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Settlement and subsistence among the Early Formative Gulf Olmec

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ABSTRACT

Mounting archaeological evidence suggests that floodplain resources, not maize (*Zea mays*) agriculture, were instrumental in the emergence of Early Formative (ca. 1500–900 uncal BC) complexity across Mesoamerica's isthmian lowlands. The lion's share of these data derives from the Pacific side of the isthmus; discussions of the Early Formative Olmec along Mexico's southern Gulf lowlands have not kept pace. This paper presents settlement and subsistence data that highlight the role of floodplain resources in the development of Gulf Olmec politico-economic complexity. These data support a non-agricultural alternative to traditional models of Gulf Olmec emergence at San Lorenzo, the premier Early Formative Gulf lowlands center. Increased productivity of maize toward the end of the Early Formative period challenged San Lorenzo's extant politico-economic basis, bringing about a short-term, hyper-acceleration of elite competitive displays. Ultimately, the adoption of maize agriculture generated a reorganized Middle Formative period (ca. 900–400 uncal BC) landscape in and around San Lorenzo. This agrarian adjustment saw occupation move out of the floodplain and into the upland areas, a process sometimes characterized as a cataclysmic system collapse in the Coatzacoalcos basin.

Although they have not eaten in over 3000 years, Early Formative (1500–900 BC)[1] occupants of Mexico's isthmian lowlands appear to be changing their diet. Traditionally framed as maize (*Zea mays*) agriculturalists (e.g., Caso, 1965, pp. 34–35; Coe and Diehl, 1980a, p. 389; Willey and Phillips, 1958, pp. 144–151), more recent research presents these Early Formative groups as practicing a thoroughly mixed subsistence strategy, characterized by a primary reliance on floodplain resources and only limited maize cultivation (e.g., Arnold, 2000, pp. 128–129; Clark et al., 2007; Wendt, 2003, p. 548).

Published evidence for this dietary shift derives primarily from fieldwork conducted along the Pacific coast of the isthmian lowlands. Researchers there have proposed that maize was a minor component of Early Formative subsistence (Blake, 2006; Blake et al., 1992a,b; Chisholm and Blake, 2006; Clark et al., 2007; Rosenswig, 2006). This realization led some scholars to re-evaluate maize agriculture's role in the origins of politico-economic complexity in lowland Mesoamerica and to look instead toward the mechanisms of social competition and feasting within a coastal environment rich in natural resources (e.g., Clark and Blake, 1994; Hill and Clark, 2001; Smalley and Blake, 2003).

Discussions of the Early Formative Olmec along Mexico's southern Gulf lowlands have not kept pace. Although the availability of substantial estuarine/riparian resources is frequently acknowledged, maize continues to hold center stage in accounts of the emergent Gulf Olmec political economy. At San Lorenzo, the premier Early Formative Gulf Olmec site, maize recently reprised its role as "the Olmec staple" (Diehl, 2004, p. 85) while aquatic resources such as fish and turtle earned secondary billing as occasional "banquet food" (Cyphers, 1996, p. 66, 1997a, p. 266).

Despite such claims, mounting archeological evidence encourages a reassessment of corn's clout in the development of Gulf Olmec complexity. I undertake that review here, employing data from Early Formative contexts in southern Veracruz, Mexico. I adopt this spatio-temporal focus because it subsumes the autochthonous development of San Lorenzo, widely regarded as the earliest Gulf Olmec political center (Clark, 1997; Diehl, 2004; Grove, 1997; Pool, 2007).

I do not consider fieldwork in and around La Venta, in western Tabasco. Although La Venta may contain an Early Formative component (e.g., Raab et al., 2000; Rust and Leyden, 1994; Rust and Sharer, 1988), politico-economic complexity at the site is generally attributed to the Middle Formative period (900–400 BC) and thus post-dates the Early Formative changes addressed here (González Lauck, 2000; Pool, 2007, pp. 158–160). Moreover, there is ample evidence that corn agriculture underwrote La Venta's politico-economic complexity (e.g., Rust and Leyden, 1994; Pope et al., 2001); the present discussion considers the forces in play prior to that economic transformation. Finally, the socio-political connection between San Lorenzo and La Venta remains murky (Grove, 1997,

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[1] All dates are uncalibrated radiocarbon years unless otherwise specified.

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p. 76; Pool, 2007, p. 160). La Venta's sculptural corpus suggests that kinship ties and/or ideological referents to San Lorenzo fueled La Venta's own political rise (e.g., Cheetham, 2009, p. 261; Grove, 1981, pp. 66–67). The processes behind such secondary political formations generally differ from the pristine development of politico-economic complexity proposed for San Lorenzo and considered below (e.g., Marcus, 2008, p. 259).

The following discussion argues that available archeological data from southern Veracruz track the same pattern of minimal Early Formative maize dependence already documented along the Pacific coast. Rather than an agricultural base, I propose that the control and exploitation of floodplain and wetland resources provided the foundations for the initial Gulf Olmec political economy. In fact, the available data suggest that an agrarian adaptation along the southern Gulf lowlands may have precipitated the collapse of San Lorenzo at the end of the Early Formative period.

I make the case in several parts. The first section offers a brief overview of current subsistence models as they relate to the emergent Early Formative Gulf Olmec. Such discussions have generally emphasized either the importance of agricultural farmland controlled by Olmec elite (e.g., Coe, 1981a; Coe and Diehl, 1980a, p. 389) or the likelihood that agricultural shortfalls encouraged governmental intervention and the creation of a regionally integrated settlement network (Symonds et al., 2002, pp. 78–79). Nonetheless, data ranging from isotopes to iconography suggest that an agrarian economy post-dates the onset of institutionalized inequality at San Lorenzo. Moreover, appeals to maize as a prestige food and/or suggestions of alternative domesticated crops are unconvincing in the face of published evidence. Rather, managed floodplain resources augmented by minimal maize production appear to underwrite the Early Formative Gulf Olmec political economy.

In the second section, summaries of four settlement surveys highlight an initial Early Formative emphasis on estuarine/riparian environments, with significant settlement shifts toward upland zones by the end of the Early Formative period. Section three bolsters these settlement patterns with excavation data from La Joya, a site within the Tuxtla Mountains of southern Veracruz. La Joya exhibits a well-documented occupational sequence spanning the Early and Middle Formative periods and currently provides the most robust published dataset on Gulf Olmec subsistence (VanDerwarker, 2006). Taken together, the data from regional settlement studies and the La Joya excavations strongly suggest that a Gulf Olmec agrarian lifestyle occurred well after initial Early Formative socio-political developments commenced.

The paper's final section explores these implications for the arc of the Early Formative Gulf Olmec. I argue that the control of localized extraction points for floodplain resources and/or extraction technologies underwrote initial factional competition and alliance building in the area around San Lorenzo. This economic basis provided the impetus for Gulf Olmec development until the latter portion of the Early Formative period.

Improvements in maize productivity between ca. 1000–900 BC (e.g., Blake, 2006; Clark et al., 2007; Rosenswig, 2006) likely challenged the floodplain-focused economy and the cultural codes that had developed around it. Permanent settlements and politico-economic relationships that did not rely on the floodplain resources became increasingly viable, undermining the control exerted by the extant leadership and their dominant ideology (e.g., Arnold, 2005a). Facing these challenges, some leaders responded with an accelerated program of monumental installations and inter-regional exchange in an attempt to entice, cajole, and otherwise convince their constituents to maintain the traditional floodplain-oriented economy. These attempts ultimately proved futile and corn farming was widely adopted throughout the region. Thus, what has been viewed as a cataclysmic collapse at San Lorenzo (e.g., warfare, tectonic activity) is better approached as a successful demographic and settlement re-organization that reflects new subsistence strategies and alternative mechanisms of social integration (e.g., Tainter, 2006).

Background

As traditionally framed, the Gulf Olmec region stretches from the Papaloapan basin on the west to the Tonalá drainage on the east, and includes the marquis sites of San Lorenzo, La Venta, and Tres Zapotes (Fig. 1). The area also includes the Tuxtla Mountains, an isolated volcanic uplift characterized by fertile agricultural land, abundant rainfall, and multiple sources of fresh water (e.g., Andrle, 1964). Recent questions have been raised regarding the inclusion of the Tuxtlas within the "true Olmec core zone" (Diehl, 2004, pp. 18–19; see discussion in Pool, 2007, pp. 13–14, 130–132); the present discussion sides with the majority opinion and keeps the Tuxtlas within the traditional Olmec "heartland" (e.g., Grove, 1997; Lowe, 1989; Pool, 2007).

The Gulf Olmec zone receives considerable attention as the location of emergent, *in situ* politico-economic complexity (Clark, 1997, 2007; Cyphers 1997f; Diehl, 2004; Pool, 2007). Maize agriculture offers a favored touchstone to reconstruct that development. Terms like agriculture and horticulture can be problematic (e.g., Smith, 2001): as used here, agriculture (farming) denotes a primary cultural commitment to, and reliance on, domesticated plants while horticulture (gardening) reflects small-scale investment in the production and consumption of cultigens. From an archeological perspective, each food-producing system has different implications for the location of cultivated plots and the activities carried out at those places (e.g., Drennan, 1988; Killion, 1992, 2008; VanDerwarker, 2005, 2006).

Earlier treatments of Gulf Olmec subsistence discussed the productivity of tropical lowland agricultural practices (e.g., Dumond, 1961; Heizer, 1960). Based on such examinations, Sanders and Price (1968, p. 131) concluded that swidden agriculture could have generated per-capita surpluses and supported rapid population growth among the Gulf Olmec. Ten years later Sanders and Webster (1978, p. 290) suggested that the Gulf Olmec environment, marked by low agricultural risk and relative resource homogeneity, generated a hierarchical society in which competition played a larger role than redistribution.

