca, much slower in the western Liao Valley). This relative political and demographic stability is later ruptured by political change and dramatic demographic growth but with rather different outcomes in terms of scale and nature of political integration.

Demographic Centralization and Political Integration

As in Oaxaca, centralized supra-local communities are in evidence from the very beginnings of settled life in the Alto Magdalena at 1000 BC (Figs. 14 and 15). The Cerro Guacas chiefdom is readily recognizable in the Formative 1 period (1000–600 BC), with a B value of 0.4462. Through Formative 2 (600–300 BC) and Formative 3 (300 BC–1 AD), this increased to 0.5592 and 0.6610, respectively. Essentially the same level of regional centralization persisted into the Regional Classic Cerro Guacas chiefdom discussed above ($B = 0.6754$), when the Alto Magdalena's chiefly social organization was in full flower. The subsequent Recent period (900–1530 AD) saw regional centralization decline to 0.5017. This rising then falling arc of regional demographic centralization follows a pattern very like that of Oaxaca (compare Figs. 13 and 15). In both cases the initial rising arc reflects a process of drawing scattered regional population toward a central place where diverse activities were carried out by and for not only the residents of the center itself but also those of a surrounding area. It was interaction involving these centralized activities that created a recognizable supra-local community whose development can be tracked through two periods of increasing demographic centralization in Oaxaca and three in the Alto Magdalena. Demographic centralization then recognizably holds steady for two periods in each sequence. Although only one regional community in the Alto Magdalena provides enough information to measure changing centralization through time, the Cerro Guacas chiefdom was one of an undetermined number of developing polities in the larger area, whereas the San José Mogote chiefdom had no immediate neighbors undergoing changes of similar magnitude.

A rising arc of regional demographic centralization might well characterize early chiefdom emergence in the Chifeng sequence as well. Although the archeological periods are much longer, centralization can be measured for several separate Hongshan supra-local communities. As noted above, the B values for these communities cover a sizeable range. This may well reflect different stages of development in different Hongshan chiefdoms by the end of the period. Those with higher centralization values might well have begun drawing surrounding populations toward their centers at an earlier date. Those with lower centralization values might have gotten a later start and thus could represent earlier stages in the drawing-in process.

