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Sustainability and duration of early central places in prehispanic Mesoamerica

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During the last millennium BCE, central places were founded across many regions of western (non-Maya) Mesoamerica. These early central places differed in environmental location, size, layout, and the nature of their public spaces and monumental architecture. We compare a subset of these regional centers and find marked differences in their sustainability--defined as the duration of time that they remained central places in their respective regions. Early infrastructural investments, high degrees of economic interdependence and collaboration between domestic units, and collective forms of governance are found to be key factors in such sustainability.

KEYWORDS

Mesoamerica, collective governance, path dependence, sustainability, cooperative labor investments

Introduction

Popular perceptions have often linked prehispanic Mesoamerican civilizations with collapse. The decline of lowland Maya cities (ca. 700–900 CE) often serves as a type case for this phenomenon (e.g., [Diamond, 2011](#); [Turner and Sabloff, 2012](#)). Likewise, the drastic demographic downfalls and political upheavals associated with the sixteenth-century Spanish invasion are amply referenced ([Carballo, 2020](#)). Yet, despite the familiarity of these two oft-discussed cases, extrapolation to a more generalized common wisdom is misinformed. Many prehispanic Mesoamerican cities were actually rather long-lived ([Feinman and Carballo, 2018](#)). For example, several of us have recently analyzed the more than 1,300-year duration of Monte Albán, the premier urban center of its region, the Valley of Oaxaca, Mexico (e.g., [Feinman et al., 2022](#); [Nicholas and Feinman, 2022](#)).

How typical was the persistence of this Valley of Oaxaca regional center, and, importantly, can we gain further insight into Monte Albán's sustainability through comparison with other Mesoamerican central places of its era? We selected 24 primary centers (towns and cities) with adequate data from the western half of Mesoamerica that were founded after 1000 BCE but prior to 300 BCE. Our focus is on the sustainability of these places as the largest settlements in their respective regions. We find marked variance in sustainability and draw attention to factors that may be implicated in that variation.

In prehispanic Mesoamerica, the cultural region that included the southern two-thirds of Mexico and neighboring countries in Central America, fully sedentary communities were first established ca. 2000–1500 BCE, and most of these early settlements were small, occupied by fewer than 1,000 people. Beginning around 1000 BCE, larger communities were established in many regions of Mesoamerica. The organizational decisions and paths taken by Mesoamerica's earliest urban dwellers were diverse, and there was no one factor that can account for the varied historical

sequences compared in this sample, but both governance (Bevir, 2012) and newly emergent conditions are argued to be relevant.

Conceptual framing

Our aim is to leverage the diversity of the past to inform present and future sustainability (e.g., Loorbach et al., 2017), and to assess the roles that governance, infrastructural investment, urban form, and macroscale inter-community networks had in urban persistence. Through comparative historical analysis, we endeavor to identify potential causal mechanisms behind the observed empirical patterns (Thelen, 1999, p. 372). We employ a definition of sustainability that equates with survival or persistence (Costanza and Patten, 1994, p. 193), and so our focus is on what we term the apogee, or the duration of time each center was its region's principal center (e.g., prior to a massive abandonment, a loss of political autonomy, or a major governmental reversal).

By using apogee length as a key dimension of sustainability, we avoid the pitfall of attributing causality to presumed correlations between specific environmental perturbations and hypothesized human responses. In archaeology, the lion's share of such attempts not only place undue stress on available chronological controls, but they also sidestep the growing recognition that how people respond to environmental perturbations is in large part a consequence of organizational effectiveness both prior to and during challenges (e.g., Middleton, 2017; Molloy, 2022). Our focus on sustainability recognizes that perturbations may be environmental, economic, or sociopolitical, and that most frequently these stresses are synergistically intertwined (Fisher and Feinman, 2005; Løvschal, 2022; Silva et al., 2022). Furthermore, the effectiveness of responses to climatic and other perturbations is to a large degree underpinned by the nature and quality of governance (e.g., Adger, 2003; Pildes, 2021; Jones et al., 2022). To assess features of political organization, we leverage a key attribute of archaeology's deep time perspective, the ability to record and evaluate historical outcomes (Grant, 2004), often not possible when investigations are focused exclusively on the present. Here, we endeavor to address the call for an expansion in the temporal range of sustainability studies (Clark and Harley, 2020).