Competition coupled with maize agriculture also figured prominently in the model of Gulf Olmec development proposed by Michael Coe (1981a; Coe and Diehl, 1980a, p. 389, 1980b, pp. 147–152). That model, based in part on Carniero's (1970) "circumscription theory" and informed by ethnographic observation, suggested that Early Formative elites underwrote their power base directly through maize agriculture and the control of fertile river-levee farmland. The localized productivity of the river levees allowed these families to sponsor larger festivals, larger work parties, and even assist smaller communities during times of need. Moreover, this additional surplus made it possible to support a militia, giving the San Lorenzo elite "a clear military power advantage" (Coe and Diehl, 1980b, p. 148) over surrounding smaller communities.

Rathje (1972) suggested that resource deficiency, rather than homogeneity, was primarily responsible for the development of Gulf Olmec society. According to this perspective, the southern Veracruz lowlands suffered a dearth of necessary products, including hard stone to grind maize. An institutional hierarchy developed within the Gulf Olmec core area in order to manage and oversee the acquisition of these necessities (Rathje, 1972). Obtaining these goods meant using maize surpluses to underwrite the manufacture of "sociotechnic and ideotechnic products" that could be traded (Rathje, 1972, p. 373). Thus, maize farming prefaced, and contributed to, the origin and maintenance of Gulf Olmec complexity.

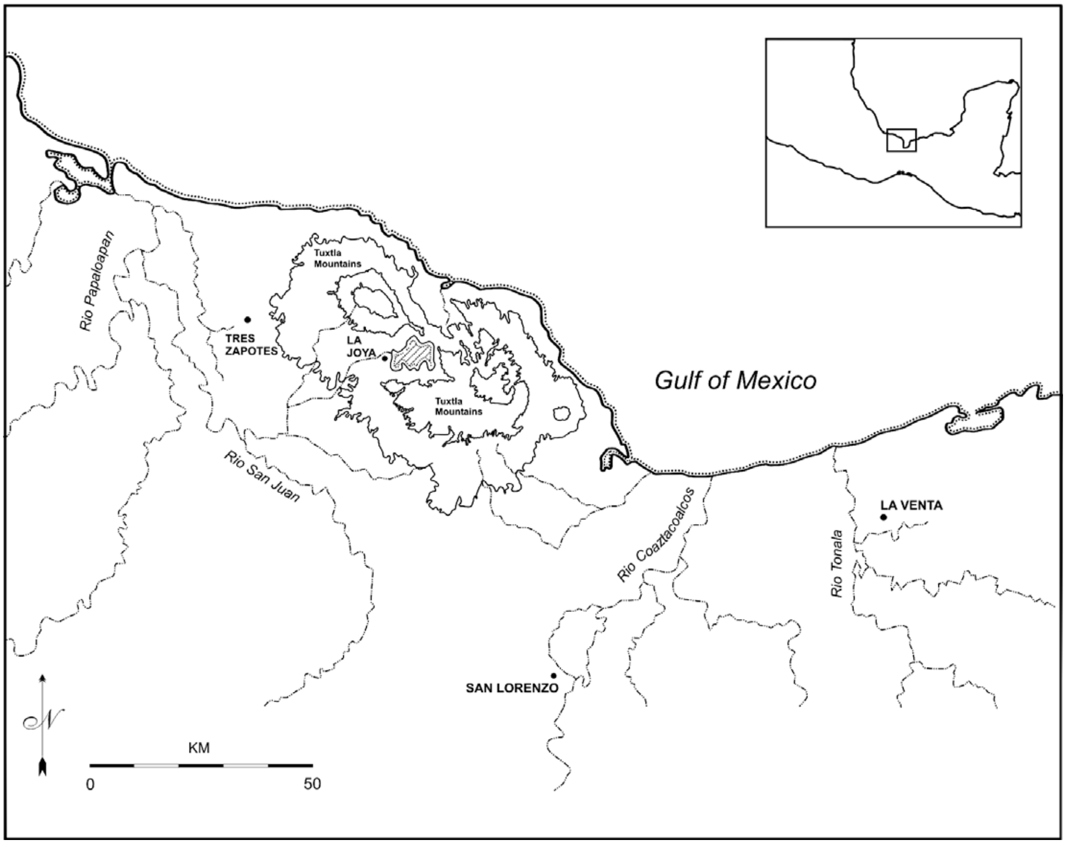

Fig. 1. The Gulf Olmec region, showing major archeological sites.

Symonds et al. (2002, pp. 78–80) offer an inventive twist on Rathje's (1972) deficiency model, arguing that population growth at Early Formative San Lorenzo created shortfalls in the maize harvest. Crop deficits in the immediate vicinity of San Lorenzo were offset by importing corn from the outer portions of the San Lorenzo hinterland. From this perspective maize agriculture—or rather its occasional failure—was instrumental in the development of a regional redistribution system centered at San Lorenzo (Symonds et al., 2002, pp. 79–80).

In one form or another, the above models for emergent complexity at San Lorenzo reflect what Jeanne Arnold (1996, pp. 3–4) calls "agricentrism"—the assumption that agriculture was intimately involved in the development of politico-economic complexity. Several lines of information encourage a re-evaluation of this agricentric bias with respect to the Gulf Olmec emergence.

Perhaps the single most revealing fact is the paucity of botanical remains reported from San Lorenzo. Coe and Diehl (1980b, p. 144) did not recover direct evidence of maize and instead relied on the presence of ground stone artifacts as a proxy for maize farming. More recent fieldwork at San Lorenzo has recovered maize microfossils; nonetheless, published data identified maize phytoliths in only 9 of the 59 (15%) reported samples (Zurita Noguera, 1997). And while the acidic nature of Gulf lowland soils may share part of the blame, it is worth remembering that carbonized plant remains should be less susceptible to such destruction than the many small, uncarbonized fish bones recovered from San Lorenzo (see below).

Available data from the Pacific coast of the isthmian lowlands also suggest that maize agriculture was not a common practice during the Early Formative period. Bone isotope studies consistently indicate that maize constituted a minor contribution to the Early Formative diet (Blake et al., 1992a,b; Chisholm and Blake, 2006). Clark et al. (2007) propose that maize became a staple crop only after it crossed a productivity threshold toward the end of the Early Formative period. Such a productivity threshold may have included new strains of maize or changes in maize processing (e.g., Diehl, 2004, p. 86). Rosenswig (2005, pp. 148–149, 2006) observes that Early Formative subsistence in the Soconusco region of coastal Chiapas included a wide range of wild resources, with fish making a considerable dietary contribution. Maize agriculture did not become important until the Middle Formative period, when changing environmental conditions were "conducive to increased plant production" (Rosenswig, 2006, p. 330).

Nonetheless, several scenarios might salvage an agricentric Gulf Olmec model. Maize products in the form of fermented feasting beverages may have been manipulated by aggrandizers, a model proposed for the Soconusco region (e.g., Clark and Blake, 1994; Hill and Clark, 2001; Smalley and Blake, 2003). Elaborately embellished ceramic containers provide a crucial line of evidence in this feasting model (e.g., Clark and Blake, 1994; Clark and Gosser, 1995). Moreover, Clark and Gosser (1995, p. 213) underscore the widespread occurrence of these decorated vessels within their excavated assemblage, emphasizing that "an unmodified surface on a Barra [phase] sherd is unusual."

The ceramic assemblage of the Early Formative Gulf Olmec, however, differs markedly from its Soconusco counterpart (Rosenswig, 2006, pp. 343–345). This difference was famously recognized by Coe and Diehl (1980a, p. 137; also Coe, 1981b, p. 123) who characterized the earliest pottery at San Lorenzo as a "country cousin" version of the "far more sophisticated" Soconusco ceramics.

Of course, a more appropriate comparison involves the ceramics from the Chicharras and San Lorenzo phases, that era when political complexity at San Lorenzo is said to have developed (e.g., Diehl, 2004; Pool, 2007). But despite the presence of a few decorated types (e.g., Calzadas Carved, Limon Incised), the San Lorenzo pottery from this period fails to match the Soconusco precedent of an elaborate, and ubiquitous, ceramic tradition. In fact, Stark (2007, Table 3.1) notes that only 2% of sherds from Coe and Diehl's (1980a) San Lorenzo excavations contained excised Olmec motifs. If Early Formative Gulf Olmec aggrandizing included maize-derived beverages served in elaborate pottery vessels, those activities are poorly represented in the published ceramic record.

Indirect evidence from other media supports these assessments. Studies of Olmec iconography indicate that maize imagery did not become prominent in sculpture and portable art until the Middle Formative period (Taube, 2000). As I have argued previously (Arnold, 2000, p. 120, 2005a, pp. 6–7) this temporal association is counterintuitive if the manipulation of maize and/or maize farming was a fundamental component of emerging power strategies during the Early Formative period.

But if maize was not a dietary staple, what was? Perhaps manioc (*Manihot esculentum*) provided the basic foodstuff for the Early Formative Gulf Olmec. Although a possibility, there is even less evidence for manioc than maize in Early Formative Gulf Olmec deposits. The only published evidence is a single pollen grain "that is probably from domesticated manioc" obtained from a sedimentary core near La Venta (Pope et al., 2001, p. 1373). Cyphers and Zurita-Noguera (2006, p. 39) cite a personal communication that manioc phytoliths have been recovered at San Lorenzo, but a more detailed account awaits publication. Thus, while it is true that an absence of evidence is not the same as evidence of an absence, the published data simply do not support a conclusion regarding manioc's role in the Gulf Olmec emergence.