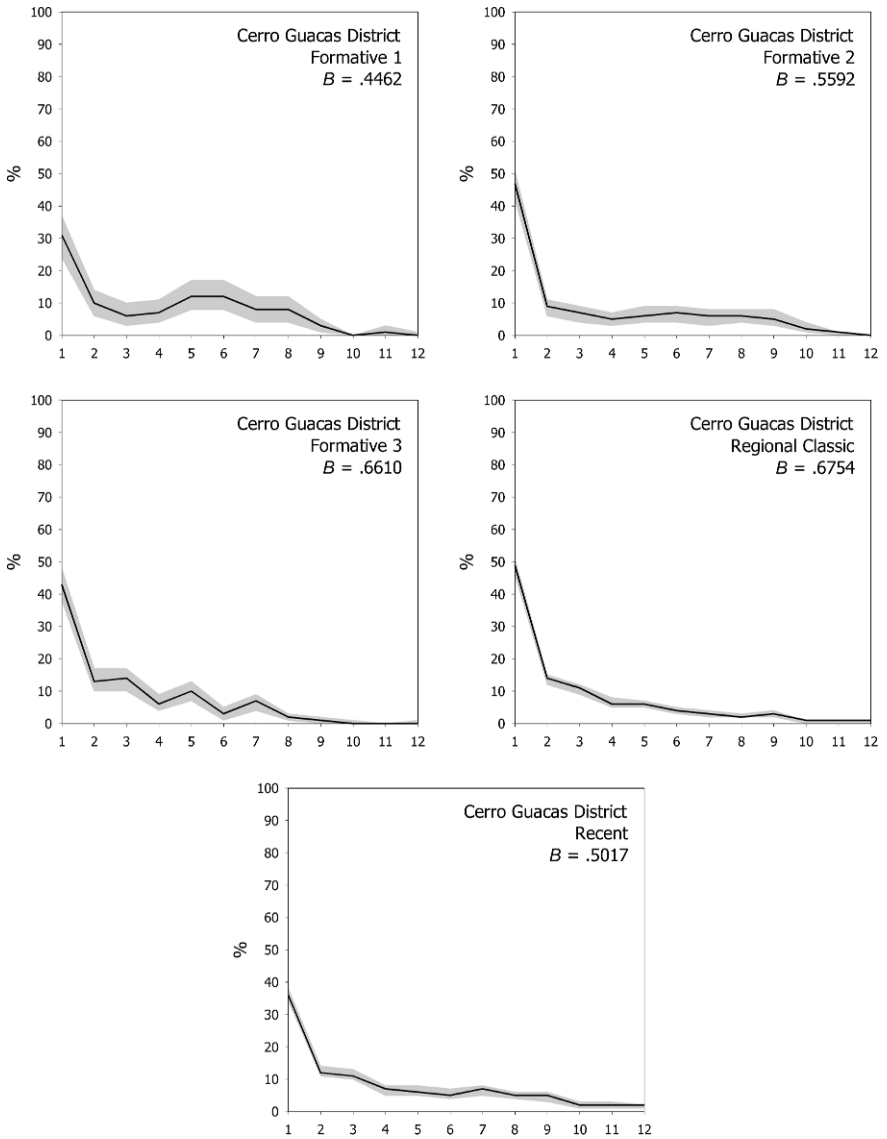

Fig. 14 Ring graphs for the Cerro Guacas chiefdom in the Alto Magdalenaa through the sequence discussed in the text (90% confidence zone)

In Oaxaca the rising then stabilizing part of the demographic centralization arc occupies the first 800 years of sedentary agricultural life; in the Alto Magdalena it takes 1900 years; and in Chifeng it takes fully 3000 years. Regional demographic centralization, however, has reached a structurally similar point in these trajectories at the end of the Guadalupe phase, the Regional Classic, and the Hongshan period.

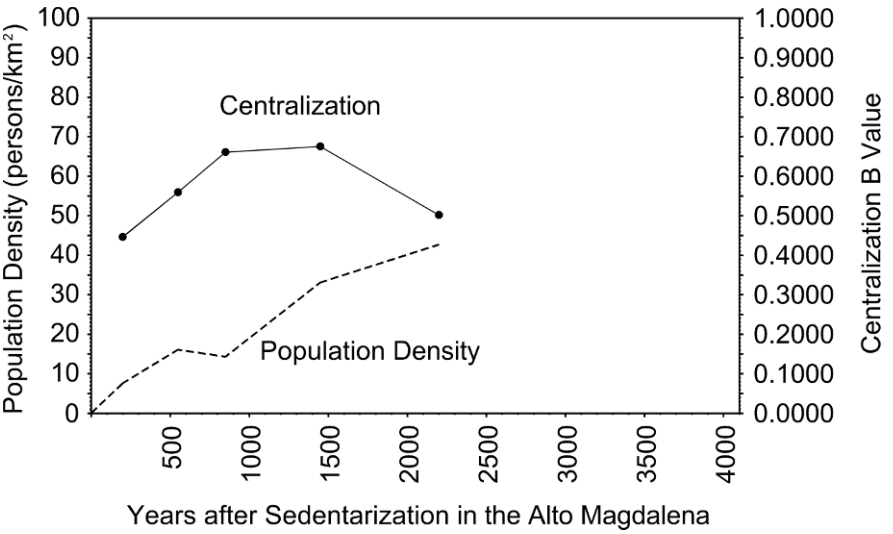

Fig. 15 Summary of changes in population density and centralization in the Alto Magdalena

The rising arc of demographic centralization in supra-local communities in Oaxaca begins during initial Neolithic population growth and continues during the subsequent demographic plateau. In Chifeng population growth is very slow, and the length of the periods makes it impossible to know whether there were episodes of more rapid change. For the Alto Magdalena, the average annual initial Neolithic growth rate between Formative 1 and Formative 2 is 0.25%, the same as the earliest Neolithic rate calculated for Chifeng and somewhat slower than that for Oaxaca. This rate soon slowed to effectively zero for Formative 3, and stayed quite low for the next 1500 years (0.09% for Regional Classic and 0.04% for Recent). It could be considered, then, that in all three regions, the rising arc of demographic centralization occurs during the postulated two-stage Neolithic demographic transition, although this would make the transition very protracted in the Alto Magdalena and glacially slow in Chifeng.