To date, Gulf Olmec researchers have paid far less attention to aquatic resources as a potential basis to underwrite sedentism and politico-economic complexity. Of course, scholars regularly note that aquatic resources would have been available to the Early Formative inhabitants of San Lorenzo (e.g., Coe, 1981a, p. 17; Cyphers and Zurita-Noguera, 2006, pp. 37–38; Ortiz Pérez and Cyphers, 1997, p. 37; Symonds et al., 2002, pp. 60–61). Ironically, this same availability was used to negate the potential role of aquatic foodstuffs in the developing political economy. Coe and Diehl (1980b, p. 146) make this point succinctly: "If one is looking for entailable resources to explain the rise of the Olmec elite, fish and other aquatic life can be excluded."

Aquatic resources undoubtedly played a dominant role in the Early Formative San Lorenzo diet. Initial analyses conducted by Elizabeth Wing (in Coe and Diehl, 1980a, pp. 375–386) suggested that terrestrial species comprised the majority of recovered San Lorenzo fauna. In a rarely-cited re-analysis of those same data (but published before Coe and Diehl's (1980a,b) volume) Wing (1978) re-calculated and significantly increased the proportional contribution of fish within the San Lorenzo dataset. Those new figures indicate that snook (*Centropomus* sp.) supplied one-half of all edible protein within the recovered San Lorenzo sample and that aquatic species in general made up over 60% of the consumable meat.

Coe and Diehl's (1980b, p. 146) observation regarding "entailable resources" implies that aquatic foodstuffs are unlikely candidates for politico-economic manipulation. More recent discussions dispute this point; several well documented cases of precisely such manipulations have received attention (Sassaman, 2004). And while no one would reasonably argue that the Early Formative Gulf Olmec were simply tropical versions of Pacific Northwest groups (e.g., Ames and Maschner, 1999) or coastal Peruvian societies (e.g., Moseley, 1975; Stanish, 2001), the Calusa of southwestern Florida (Marquardt, 1985; Patton, 2001; Widmer, 1988) provide clear evidence for non-agrarian, politico-economic complexity in a lowland coastal setting along the Gulf of Mexico.

The possibility that floodplain resources played a much larger role—and maize farming a considerably reduced role—in the Gulf Olmec emergence is supported by recent archeological data from southern Veracruz. Below I present two dataset to advance the case. The first comprises four settlement surveys that track similar transitions in the Gulf Olmec exploitation of their landscape. The second involves excavation data that yield fine-grain and direct information on Gulf Olmec subsistence practices. These independent lines of evidence converge on the importance of floodplain resources and the limited role of maize agriculture for the Early Formative Gulf Olmec.

Gulf Olmec settlement patterns

Large-scale survey projects currently provide some of the most significant archeological data related to Gulf Olmec complexity. Four surveys are particularly relevant to our discussion (Fig. 2): from east to west these project include the *Recorrido Arqueológico en la Región Olmeca* (RARO) along the east side of the Coatzacoalcos basin (Kruger, 1996, 1997), the *Reconocimiento Regional San Lorenzo* (RRSL) along the west side of the same river system (Symonds et al., 2002), the *Recorrido San Lorenzo Tenochtitlán—Laguna de los Cerros* (RSLTLC) within the San Juan drainage (Borstein, 2001), and the Sierra de los Tuxtlas survey in the west-central Tuxtla Mountains (Santley, 2007; Santley and Arnold, 1996; Santley et al., 1997).[2] In combination, these four projects systematically surveyed a total area that exceeds 1150 km^2.

Several of these datasets have been subject to summaries and syntheses (e.g., Arnold and Stark, 1997; Cyphers and Zurita-Noguera, 2006; Pool, 2005, 2007). Thus, a detailed recounting is not in order. Instead, here I simply highlight those aspects of the survey data that speak most directly to subsistence-related behavior. Obviously, the specifics of individual survey projects (field conditions, number of personnel) may conspire to "complicate" these summary efforts (Pool, 2005, p. 229), but such complications are mitigated by the different surveys' use of similar reconnaissance techniques and reliance on the same basic suite of ceramic diagnostics. I group these studies into two major zones: lowland plains (Coatzacoalcos basin and San Juan drainage) and highlands (Tuxtla Mountains) (e.g., Grove, 1994).

Settlement in the lowland plains

The RRSL survey encompasses a 400 km^2 region around San Lorenzo. The earliest Early Formative settlements date to the combined Ojochi-Bajío phase (1500–1200 BC). Approximately 75% of these sites were occupied seasonally and include *islotes* and *caseríos* (Symonds et al., 2002, Fig. 4.4). *Islotes* (small, low platforms in the floodplains) were used to access and process floodplain resources (Symonds et al., 2002, pp. 42–43). Small *caseríos* (ephemeral artifact scatters) also represent seasonal use and may reflect fishing, hunting, collecting, and/or cropping (Symonds, 2000, pp. 58–62; Symonds et al., 2002, p. 44). According to Symonds et al. (2002, p. 61) the *islotes* underscore the importance of aquatic resources and perhaps the early establishment of use-rights over certain floodplain areas.

Permanent Ojochi-Bajío occupation appeared in the upland areas outside the floodplain (Fig. 3). One such occupation occurred atop the San Lorenzo plateau, a natural promontory that was circumscribed by navigable waterways (e.g., Cyphers and Arturo

[2] Additional regional surveys have been completed in the western Gulf Olmec region but are not include here due to the spatial/temporal detail of published settlement information (e.g., Killion and Urcid, 2001). Nonetheless, Killion (personal communication, 2009) suggests that these survey data support the overall argument presented here.

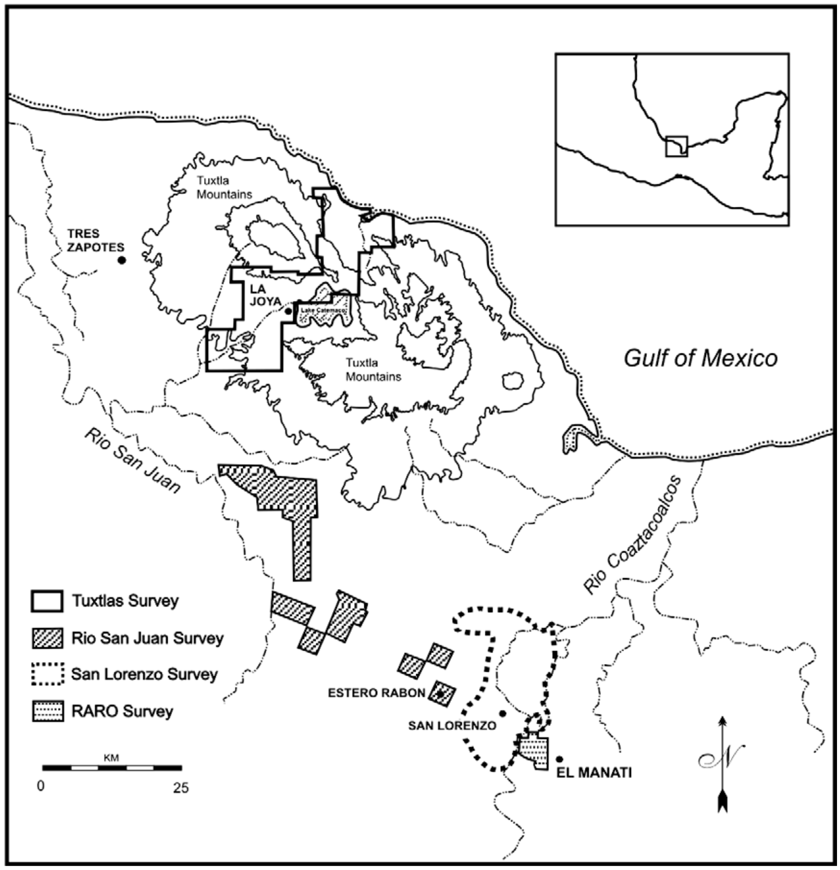

Fig. 2. Settlement surveys carried out in southern Veracruz, Mexico.

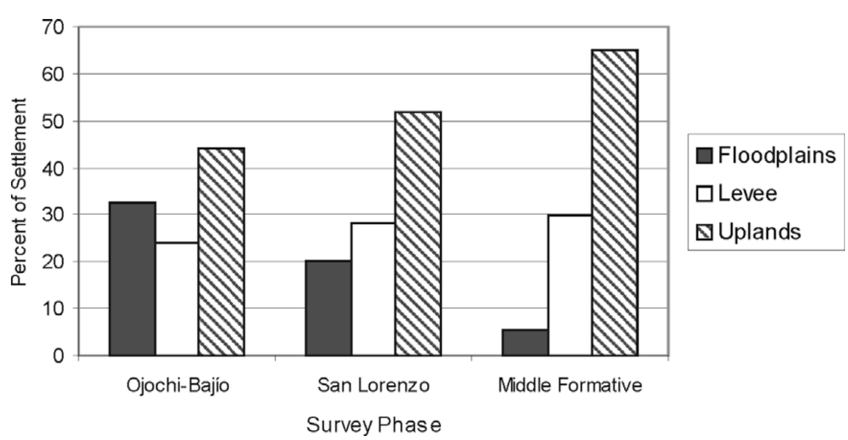

Fig. 3. Settlement patterns in the Coatzacoalcos drainage (after Symonds et al., 2002, Fig. 4.3).

Ortiz, 2000, p. 108; Ortiz Pérez and Cyphers, 1997, p. 51). San Lorenzo and other permanent settlements were positioned to balance access to the floodplains with concerns for defense; Symonds et al. (2002, pp. 56, 62) note a regular spacing of permanent sites and suggest that intra-regional competition was a factor. Overall, the Ojochi-Bajío phase pattern suggests a floodplain-focused economy that was already experiencing politico-economic stress.

In Coe and Diehl's (1980a) chronology, the Bajío phase was followed by the Chicharras phase and the San Lorenzo A and B subphases. Symonds et al. (2002, p. 62) were unable to utilize these distinctions and instead employed a San Lorenzo phase that spans 400 years (1200–900/800 BC). Regrettably, such aggregated data are ill suited to chart settlement dynamics, estimate population figures, or evaluate imbalances in a region's carrying capacity. Fortunately, other surveys undertaken within the lowland plains enjoy finer chronological resolution and can help illuminate settlement transitions at San Lorenzo (see below).

San Lorenzo phase settlements are twice as frequent as their Ojochi-Bajío phase counterparts. Seasonal sites still constitute over one-half of all occupations within the survey region (Symonds et al., 2002, Fig. 4.4). Nonetheless, upland portions of the Coatzacoalcos basin were increasingly utilized during the San Lorenzo phase and only 20% of sites were detected in the seasonally inundated floodplains (Fig. 3).

San Lorenzo was the largest settlement at this time, although estimates of its size vary by a factor of 10 and are hotly contested (e.g., Coe, 1981b, p. 119; Cyphers, 1996, p. 67, 1997a, p. 272; Flannery and Marcus, 2000, p. 4; Spencer and Redmond, 2004, p. 185; Symonds et al., 2002, p. 68). Loma del Zapote, another large site, was located along an ancient watercourse about 4 km south of San Lorenzo. According to Symonds et al. (2002, p. 69) Loma del Zapote may have exceeded 600 ha in size, but they prefer a "conservative estimate" of 400 ha for its San Lorenzo phase occupation. Inter-site competition continued to be a factor at this time (Symonds et al., 2002, p. 93, 125).

The Middle Formative (900/800–600 BC) occupation reveals a continued shift to the upland areas; only 5.5% of sites remained within the inundated floodplain (Fig. 3). Site numbers decreased from 226 to 54 and occupation dispersed throughout the survey region. Over 60% of the total population lived in small, rural settlements (Symonds et al., 2002, p. 90, Fig. 4.4).

The RRSL settlement pattern documents a significant transition from the Early Formative Ojochi-Bajio phase through the Middle Formative period. Occupation concentrated on floodplain resources at the onset of the Early Formative period. This economic orientation shifted sometime during the San Lorenzo phase as populations decreased their exploitation of the floodplain and increasingly occupied higher ground. During the Middle Formative period the overwhelming majority of sites were located in the uplands. This pattern does not appear to be the simple consequence of site preservation, as alluviation and destruction by stream meander would most likely under-represent the total number of earlier floodplain sites.

Settlement patterns across the lowland plains echo this general sequence. The RARO project covered 36 km^2 to the east of San Lorenzo, between the Coatzacoalcos River and Cerro El Manatí (Kruger, 1996, 1997). This survey region was divided into two basic areas: the "Alluvial zone" comprising the floodplain region and river levees below the 20 m elevation contour and the "Hilly zone" consisting of non-inundated uplands in the southern part of the study region (Kruger, 1996, p. 46–48).

Kruger (1996, pp. 82–95) employed a correlation analysis of pottery types to create a ceramic-based chronology. Period 1 occupation reflects the latter part of the Early Formative period (e.g., ca. 1000–900 BC) or Coe and Diehl's (1980a) San Lorenzo B subphase.[3] Period 1–2 includes material from both the Early and Middle Formative periods and may reflect a transitional phase and/or some ceramic admixture (Kruger, 1996, p. 116, Table 3-1). Period 2 pottery (ca. 900–600 BC) conforms exclusively to the Middle Formative period.

Period 1 occupation focused on the Alluvial zone with 80% of the collections clustering within the floodplains. According to Kruger (1996, pp. 102–103, 1997, p. 147), the Period 1 occupation represents a pattern of dispersed nuclear or extended families.

Period 1–2 settlements reveal a notable shift to the Hilly zone, with two-thirds of the total collections recovered from this area (Kruger, 1996, pp. 112–114). Nonetheless, there are two distinct upland patterns. One pattern includes two occupational clusters located within 200 m of a paleo-river channel while the remaining pattern is one of dispersed settlements throughout the Hilly zone. According to Kruger (1996, p. 114) "the clustering of occupation at this point again emphasizes the importance of proximity of the Alluvial zone during the Early to Middle Formative Period."

By Period 2 a floodplain-to-upland transition was mostly realized. Only 12% of the Period 2 collections were recovered within the Alluvial zone and most of these showed a lack of continuity between Period 1–2 and Period 2 occupations (Kruger, 1996, p. 117). No evidence of larger Period 2 settlements was recovered. The Hilly zone occupation suggests "a fairly dispersed population, possibly living in solitary households or grouping into small hamlets" (Kruger, 1996, p. 122).

Thus, Kruger's (1996, 1997) survey identifies a trajectory very similar to that documented around San Lorenzo, but at a smaller spatial scale and finer temporal resolution. The transition from the Early Formative period to the Middle Formative period marked a significant change in settlement character apparently fueled by an increased emphasis on upland exploitation and a marked decrease in the extraction of floodplain resources.

Joshua Borstein (2001) undertook a regional settlement survey along the San Juan River drainage, working west of the Coatzacoalcos basin and south-southeast of the Tuxtla Mountains. His survey includes the area around Laguna de los Cerros and extends south and east toward Estero Rabón and the Coatzacoalcos drainage. He separated this study region into two parts: the lowlands, including areas subject to seasonal inundation, and the uplands or the foothills of the Tuxtla Mountains. Along the San Juan drainage this division generally follows the 60–70 m asl contour line (Borstein, 2001, p. 46).

Borstein (2001) divided his Early Formative chronology into three parts. The pre-San Lorenzo phase (1500–1200 BC) combines the Ojochi, Bajío, and Chicharras phases defined by Coe and Diehl (1980a). His San Lorenzo A sub-phase spans 1200–1000 BC and his San Lorenzo B sub-phase covers the period between 1000 and 900/800 BC. His Middle Formative occupation dates from 800 to 400 BC.

Pre-San Lorenzo phase settlements were restricted to low-lying areas along waterways and to zones along the lowland–upland interface. No sites were noted in the uplands, despite the fact that this region constitutes almost two-thirds of the entire survey area. Estero Rabón was already 60–80 ha in size by this time and represents the "greatest concentration of population development" in the study region; its size is attributed to its proximity to San Lorenzo, 12 km to the east (Borstein, 2001, p. 151). According to Borstein (2001, pp. 155–157), this settlement pattern indicates that site occupants purposefully focused on floodplains resources during the pre-San Lorenzo phase.

During the San Lorenzo A sub-phase settlement numbers increased by more than 300%. Despite this increase, sites continued to cluster within the lowland areas and along the river floodplains. Borstein (2001, p. 164) suggests that the continuity in the use of the region between the pre-San Lorenzo and San Lorenzo A subphases also indicates continuity in the overall subsistence pattern.

Continued settlement growth characterized the San Lorenzo B sub-phase; importantly, this sub-phase also marked the first extensive use of upland areas within the study region. Sites within the upland zone were clustered in areas of relatively flat terrain with fertile soils, especially well-suited for crop production (Borstein, 2001, p. 184).

Regional occupation declined during the Middle Formative period. At the same time, it is worth noting that the number of Middle Formative sites ($n = 69$) is still one and one-half times greater than the frequency of San Lorenzo A sub-phase sites ($n = 43$). Moreover, the trend of increasing upland occupation continues into the Middle Formative period—despite a reduction in site numbers there are proportionately more upland settlements during the Middle Formative period (72.5%, 50 of 69) than the previous San Lorenzo B sub-phase (63%, 117 of 186).

The Río San Juan survey mimics the overall pattern identified elsewhere in the lowland plains. An intensive focus on the floodplains marks the beginning of the Early Formative period, followed by a shift towards upland areas during the San Lorenzo B subphase. By the Middle Formative period this transition was evident

[3] Subsequent excavations by Kruger (2000) at a Period 1 sites produced a calibrated radiocarbon date of 1126 BC ± 40, supporting the San Lorenzo B sub-phase association.

throughout the region and sites clustered in areas suitable for farming. In Borstein's (2001) opinion, this transformation was directly attributable to a change in the regional subsistence economy: "It is my contention that the shift represents a switch from a subsistence economy based largely on aquatic resources to one based primarily on agriculture" (Borstein, 2001, p. 184).

Settlement in the highland zone

Settlement patterns in the west-central Tuxtla Mountains offer a complementary perspective to site distributions throughout the lowland plains. The highland Tuxtla region is distinct along the southern Gulf lowlands—a localized volcanic uplift with good agricultural land, a large freshwater lake, ample supplies of material for ground stone, and no inundated floodplains (Andrle, 1964). Given the agricentric focus of early researchers, it is little wonder that the Tuxtlas once vied for contention as the original Olmec "homeland" (e.g., Coe, 1968, p. 89; Heizer, 1968, p. 22; Saville, 1929, p. 285, cited in Bernal, 1969, p. 30). Perhaps it is more telling that the supposed agrarian Early Formative Gulf Olmec *did not* realize their largest settlements and most elaborate cultural expressions within this fertile highland area.

Our survey in the west-central Tuxtlas was conducted during the early 1990s and covered almost 400 km^2 (Santley, 2007; Santley and Arnold, 1996; Santley et al., 1997). Our Gulf Olmec survey chronology, based on Coe and Diehl (1980a), was divided into an Early Formative period (ca.1400–1000 BC) and a Middle Formative period (ca. 1000–400 BC).[4] Thus, like the San Lorenzo survey (Symonds et al., 2002), our occupational phases are overly generous and mask finer-grain temporal variation. Archeological research at La Joya (see below) places this variation in improved chronological light.

The earliest evidence of human occupation in the Tuxtlas derives from a sedimentary core from Laguna Pompal, located just to the east of our survey area (Goman, 1992). This core produced evidence of maize pollen and localized forest clearance dating to approximately 2500 BC (Goman, 1992; Goman and Byrne, 1998). Unfortunately, our settlement survey did not encounter surface indications of an Archaic period occupation. Excavations within the Tuxtlas demonstrate that such deposits, if present, are likely buried under several meters of alluvium and volcanic ash fall (e.g., Santley et al., 2000).