One might well imagine that these differences in pacing of regional centralization might be related to differences in demographic growth and population density levels. Oaxaca has the fastest initial Neolithic population growth rate of these three regions, and it is also the region with the fastest initial development of social hierarchy and supra-local communities. These communities, nonetheless, continue vigorous development even after the initial population growth levels off. But the difference in pacing of centralization between Chifeng and the Alto Magdalena does not correspond to a difference in the intensity of the initial Neolithic population surge, since the two regions have the same estimated rate for this stage. Surprisingly, it is the Alto Magdalena where the highest densities seem to prevail. The estimated population density for the very earliest period of sedentary living (7.6 persons per km^2 for Formative 1) is higher than that of Oaxaca 1200 years after the beginning of

sedentary agricultural life and about the same level as Chifeng at 3000 years. By the time of the Regional Classic period chiefdoms, the estimated population density of 33.1 persons per km^2 in the Alto Magdalena was about four times that of Hongshan Chifeng and nearly 40 times that of Rosario phase Oaxaca.

The falling arc of regional centralization in the Alto Magdalena begins after the Regional Classic; Recent period centralization is at a level not much above that of Formative 1. The ceremonial central places of the preceding period might still have been known and used, but no new monumental construction occurred. This has sometimes been taken to indicate the collapse of the Regional Classic societies, but it is clear that centralized supra-local communities continued into the Recent period. Their demographic centralization, however, had weakened, and the nature of the centralizing forces may have changed. Ritual veneration of highly prestigious individuals is no longer evident in the archeological record; without the centralizing pull of such activities populations shift outward from the centers. The falling arc of regional demographic centralization in the Alto Magdalena, then, does not correspond, as it does in Oaxaca, to the emergence of new and more powerful forms of regional political integration.

The Alto Magdalena centralization trajectory is also unlike that of the Chifeng region, where demographic centralization continues to rise with the multiplication of competing polities up to 5000 years after the beginning of settled life. In Lower Xiajiadian times, a high level of conflict was an impediment to political consolidation, whereas in Oaxaca conflict was integral to the amalgamation of neighboring smaller communities into the expanding single dominant polity. Lower Xiajiadian conflict was not a constructive force in political development because it arose from localized population growth and resource scarcity. Population densities within these small highly centralized polities ranged up to nearly 600 persons per km^2, and were often above 300 persons per km^2. Larger polities faced more severe resource pressure and became more likely to fission as some residents moved away to found new polities in more sparsely occupied territory. Leaders would be more likely to further their political ambitions by raiding neighboring polities than by seeking the growth of their own polities, either through internal demographic increase or forcible incorporation of their neighbors. These were not propitious circumstances for the development of means of political incorporation that permitted effective control of less centralized populations. Nothing about this dynamics promoted the kind of forcible amalgamation through which larger scale political integration was achieved in Oaxaca.

A dynamic very different from that of Oaxaca or the western Liao Valley produced the Recent period political landscape in the Alto Magdalena. Oaxaca elites were motivated to expand their wealth and increase their power by bringing more people under their control through the forcible domination of smaller villages. In contrast, Alto Magdalena elites were not engaged in wealth accumulation; their power sprang solely from the supernatural; high population densities provided ample subordinate labor; and the dispersed residence pattern meant there were no small neighboring easily subjugated villages. This pattern appears to spring from a very high degree of economic redundancy and self-sufficiency among Alto Magdalena

households – characteristics that seem already set at the very beginning of settled agricultural life. Greater differentiation in activities between Oaxaca households produced more intense interaction, and laid the foundations for the region's dynamics of elite exploitation. As in the Alto Magdalena, the fundamental character of household interaction in Oaxaca was in place at the beginning of settled life. The social dynamics of the Alto Magdalena led to slow population growth that continued right through the Recent period, reaching a level of 42.7 persons per km^2, far above the population density of the Valley of Oaxaca, even after the Monte Albán Ia (500–300 BC) surge. The rich resources of the Alto Magdalena, however, meant that even this large population did not create a pattern of resource scarcity (Drennan and Quattrin 1995). As Regional Classic polities moved into the Recent period, they thus did not enter the cycles of conflict with each other that led to a stalemate among a growing number of densely packed competitive Lower Xiajiadian polities. Although the populations of the Alto Magdalena's polities grew slowly, elite status shifted away from its strongly religious base, and the forces of centralization weakened (Drennan 1995).