Our earliest settlement evidence thus begins with the Early Formative period and includes 24 sites. Almost all of these occupations were small settlements and almost 80% of all sites were located in the upper portion of the Río Catemaco valley. These upper valley sites tend to cluster and most are located less than 1 km from their neighbor. Settlements gravitated toward rivers and permanent freshwater streams. One of the few sites situated more than 0.5 km away from freshwater was El Salado, a salt-extraction locus exploited during the Early Formative period (Santley, 2004).

Settlement numbers increased from 24 to 38 during the Middle Formative period, a jump of almost 60%.[5] Occupation moved out of the upper Río Catemaco zone—only 13 of the 38 sites (34%) remained in this area. A second group of the settlements moved higher into the sierra. Whereas only one Early Formative site was identified above the 300 m contour line, during the Middle Formative period 29% of the sites occupied this zone.

The majority of larger sites and the survey region's population relocated to the lower, southern portion of the valley. Settlements no longer gravitated near rivers and large streams but instead were distributed throughout the western portion of our survey region. This region is characterized by relatively flat, opened areas that are well-suited for farming.

The Gulf Olmec settlement pattern in the Tuxtlas is one in which initial settlements clustered in the upper Río Catemaco valley along rivers and major tributaries. Middle Formative occupants occupied more diverse settings, including areas higher into the sierra as well as the lower portion of the river valley. Sites also shifted away from their riparian focus and occupied opened areas that were conducive to farming.

Settlement discussion and summary

Survey data denote significant regularities among Gulf Olmec settlement distributions throughout both the lowland plains and the highland zone. Sites were strongly associated with estuarine or riparian settings during initial portions of the Early Formative period. This pattern is especially apparent within the three lowland-plain surveys, but an early riparian focus also characterized site location in the Tuxtla Mountains.

Several changes occurred over the course of the Early Formative period. All regions experienced a population increase during this period. Those lowland-plain studies with sufficiently sensitive chronologies suggest that this increase was most pronounced towards the end of the Early Formative period. This population increase is also associated with population movement into upland areas outside of the floodplain.

Middle Formative settlement patterns continued one part of this trend—site locations outside the flood plain were overwhelmingly preferred. At the same time, population generally decreased and settlements were usually dispersed throughout their respective regions. Evidence for significant site nucleation was rare; populations were increasingly isolated and rural.

The main deviation from these patterns occurred in the Tuxtla Mountains. Middle Formative occupation in the Tuxtlas actually increased relative to earlier periods. Moreover, Middle Formative population in the Tuxtlas concentrated in larger settlements, many of which were newly founded within previously unoccupied portions of the survey area.

Prior discussions of Formative period settlement in the Tuxtlas invoke volcanic activity to account for this settlement re-organization. Significant volcanic eruptions at the end of the Early Formative period was said to have caused Middle Formative residents to relocate farther south in the Río Catemaco river valley (Santley, 2007, p. 32; Santley and Arnold, 1996, p. 230; Santley et al., 1997, pp. 184–185).

Although a convenient culprit, this geologic event merits reconsideration. To date, the only Early Formative lens of volcanic ash securely bracketed with radiocarbon assay was encountered at La Joya (Arnold, 2003, p. 31; McCormack, 2002, p. 61).[6] This event, however, dates to the first half of the Early Formative period and is distinct from the ash fall that purportedly marked the end of Early Formative occupation at nearby Matacapan (e.g., Santley, 1992;

[4] When we began the Tuxtlas survey there were very few radiocarbon dates for the Early and Middle Formative periods from the region. Our initial chronology, therefore, represented rough estimates of time and was based on the ceramic chronology of Coe and Diehl (1980a). In terms of the present discussion, the exact date of our Early-to-Middle Formative division should be less important than our reliance on the published ceramic diagnostics from elsewhere in southern Veracruz.

[5] This Middle Formative site total was erroneously published as 42 in previous work (Santley and Arnold, 1996; Santley et al., 1997). Moreover, Middle Formative La Joya has been re-characterized as a hamlet, which better reflects its subsurface character (Arnold and McCormack, 2002; Pool, 2007, Fig. 5.3; Santley, 2007, p. 32).

[6] A radiocarbon sample from Matacapan excavation 49:2-19-0 produced an uncorrected date of 3270 ± 250 BP (Reinhardt, 1991: Table 6). Based on information in Santley and Ortiz (1985, pp. 49–52), this sample may have come from below a lens of volcanic ash ("Stratum C" in Operation V). Unfortunately, the spatial relationship between this sample and the possible ash-lens cannot be determined from the available information.

Santley and Arnold, 1996). In fact, that Matacapan ash stratum was originally attributed to the Middle Formative period (Santley et al., 1984, pp. 32–33), but this dating was later revised. Recent assessments suggests that it is more judiciously interpreted as a Middle Formative phenomenon (e.g., Pool, 2007, p. 146).[7]

Geologic activity is used to account for changes in settlement patterns beyond the Tuxtlas. For example, researchers at San Lorenzo (Cyphers, 1996, p. 71; 1997a, p. 274; 1997b, p. 137–138; Symonds et al., 2002, p. 129) propose that tectonic uplift and volcanic activity in the Tuxtlas impacted river courses within the Coatzacoalcos drainage, contributing to the end of the Early Formative occupation in and around San Lorenzo. It is clear that changes in the dynamic fluvial system of the Coatzacoalcos basin affected the placement of Formative period settlements (e.g., Cyphers and Arturo Ortiz, 2000; Ortiz Pérez and Cyphers, 1997). Nonetheless, no systematic geomorphologic data have been published to support the claim that the Coatzacoalcos drainage was significantly modified at the end of the Early Formative period by geologic activity in the Tuxtlas.

But if not for geologic activity, why did settlement relocation occur in this portion of the Gulf Olmec region at the end of the Early Formative period? Moreover, why did settlement occupation in the Tuxtlas increase during the Middle Formative period, contrary to occupation in floodplains of the surrounding coastal region?

I suggest that an increased emphasis on maize farming affected settlement distributions and drew Middle Formative immigrants to the highland soils of the Tuxtlas. Thus, I firmly agree with Borstein (2001, p. 184) that these settlement transitions track a significant change in the subsistence economy, one that probably began by the latter portion of the Early Formative period (i.e., San Lorenzo B sub-phase). Evaluating this possibility requires data from sites with securely dated contexts that span the Early and Middle Formative periods. Published excavation data from the Coatzacoalcos basin are currently insufficient for such an evaluation, so we return to the Tuxtla Mountains and the site of La Joya.

Excavations at La Joya

La Joya is situated within the upper Río Catemaco valley, along a lazy bend of the river at approximately 200 m asl. The site extends across 20 ha and contains a multi-component occupation that spans the Formative period. Data from several seasons of fieldwork document increased settlement permanence and intensified maize cultivation from the Early Formative to the Middle Formative periods (Arnold, 1999, 2000, 2003, 2005b, 2007; Arnold and McCormack, 2002; McCormack, 2002; VanDerwarker, 2003, 2006).

The early portion of the La Joya chronology is anchored by twelve stratigraphically consistent radiocarbon dates and supported through stylistic cross-references (Table 1). The Tulipan phase (1300–1150 BC) is comparable to the Ojochi-Bajío phase, the Coyame A phase (1150–1000 BC) is coeval with the Chicharras phase and San Lorenzo A sub-phase, and the Coyame B phase (1000–850 BC) is consistent with the San Lorenzo B sub-phase. The Middle Formative Gordita phase (850–400 BC) covers much of the same temporal territory as the Nacaste and Palangana phases at San Lorenzo (Coe and Diehl, 1980a; also Pool, 2007, Fig. 1.4).

We began our excavations at La Joya expecting to find a sedentary, agrarian occupation coeval with the agricultural adaptation proposed for San Lorenzo (e.g., Coe and Diehl, 1980a). These expectations were not met. Rather than evidence for domestic architectural investment and sedentism, we encountered a series of thin sheet middens and burned, superimposed ovoid pit features. Cyphers (2001, p. 108) likens these La Joya features to the superimposed hearths found at the seasonally occupied *islote* sites in the Coatzacoalcos basin (see also Symonds et al., 2002, p. 43).

These pit features underwent a notable transition at La Joya (Arnold, 2005b). Pits that date to the Tulipan and Coyame A phases were generally ovoid and averaged about 0.25 cu m. In contrast, Coyame B phase features included circular pits with almost four times the volume. Coyame B phase circular pits also became the locus of domestic refuse and debris, a disposal practice not detected with the earlier ovoid features.

Archeological deposits within the Coatzacoalcos basin offer a similar connection between large circular pit features and the end of the Early Formative period. Aguilar Rojas (1992, pp. 37, 49–50, 137) describes such a feature associated with a calibrated radiocarbon date of 1040 BC ±130 at the D5-9 locality atop the San Lorenzo plateau. A large, circular pit feature at RARO-154 produced an associated calibrated radiocarbon date of 1126 BC ± 40 (Kruger, 2000; also Kruger, 1996, pp. 239–241). Both of the calibrated dates are consistent with a San Lorenzo B sub-phase designation (e.g., Pool, 2007, Fig. 1.4).

Shifts in the capacity and contents of pit features at La Joya suggest alterations in domestic activities and the management of residential space during the Early Formative period. Elsewhere I (2000, 2005b) have suggested that the superimposed, shallow pits are among several independent indicators of settlement re-occupation based on a pattern of seasonal site use (e.g., Kent, 1992). Furthermore, changes in feature characteristics over time herald intensified site occupation, probably associated with increased settlement permanence and a changing subsistence strategy.

Ground stone artifacts provide another window into a changing settlement-subsistence strategy. McCormack (2002, pp. 170–182) discusses several ground stone datasets from La Joya that represent temporal variation in the function and formal properties of these tools. Due to small sample sizes, these data are collapsed into Early Formative and Middle Formative contexts. Nonetheless, patterns indicate important differences in these datasets across time.

One such pattern involves multi-functional versus task-specific tools. Literature on technological organization suggests that tool use can be sensitive to the intensity of settlement occupation—tools used in a context of residential mobility tend to be multi-purpose, while permanent occupation often associates with single-purpose artifacts (e.g., Nelson, 1991). Data presented in Table 2a show a pronounced shift from multi-purpose *metates* (grinding slabs) to single-purpose metates, as revealed in distinct grinding patterns.

Manos (cylindrical grinding stones) offer another indication of changing subsistence organization. One-handed manos are often associated with a multiplicity of tasks, while two-handed manos are more likely associated with targeted grinding, such as maize processing (e.g., Morris, 1990). At La Joya a shift from one- to two-handed manos tracked the intensification of grinding activities by the Middle Formative period (Table 2b). A similar increase in two-handed manos (“triangular” and “lenticular” in cross section) characterizes the transition from the San Lorenzo B sub-phase to the Middle Formative Nacaste phase at San Lorenzo (Coe and Diehl, 1980a, p. 224, Table 5-1).

Raw-material type offers a third line of ground stone evidence and subsistence-related activities (Table 2c). Maize grinding is most efficiently conducted with a rough-surfaced metate. At La Joya, two locally available basalts—massive and vesicular—were

[7] The Matacapan ash stratum was initially exposed in Pit 8 and covered the remnants of an undulating garden plot (Santley et al., 1984, pp. 32–33). Although later attributed to the Early Formative period, artifact-bearing deposits below this ash fall did not produce Early Formative period diagnostics such as local variants of Calzadas Carved, Limon Incised, or Tatagapa Red, all of which were recovered from excavated Early Formative depostis at nearby La Joya (Arnold, 2003, 2005b).

Table 1
La Joya Early and Middle Formative radiocarbon dates.

Lab number[a]	BP	Uncal BC	1 Sig Cal. BC[b]	Cal. intercepts BC[b]	Phase
DRI 3302	2290 ± 237	577–103	764–47	387	Gordita
DRI 3300	2627 ± 159	836–518	965–540	802	Gordita
ETH 17502	2735 ± 55	840–730	967–826	895, 877, 841	Gordita
DRI 3301	2754 ± 263	1067–541	1288–555	900	Coyame – B
DRI 3299	2876 ± 170	1096–756	1368–831	1019	Coyame – B
ETH 17500	2905 ± 60	1015–895	1211–1000	1109, 1101, 1074, 1062, 1052	Coyame – B
AA 32679	2950 ± 55	1055–945	1260–1048	1207, 1203, 1189, 1179, 1156, 1142, 1130	Coyame – B
ETH 17503	3005 ± 60	1115–995	1373–1129	1260, 1227, 1223	Coyame – A
ETH 17496	3015 ± 60	1125–1005	1378–1130	1287, 1283, 1261	Coyame – A
AA 32683	3050 ± 60	1160–1040	1404–1215	1369, 1360, 1347, 1344, 1316	Coyame – A
AA 32682	3055 ± 85	1190–1020	1412–1132	1370, 1358, 1350, 1342, 1317	Coyame – A
ETH 17504	3165 ± 55	1270–1160	1503–1399	1430	Tulipan

[a] Lab abbreviations as follows: ETH—Swiss Federal Institute of Technology, Zurich AA—University of Arizona AMS Facilty, Tucson DRI—Desert Research Institute, Reno.
[b] Calibrated using Calib Rev. 4.3 (Stuiver et al., 1998)—all samples are charcoal.

Table 2
Early and Middle Formative ground stone data from La Joya.

	EF	MF
(a) Metate versatility		
Multi-use	5	1
Single use	1	5
(b) Mano types		
One-handed	3	1
Two-handed	0	3
(c) Raw materials		
Massive basalt	12	4
Vesicular basalt	1	3

used to manufacture metates. Massive basalt has small pores and will grind to a smooth surface; roughening it requires additional energy in the form of surface pecking. In contrast, vesicular basalt has numerous voids and retains a rough exterior texture throughout its use-life (e.g., Hayden, 1987, p. 14). The La Joya data reveal an increasing preference for vesicular basalt from the Early to the Middle Formative period, consistent with intensified maize grinding through time.

Of course, faunal and floral data offer the best evidence for subsistence practices. In contrast to the surrounding Gulf coastal plain, the volcanic soils of the Tuxtlas are less destructive to organic materials, especially ancient plant remains. Thus, macrobotanical data provide the majority of the floral information and derive primarily from flotation samples. The faunal assemblage, representing large and small species, was obtained from screened soils as well as flotation samples (VanDerwarker, 2003, 2006).

Macrobotanical remains of maize were recovered from La Joya's Early Formative contexts (VanDerwarker, 2006, p. 86). Although some of the maize might have been grown in nearby gardens, pre-processed maize was brought to the site from elsewhere; kernel-to-cupule ratios from these Early Formative samples indicate that maize was not intensively processed at La Joya and was already shelled before it arrived on site (VanDerwarker, 2006, pp. 102–106).

This pattern is consistent with the Laguna Pompal data noted above. Pollen evidence from this sedimentary core indicates that maize was present in the Tuxtlas by 2500 BC, or 1000 years before occupation at La Joya (Goman, 1992; Goman and Byrne, 1998). According to the pollen data, this initial phase of maize use ended by ca. 2000 BC; maize re-appeared at approximately 500 BC and was present for another 1000 years (Goman and Byrne, 1998, pp. 85–86). This interpretation is supported by patterns in the presence of tree pollen, which indicate significant reforestation between ca. 2000–500 BC. The Laguna Pompal sequence also mirrors a more general Mesoamerican pattern in which the initial appearance of maize pollen and the onset of maize agriculture may be separated by several thousand years (e.g., Blake, 2006; Rosenswig, 2006).

La Joya's Early Formative residents consumed a range of plant products in addition to maize. A possible tepary bean (*Phaseolus acutifolius* cf.) was recovered (VanDerwarker, 2006, p. 87), although its status as a domesticate is currently unclear (VanDerwaker, personal communication 2008). Trianthema (*Trianthema* sp.) is present and may have been used as a seasoning by Early Formative inhabitants at La Joya (VanDerwarker, 2006, p. 86).

Floral evidence also represents a variety of tree resources. Coyol (*Acrocomia mexicana*) is a palm fruit that provide a rich source of fat, protein, and calories. The seeds of other oil- and vitamin-rich fruit, such as avocado (*Persea americana*) and sapote (*Pouteria sapota*), were recovered. In addition to their nutritional value, these tree products have useful medicinal properties (VanDerwarker, 2006, pp. 81–85).

The recovered Early Formative faunal material exhibits an even greater range of species. Larger mammals include white tailed deer (*Odocoileus virginianus*), red brocket deer (*Mazama americana*), and collared peccary (*Tayassu tajacu*). Among the smaller mammals were ocelot (*Leopardarus pardalis*), dog (*Canis familiaris*), opossum (*Didelphis* sp.), nine-banded armadillo (*Dasypus novemcinctus*), and rabbit (*Sylvilagus* sp.).

Recovered fish remains represent both fresh water and marine species. Fresh-water mojarra (*Cichlasoma* sp.) would have been available locally in the nearby Río Catemaco and Lake Catemaco. In contrast, salt- and brackish-water snook (*Centropomus* sp.), jack (*Caranx* sp.), and snapper (*Lutjanus* sp.) could only be obtained in the floodplain zones south of the Tuxtlas or from the Gulf waters on the north side of the sierra. In either case these aquatic species reflect an investment of a 2-day roundtrip journey (VanDerwarker, 2006, pp. 125–126).

A variety of birds were exploited at La Joya during the Early Formative period. Identified remains include terrestrial species such as turkey (*Meleagris gallopavo*) and bobwhite (*Colinus virginianus*). Birds of prey include hawk (*Buteo* sp.) and falcons (Falconidae). Waterfowl are also present within the assemblage and are represented by members of the duck family (*Anas* sp.).

This dietary pattern underwent significant alterations through time. Although Middle Formative contexts contained limited floral remains, excavations at La Joya produced ample data from later Formative deposits. Two inverse patterns appeared when plant data were viewed across the entire Formative period. First, the kernel-to-cupule ratio decreased over time, suggesting increased on-site maize shelling (VanDerwarker, 2006, pp. 102–103). At the same time, the ratio of tree fruits (including avocado, coyol, and sapote) to "field crops" (including maize and beans) increased across this same span; that is, La Joya residents consumed greater amounts of fruit relative to field products. VanDerwarker (2006, p. 110) suggests that this pattern reveals a long-term intensification of agriculture, in which fruit trees became increasingly important components of a managed forest economy.

Although floral data specific to the Middle Formative period are scant, the faunal record from this period is more robust and reveals important shifts from the earlier occupation. There is an increase in the frequency of mammals represented in both NISP (Number of Individual Specimens) and MNI (Minimum Number of Individuals) indices between the Early and Middle Formative periods (VanDerwarker, 2006, Fig. 5.1). At the same time, the Middle Formative dietary contribution of both fish and fowl declined appreciably (VanDerwarker, 2006, Tables 5.5 and 5.17). This decrease impacts both the evenness and richness values of the Middle Formative animal assemblage, which are much lower than the corresponding Early Formative indices (VanDerwarker, 2006, p. 156).

According to VanDerwarker (2006, pp. 163–164), these patterns likely represent an intensification of "garden hunting," in which disturbed habitats and/or fallow plots became an increasingly exploited hunting territory. In other words, Middle Formative occupants at La Joya were staying closer to home, intensively using the nearby gardens for hunting and tree management. More locally focused animal-capture also contributed to the decrease in fish and fowl remains during the Middle Formative period.