A final comparison permits further exploration of the roles played in political development by different bases of power utilized by emerging elites. At about the same time that the San José Mogote chiefdom was emerging in the Valley of Oaxaca, broadly similar social developments were underway in the Basin of Mexico, some 400 km to the north (Sanders, Parsons, and Santley 1979). The Early Horizon (1500–1150 BC) represents the beginning of sedentary agricultural living at the same time as in the Valley of Oaxaca. Population density (1.3 persons per km^2) was slightly higher in this first agricultural period than in the other regions discussed. Like Oaxaca, local communities were not numerous, but some of them were extraordinarily large compared to the earliest villages in Oaxaca or the western Liao Valley – nearly half the known settlements had populations numbering several hundred or more. Initial Neolithic population growth was rapid (about 0.32% per year), resulting largely from an increasing number of ever larger local communities. By First Intermediate 2 (650–300 BC) there were six local communities numbering several thousand inhabitants apiece. Burial evidence for social hierarchy, together with public architecture and ritual spaces, suggests these were chiefdoms on a demographic scale similar to those of other regions, but they had very little of the supra-local community structure we have identified in other regions. Smaller settlements just did not cluster around these larger communities at all consistently (Drennan and Haller, 2007).

We have suggested that the formation of compact local communities could result from economic specialization and interdependence, and that this in turn could provide the basis for social hierarchy predicated on wealth accumulation. Of the regions we have discussed, the Alto Magdalena shows the least development of specialization and wealth accumulation and by far the most dispersed settlement pattern throughout the sequence. Hongshan chiefdoms exhibit stronger evidence of specialization and economic differentiation, occurring in recognizable but only moderately compact local communities. The considerably more nucleated villages of the Valley of Oaxaca sequence display still greater evidence of economic specialization and wealth accumulation. The remarkable degree to which social life

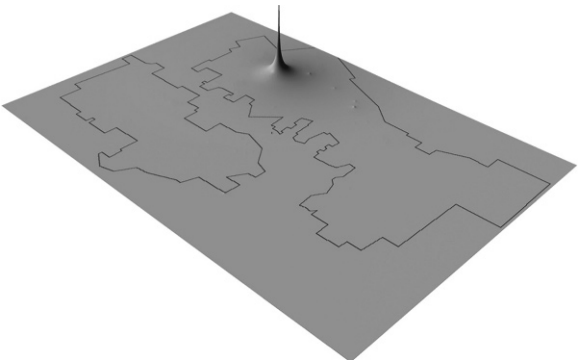

Fig. 16 A smoothed surface representing the demographic density across the Basin of Mexico during First Intermediate 4 times. The survey area is outlined

was concentrated into large, compact, local communities would place the Basin of Mexico still farther along this dimension – an unusual example, in fact, of large but compact single-community chiefdoms. If the same factors were involved in local community nucleation as in the other three regions, we might imagine that these chiefdoms showed even more elaboration of economic specialization and greater concentration of control over the local economy in the hands of elites.

In First Intermediate 3 (300–100 BC) regional population density exceeded 20 persons per km^2, and these compact chiefdoms came to number a dozen or more, even though the population growth rate dropped substantially (to 0.06% per year). With the emergence of urban Teotihuacan in First Intermediate 4 (100 BC–100 AD), there is firm evidence of the intensive craft specialization under elite control that might characterize earlier periods. As often recognized in rank-size graphs (Blanton 1976), Teotihuacan was an extremely compact primate urban state capital that had drawn in practically the entire population of the region (reflected in a *B* value of 0.9170 for First Intermediate Four, Figs. 16–18). These extreme characteristics of Teotihuacan are perhaps less surprising than they have sometimes seemed, when we