These changes in both the artifact assemblage and subsistence data accord well with internal community dynamics at La Joya. McCormack (2002) explored the development of corporate groups across the site, using a combination of dated stratigraphic materials and diagnostic artifacts. Factors that affect corporate group formation include domestic scheduling conflicts, the need to mobilize labor, and issues surrounding land tenure (e.g., Hayden and Cannon, 1982; Pasternak et al., 1976).

McCormack (2002, pp. 266–269) suggests that corporate groups appeared at La Joya during the Coyame B phase; that is, toward the end of the Early Formative period. Given the possibility of intensified maize cultivation, these corporate groups may have emerged partly in response to new scheduling conflicts involving labor demands associated with crop production and processing (McCormack, 2002, p. 275). Early Formative volcanic activity reflected at the site may have impacted subsistence options, encouraging maize cultivation but restricting the availability of farmlands.

Middle Formative period La Joya was occupied less intensively, as manifest in smaller, isolated artifact aggregations. The Middle Formative pattern suggests greater household autonomy, more dispersed intra-site occupation, and a reduced function for corporate groups (McCormack, 2002, p. 276). This pattern is consistent with the regional settlement data, which denote extensive occupation throughout the survey area. McCormack (2002, pp. 277–278) suggests that the effects of volcanic activity may have lessened, allowing agricultural groups to spread out and occupy new portions of the region. Previous social pressures affecting the succession of land tenure may have changed, decreasing the selection for corporate group cohesion and promoting autonomous, nuclear families.

In an insightful paper, Drennan (1988) argued that settlement dispersal is often associated with an agricultural regime experiencing intensified labor inputs. Such inputs may reflect a developing infield–outfield system, in which households locate near an adjacent infield but also cultivate a more distant outfield. Killion's (1987, 1990, 1992, 2008) research among peasant farmers in the Tuxtlas demonstrates a strong positive correlation between the house lot area devoted to extra-mural tasks and the intensity of infield farming activities. If such intensification characterized Middle Formative Tuxtlas, a distribution of more widely spaced farming households is a predictable result.

In sum, the La Joya data provide a well documented case of settlement and subsistence transitions spanning the Early and Middle Formative periods along the southern Gulf lowlands. Consistent with other recent discussions (e.g., Clark et al., 2007; Robinson et al., 2005; Rosenswig, 2006; Wendt, 2003, p. 450) the La Joya data indicate that maize farming was not an important economic activity throughout much of the Early Formative period. Residential occupation at La Joya involved minimal investment in architecture and storage until the Coyame B phase, coeval with the San Lorenzo B sub-phase. Site occupation intensified at that time and sedentary, corporate groups were established by the end of the Early Formative period. La Joya residents began to turn away from riparian and floodplain-related resources and relied more intensively on cultivated plants along with mammals from disturbed habitats. Agricultural practices intensified during the Middle Formative period, households became more self-reliant, and settlements appeared in portions of the survey area that were unoccupied during earlier times.

Discussion

The above data strongly suggest that the Gulf Olmec relied more extensively on floodplain/riparian resources than domesticated staples at the beginning and throughout much of the Early Formative period. If correct, this finding undermines models that identify agriculture as the basis for the emergence of Gulf Olmec politico-economic inequality. These data also suggest that the adoption of maize agriculture was associated with significant settlement reorganization at the end of the Early Formative period. If accurate, this finding offers a counterpoint to conventional views of the Gulf Olmec collapse at San Lorenzo.

Below I outline an alternative to the agricentric view of Gulf Olmec emergence. This alternative focuses on the Coatzacoalcos drainage and builds upon the following points: (a) the growing consensus that maize did not become a dietary staple across the isthmian region until approximately 1000–900 BC (e.g., San Lorenzo B sub-phase); (b) the likelihood that such an economic shift was not a seamless substitution of foodways, but likely required a re-organization of social roles, politico-economic power relations, and residential activities; (c) the evidence that the San Lorenzo B sub-phase was the period of the most intensive monument manipulation and interaction with groups outside the Coatzacoalcos basin; and (d) the fact that the San Lorenzo collapse is associated with a relocation of occupation into the surrounding uplands and highlands, along with the appearance of corn imagery on elite paraphernalia throughout Mesoamerica.

Archaic occupation within the Coatzacoalcos basin is all but unknown. Tribal groups likely practiced a fishing/hunting/gathering strategy, perhaps supplemented with some gardening (e.g., Clark and Cheetham, 2002; Pool, 2007, pp. 92–95; Pope et al., 2001). By the Ojochi-Bajío phase, occupation concentrated on floodplain resources but with an eye toward defense. At an estimated 20+ ha, San Lorenzo was the largest community within its immediate sustaining area but Estero Rabón, located 12 km to the west, was more than three times as large (Borstein, 2001, p. 151).

Seasonal *islotes* sites imply that preferred resource locations were increasingly controlled and perhaps monopolized by families or lineages (Arnold, 2000, p. 129; Symonds et al., 2002, pp. 61, 121–122). It is worth noting that not all locales along the Coatzacoalcos River or within the floodplain are equal in terms of accessing aquatic resources (Coe and Diehl, 1980b, pp. 107–122; Symonds et al., 2002, p. 121). Fish do not school evenly throughout the river or throughout the year. Some areas, such as localized eddies and whirlpools or *remolinos* (Coe and Diehl, 1980b, p. 108) offer preferred fish habitats. During the fall, large catadromous species, such as the locally known *Bobo*, migrate downriver to spawn (Cyphers, 1997a, p. 266). Moreover, catching large numbers of fish is best accomplished by building fish fences or using long (>30 m) woven nets (Coe and Diehl, 1980b, pp. 110–117); these techniques require cooperative labor and specific microenvironments (Coe and Diehl, 1980b, pp. 116–117). Finally, localized oxbow lakes offer natural holding tanks for the live-storage of resources like turtle and fish (e.g., Ortiz Pérez and Cyphers, 1997, p. 37; Symonds et al., 2002, p. 60). Such "storage on the fin" can significantly extend the shelf-life of aquatic resources; groups with direct access to and/or use-rights over backwater lakes would enjoy a significant politico-economic advantage.

Despite their observations regarding the defensive location of sites, Symonds et al. (2002, p. 120) conclude that "population pressure" did not contribute to increasing social complexity during the Ojochi-Bajío phase. Rather than population pressure per se, it appears that the San Lorenzo hinterland was undergoing a form of packing characterized by greater competition over localized floodplain resource areas (Symonds et al., 2002, pp. 121–122).

Binford (2001) has explored this "spatial packing" phenomenon with global ethnographic data. He notes that an intensified reliance on aquatic foodstuffs encourages a socio-political structure in which individuals and/or "houses" exercise an increasing monopoly over access to those resources (Binford, 2001, pp. 368–372, 424–437, 446). Sites assume "a more linear distribution along shore-lines…increases in packing result not so much from increased population as from its spatial restructuring" (Binford, 2001, p. 384). Moreover, an intensive reliance on aquatic resources is often associated as much with control over the technology of extraction as a physical control of extraction points (Binford, 2001, p. 370). Concomitant with these changes, economic exchange takes on the form of delayed "donor-debtor transactions" often involving craft-specialization as an activity patronized by higher-ranking members of the community (Binford, 2001, p. 371).

Although the RRSL chronology cannot capture the settlement and demographic dynamics over the course of the San Lorenzo phase, archeological data from the adjacent San Juan drainage (Borstein, 2001) indicate that the early portion of the San Lorenzo phase was characterized by population growth and relative stability in settlement location. If applicable to the Coatzacoalcos drainage, these observations suggest that settlement changes during the San Lorenzo A sub-phase were more a difference of degree than of kind.

Status differences were evident and likely mark leaders who successfully negotiated factional conflicts or prevailed in armed confrontations. These leaders, in turn, would have recruited additional supporters, perhaps from outside their community. Leaders or other individuals may have been responsible for interceding with nature to insure the smooth operation of the cosmic order (e.g., Reilly, 1995). Increasing politico-economic status and differentiation was likely expressed through access to exotic materials, such as ilmenite cubes and perhaps obsidian blades (e.g., Clark, 1987; Stark, 2000, 2007). Monuments became a means by which certain leaders displayed social power (Clark, 1997; Coe and Diehl, 1980a, p. 294). Although the tradition of lithic sculpture at San Lorenzo may date back to the Chicharras phase (e.g., Coe and Diehl, 1980a, pp. 351–352), the earliest colossal heads do not appear to pre-date the San Lorenzo A sub-phase (Clark, 2007, p. 29). As possible portraits of leaders (e.g., Coe, 1981b, p. 139; Pool, 2007, p. 106; Stirling, 1955) such representations are consistent with the process of individualized monopolization of floodplain resources and extraction technologies noted above (Binford, 2001, pp. 368–372).

In contrast to the San Lorenzo A sub-phase, multiple lines of evidence suggest that the San Lorenzo B sub-phase was a significant period of politico-economic tumult. Temporally-sensitive survey data indicate dramatic population growth and the first extensive use of upland areas attractive for cultivation. Moreover, the majority of megalithic sculpture was installed, actively manipulated, and decommissioned at this time (Coe, 1981b, p. 139; Coe and Diehl, 1980a, pp. 294–295, Table 6-1). For example, Cyphers et al. (2006, pp. 24–25) report that Monument 14, a stone throne, was associated with a patio re-surfacing event that yielded an uncalibrated radiocarbon date of 981 ± 60 BC.