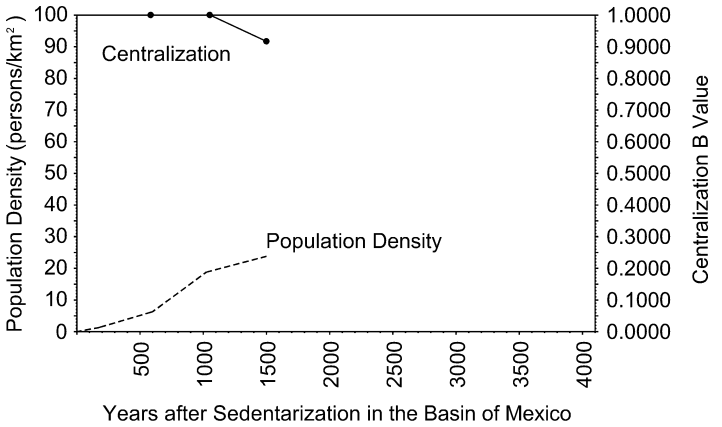

Fig. 17 Ring graph for the Basin of Mexico during First Intermediate 4 times (90% confidence zone)

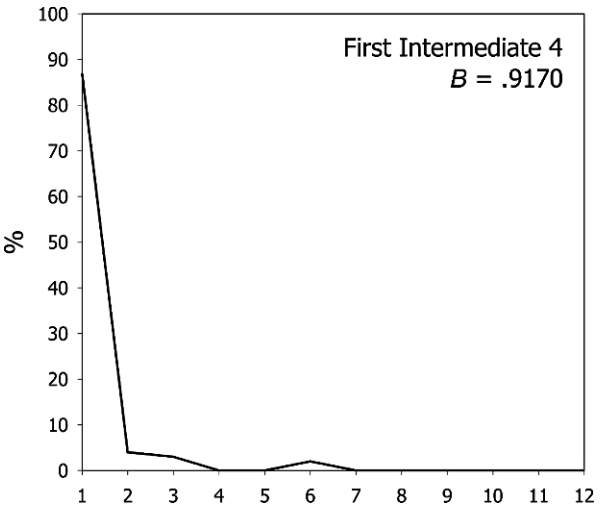

Fig. 18 Summary of changes in population density and centralization in the Basin of Mexico

see them as the culmination of a long tradition. From very early on in the Basin of Mexico trajectory, entire social systems that in most regions would have had a strongly supra-local character, were encapsulated in unusually large single local communities (Drennan and Haller, 2007).

Developmental Dynamics

Broadly parallel developments followed the establishment of sedentary agricultural life in the four regions discussed here: hierarchical social relations became a fundamental principle integrating substantially larger communities than had existed before. In general terms, at least, the "Neolithic Revolution" did open the door to these developments. Most fundamentally, agricultural subsistence provided for sustaining relatively dense sedentary populations. The intensified social interaction within these populations provided both organizational challenges and new opportunities for individuals and groups. These challenges were faced and opportunities taken advantage of in highly varied ways in different developmental trajectories.

Centralization turns out to be a more complicated subject than usually thought. The emergence of hierarchical social organization does often lead to centralized supra-local communities, but sometimes the forces of demographic centralization are so strong, as in the Basin of Mexico, as to virtually overcome the supra-local character of these systems. More effective political integration is not always accompanied by greater demographic centralization. In the Valley of Oaxaca, as the San José Mogote chiefdom extended greater control over a growing territory, the regional centralization of the chiefdom decreased. Demographic centralization was extremely strong in the Basin of Mexico, but even the very high centralization values

for early Teotihuacan should probably be considered a decrease from First Intermediate 1 and 2, whose large local communities had no easily recognizable supra-local manifestation and thus could reasonably be assigned maximal B values of 1.0000. The Alto Magdalena and the western Liao Valley conform better to simple expectations; the main trajectories of social development discussed here occurred in increasingly centralized supra-local communities. When the Alto Magdalena reached a falling arc of centralization, it was not a period of territorial consolidation, as in Oaxaca, but one of decreasing political integration.

Village living and consequent increased need for conflict resolution often accompanied agricultural emergence, but the development of complex social organization in the Alto Magdalena without any village structure shows that local crowding and conflict resolution are not essential ingredients. Neither are high levels of economic interdependence, as shown again by the Alto Magdalena with its poorly developed specialization. The interrelated absence of village life and weakness of economic specialization may have limited the possibilities for aspiring elites in the Alto Magdalena to mediate conflicts and accumulate wealth. Perhaps as a consequence, religious and symbolic sources of power loomed large in Alto Magdalena chiefdoms (cf. Earle 1997). The high regional population densities in the Alto Magdalena may also have had a hand in the emergence of complex social organization there. High levels of interaction provide a fertile matrix for elite activities – levels unlikely to be achieved in a dispersed settlement system unless regional population density is high and neighbors are thus closely spaced.

In contrast to the Alto Magdalena, the village organization of Oaxaca and Chifeng appears to have fostered specialization and economic interdependence, and the same may be true of the Basin of Mexico during the first millennium of sedentary life, as it was later on. In all three of these regions, but not in the Alto Magdalena, economic differentiation was an important part of chiefdom development. The local community matrix of economic interdependence may have provided the critical opportunity for some households to concentrate wealth and for this economic inequality to contribute to increasingly hierarchical organization, as it clearly did in the Basin of Mexico, Oaxaca, and the western Liao Valley. Religious sources of power, so central in the Alto Magdalena, were also important in elite activities in the other three regions, but the economic aspect of hierarchy was much more strongly developed.

Effective means of managing local conflict are especially important when economic interdependence is strong, as appears to have been the case in the three regions with compact local communities. This must be especially true for the Basin of Mexico, where villages of several hundred inhabitants or more were among those of the very first sedentary period. Within a millennium of agricultural beginnings, the Basin of Mexico had multiple single local communities with populations of several thousand – larger populations than entire regional chiefdoms like San José Mogote in Oaxaca. It is clear that very effective means of preventing large local communities from fissioning were in place in the Basin of Mexico from the beginning of the Neolithic. In such well-integrated communities, economic specialization could generate powerful centripetal forces drawing population into rapidly growing

local communities. With Oaxaca's low regional population densities and small local communities, the demographic centripetal forces were weaker. Social growth came through progressive forcible amalgamation of neighboring communities, which remained spread across the landscape, and gave a much more territorial character to chiefdom organization in Oaxaca. In smaller local communities economic development would not be so strongly encouraged, problems of local conflict were less severe, political organization had a more supra-local character, and projection of coercive power at larger distances was more effective.

Oaxaca elites, in such a setting, could further their political ambitions through territorial expansion; conditions did not especially spur regional population growth, and the bulk of the social change of the first millennium of sedentary living occurred during centuries of little or no regional demographic increase. Basin of Mexico elites, on the other hand, thrived in large communities, where robust local population growth right through the first millennium of sedentary living steadily expanded economic opportunities. In contrast to both these sequences, the first millennium-and-a-half of sedentary living in the western Liao Valley saw very little demographic or social change. Demographic growth added up substantially through the subsequent three-and-a-half millennia, as small territorial polities emerged and multiplied. These all stayed below 1,000 inhabitants until they had filled the landscape, when demographic growth turned inward, producing supra-local polities of several thousand people that were still territorially quite small. Some 5,000 years of sedentary living in the western Liao Valley had produced regional polities of no greater population than single towns in the Basin of Mexico a mere millennium into the Neolithic.

The establishment of sedentary agricultural living, thus, did initiate a series of social changes that progressively unfolded in different regions. In some regions these changes were underway in the very midst of the Neolithic demographic transition; in others, they were so long delayed that it is difficult to place the Neolithic demographic transition in a causal role in the conventional sense (cf. Bandy, Global Patterns of Early Village Development). The changes also unfolded in different ways, producing complex hierarchical social organizations of persistently different flavors. These different flavors are detectable in the interaction structures of the earliest sedentary occupations, whether highly dispersed or compactly nucleated. The dynamics of the emergence of elites, and ultimately the nature of social power, depended on the ways in which these matrices of interaction presented different challenges and opportunities. Trajectories of complex society development were thus conditioned by the ways in which hunting and gathering bands formed the first Neolithic communities in different regions.

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