The frequency of exotic materials at San Lorenzo jumps dramatically during the San Lorenzo B sub-phase. A 12-fold increase in imported obsidian blades is matched by the largest number of sources represented in the obsidian assemblage (Coe, 1981b, p. 145; Coe and Diehl, 1980a, pp. 248, 258). Schist and serpentine are more common in San Lorenzo B sub-phase refuse than previously and "foreign figurine types" appear at this time (Coe, 1981b, p. 130). Overall, "San Lorenzo B shows much greater involvement with other regions in Mesoamerica, most likely through increased trade contacts necessitated by the sharp production rise in local industries" (Coe, 1981b, p. 130).

The scale of such activities in and around San Lorenzo has been used to model a unified, centralized system overseeing a complex political economy (Clark, 2007; Cyphers, 1997a,c; Cyphers and Zurita-Noguera, 2006; Symonds et al., 2002). But while short periods of consolidation may have occurred, the evidence for unification is equivocal (Clark, 1997, p. 222). As mentioned above, site size estimates of Loma del Zapote compare favorably with those of San Lorenzo. The fact that coeval, comparably sized polities occupied the same portion of the Coatzacoalcos basin raises questions about a unified San Lorenzo landscape. Symonds et al. (2002, pp. 93,125) acknowledge that several sites, including Loma del Zapote, and Estero Rabón, may have competed with San Lorenzo at this time.

Rare, table-top thrones provide a possible indication of this competition. To date, only three Early Formative sites within the immediate Coatzacoalcos region have yielded such sculpture: these sites are San Lorenzo, Loma del Zapote, and Estero Rabón (e.g., Cyphers, 1997c, pp. 232–233).[8] And while some researchers (Clark, 2007, p. 17; Cyphers, 1997c, pp. 232–233, 2004, p. 238; Cyphers and Zurita-Noguera, 2006; Symonds et al., 2002, p. 84), believe that formal differences in these thrones reproduce a settlement hierarchy, it is also possible that the properties of these megalithic sculptures represent distinct socio-political factions co-existing in the Coatzacoalcos basin (e.g., Gillespie, 1999).

Monument re-sculpting, such as the transformation of thrones into colossal heads at San Lorenzo (e.g., Porter, 1990) is also evident at Loma del Zapote. In this case, however, the re-sculpted image is not a colossal head, but rather a megalithic feline (Monument LZ-7; Cyphers, 1997d, p. 219, 1999, p. 172, 2004, p. 246). This feline was associated with two "twin" figures creating a sculptural arrangement thought to represent a mythical or historical event (Cyphers, 1997a, p. 271, 1997e, p. 188, 1999, p. 172). Twin imagery similarly adorns the stone throne from Loma del Zapote (LZ-2; Cyphers, 2004, p. 235–238; de la Fuente, 1996, pp. 47–48). Such re-occurring motifs imply a local ideological continuity; comparable sculpted twin motifs are not reported from San Lorenzo (de la Fuente, 1996, pp. 47–48).[9] Differences in re-carved monuments, coupled with site-specific motifs, may signal distinct lineage affiliations and/or political factions within the

[8] A table-top throne has also been recovered from El Marquesillo, a site located along the San Juan River some 50 km northwest of San Lorenzo (Doering, 2007). The age of the throne is unknown, although excavated data suggest that it was ritually interred during the latter portion of the Formative Period (Doering, 2007, p. 65).

[9] Monument SL-18 (Coe and Diehl, 1980a, p. 327; Cyphers, 2004, pp. 78–80), a possible stone throne from San Lorenzo, includes two partially destroyed dwarf-like figures. Nonetheless, they are positioned at the corners of the monument and not side by side, such as on the LZ-2 throne; moreover, the poor state of their condition makes it extremely difficult to assess their formal similarities and differences.

Coatzacoalcos drainage rather than an elaborate regional political hierarchy.

San Lorenzo's regional oversight is also said to extend to the control of local raw materials. For example Symonds et al. (2002, pp. 81–84) suggest that *chapopote* (bitumen) was one such resource. Recent chemical analysis, however, reveal that *chapopote* samples recovered from San Lorenzo reflect only two of six archeological sources identified for the region while samples from Loma del Zapote and adjacent El Azuzul formed a third, mutually exclusive cluster (Wendt and Lu, 2006). Such evidence casts doubt on the control over bitumen by San Lorenzo's elite (Wendt and Cyphers, 2008).

The above data suggest that a competitive cultural environment existed during the San Lorenzo B sub-phase. The appearance at this time of a more productive form of maize—or new techniques to extract additional energy from maize (Diehl, 2004, pp. 86–87)—may have altered the economic playing field and fostered additional politico-economic stress (e.g., Clark et al., 2007; Rosenswig, 2006). A cultural code that had developed primarily around floodplain resources (e.g., Arnold, 2005a) could be challenged by a productive, terrestrial, domesticated foodstuff exploited with a smaller labor pool, minimal technological investment, and increased storability. I propose that this situation threatened the existing elite politico-economic structure, causing these elites to ramp up traditional displays and competitive events. The dramatic increase in exotic goods and the more frequent installation of megalithic sculpture are predictable outcomes. In fact, Diehl (2004, p. 112) suspects that the practice of sculpting colossal heads was "a short-lived fad" lasting a century or less.

Thus, an accelerated investment in elite self-promotion at San Lorenzo need not reflect the operation of a stable government but instead may have represented greater politico-economic instability in the face of a changing subsistence economy. As Gregory Johnson (1982, p. 406) notes, "[i]ntensification of ritual. . .may signal a system in trouble rather than one doing particularly well." Or, phrased more bluntly: "they're not waving, they're drowning" (Blintiff, 1991, p. 278).

By the Middle Formative period a settlement transition to the uplands was mostly complete. Survey and excavation data indicate that settlements spread across the upland region, taking advantage of additional agricultural soils and intensifying maize production. This Middle Formative transition is associated with substantial direct and indirect evidence for the increased importance of corn as a politico-economic tool (e.g., Pool, 2007, pp. 145–146; Rosenswig, 2006; Rust and Leyden, 1994, pp. 192–194; Taube, 2000).

This transition at San Lorenzo has often been characterized as a "collapse" or "demise" (e.g., Coe and Diehl, 1980b, p. 152; Diehl, 2004, p. 58; Symonds et al., 2002, p. 94) but it is viewed just as easily as a social and economic re-organization. Binford's (2001) cross-cultural ethnographic analysis is again instructive. Although cropland varies, farming options are usually more even and continuous when compared to the extraction points necessary to acquire sufficient aquatic resources to feed population aggregates. Thus, at the point of a transitioning economy, smaller, more autonomous social units become viable and methods of social integration emphasize more horizontal, cross-cutting connections (e.g., "sequential" rather than "simultaneous" hierarchies [Johnson, 1982]). Binford (2001, p. 406) notes that societies with such "multilocal social groups" are likely to develop mechanisms such as sodalities and/or secret societies to promote horizontal social integration, rather than emphasizing more vertical integrative mechanisms.

Often lacking the overt nature of their vertical counterparts, these horizontal mechanisms can be misinterpreted as reflecting a system failure rather than a successful adaptation to new circumstances (Tainter, 2006). It is worth remembering that comparable changes mark intensified crop usage in several archeological sequences, such as the Middle-to-Late Woodland transition in the Midwestern United States (e.g., Braun, 1986; Milner, 2004) and the transition from the Mesolithic to the Neolithic in northern Europe (e.g., Price, 2000).

Conclusions

It seems clear from the above discussion that agricentric models for the emergence of the Gulf Olmec political economy require revision. This paper presents data supporting the position that the origins of Gulf Olmec social differentiation were based more on floodplain resources than domesticated maize. Although maize was certainly cultivated by Early Formative Gulf lowland occupants, it does not appear to have become a staple food resource until after the development of significant socio-political differentiation at San Lorenzo. Nor can maize be linked to aggrandizing displays, as suggested in the Early Formative ceramic record of the Pacific coast (e.g., Clark and Blake, 1994; Clark and Gosser, 1995).

The timing of the adoption of maize agriculture has interesting implications for reconstructions of Early Formative Gulf Olmec society. Floodplain resources may have provided the primary subsistence and politico-economic leverage throughout much of the Early Formative period. Individuals or families controlled specific extraction points, access technologies, and natural holding tanks for live-storage; competition among these groups is represented in the distribution of settlements throughout the Coatzacoalcos drainage. This competition is also reflected in the initial appearance of exotic commodities and the first investment in megalithic sculpture.

A significant subsistence shift brought about through the increased productivity of maize resulted in a re-imagined economic landscape (e.g., Binford, 1982). During the San Lorenzo B sub-phase this transition is associated with a repositioning of settlements into upland portions of the river basin. These changes may have also disrupted the pre-existing cognitive codes that validated social differentiation and prompted a hyper-acceleration in elite displays, gift-giving, and other forms of self-promotion and recruitment.

These responses were not sustained in the long-term. Ultimately, households adopted an agrarian lifestyle and by the Middle Formative period had turned away from the floodplains that were the focus of earlier settlement. Although often framed as a dramatic—even cataclysmic—event, the result was just as likely a successful adjustment to new economic opportunities.

In sum, Gulf Olmec society represents an early, autochthonous example of the relatively rapid transition from a fishing/gathering/horticultural adaptation to a subsistence system and political economy based primarily on agriculture. As such, it offers a well-focused arena to investigate some of the major issues in the emergence of sedentism, trans-generational inequality, and population nucleation. Moreover, the zonal variability exhibited across the Gulf lowlands provides an opportunity to examine the different tempos and conditions under which this subsistence-settlement transition took place. Recent exchanges highlight the impact of the Gulf Olmec culture on Mesoamerican civilization at large (e.g., Blomster et al., 2005; Flannery et al., 2005; Neff et al., 2006; Sharer et al., 2006). We should give equal time to the earlier portion of the Early Formative Gulf lowlands sequence, mindful that the significance of the Gulf Olmec phenomenon lies as much in its infancy as its legacy.

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