Based on prior comparative analyses of the apogee lengths for large, well-studied prehispanic Mesoamerican central places over roughly three millennia (1500 BCE–1520 CE), two of us (Feinman and Carballo, 2018, 2022; Feinman, 2018a; Carballo et al., 2022) found a consistent relationship between more collective forms of governance (in which power was distributed) and apogee duration. This finding parallels a similar tendency in a global sample of premodern polities (albeit not statistically significant, Blanton, 2010, p. 48), that although collective governance tends to foster sustainability, it certainly does not ensure it (e.g., Murphy and Crumley, 2022).

Drawing on the frameworks of collective action, especially its fiscal foundations (Blanton and Fargher, 2008, 2016; Blanton et al., 2021, 2022a), and historical institutionalism (Hechter, 1990; Mahoney, 1990; Thelen, 1999), we examine variation in the infrastructural investments and socioeconomic contexts in which centers in the sample were established. The sustainability of a place as a regional center might be most likely to advantage major central institutions and people with power. Yet people tend not to act voluntarily and continuously for the good of the whole, so we also examine agentic manifestations implemented from the bottom-up (e.g., cooperative domestic investments). “Infrastructure is... the overt point of contact and access

between us all—the rules governing the space of everyday life” (Easterling, 2016, p. 11). Infrastructure impacts how interpersonal relations, architectural spaces, and objects are ordered and circulated; “an operating system for shaping the city” (Easterling, 2016, p. 13).

Our focus on early primary centers is specifically intended to examine factors, including institutions, governance, and infrastructure, that impact sustainability. Comparative investigations have previously noted that early centers and cities often are collectively governed, at least when contrasted to subsequent cycles of urban formation in the same cultural regions (Blanton and Fargher, 2008, p. 290; Feinman, 2018b). This sample of early Mesoamerican central places largely, but not entirely, conforms to that expectation, but the architectural investments through which distributed power and collective governance were implemented were not uniform. Infrastructural investments, settlement forms, and institutional arrangements varied across the sample. Likewise, the historical paths taken by these centers and their relative sustainability were anything but uniform.

Preshispanic Mesoamerica: Governance

Across millennia, from the advent of sedentary communities to the Spanish invasion, Mesoamerican societies were underpinned by key institutions, including states, markets, temples, water-management societies, local communities, neighborhoods/districts, and households (Kowalewski and Heredia Espinoza, 2020, p. 496). Nevertheless, over time and space, these consequential institutions had different modes of organization and they were articulated with each other in highly variable ways. These differences are evidenced in sixteenth-century texts, which though they must be read with appropriate caution, yield ample descriptions of both power-sharing confederations as well as more absolutist configurations in which patron-client relations concentrated political clout (Fargher et al., 2010, 2011; Carballo, 2022). More collective, distributed power arrangements were enacted through distinct institutional arrangements, which included modes of co-rulership and governing councils. In contrast, concentrated power tended to be personalized, associated with aggrandizing dynastic histories, such as the codices of the Mixtec royals (e.g., Boone, 2000). Axes of variation also are described in the organization of more localized, supra-household social and labor units, which in certain contexts were networked through hub-and-spoke ties to exclusionary elites, while in others collectively organized householders acted through reciprocal obligations without marked status distinctions (López Corral and Hirth, 2012; Carballo, 2022; Carballo et al., 2022). In a general sense, and contrary to much ‘common wisdom,’ neither getting things done nor fruitful cooperation requires strictly top-down governance or individualized leadership (Bregman, 2019).

Late prehispanic Mesoamerican textual accounts provide an empirical basis to define material correlates that help us understand deeper histories of political organization, especially for times when documents were absent, scarce, or limited in scope (e.g., Feinman and Carballo, 2018; Carballo, 2022). In general, more collective organizations were funded by internal financing—labor drafts and staple goods exacted from local populations. This contrasts with the external resourcing associated with more autocratic regimes, dependent on elite estates, monopolization of the exchange of precious goods, and war booty. Collective governance tended to be ‘faceless,’ associated with offices rather than aggrandized individuals, with power distributed.

Concentrated power arrangements tended to be personalized, frequently tied to descent and often conspicuous in individualized funerary treatments and monuments to specific rulers. Whereas autocratic governance frequently was focused on the palaces or mortuary monuments of individual rulers, characterized by restricted access to non-elites, more collective formations tended to be associated with accessible plazas, open accessways, and disseminations of public goods.

Nevertheless, there is no simple, single indicator, since human institutions take an array of forms and the archaeological findings on which we rely are generally uneven and partial. Given this caveat, we have devised a three-way nominal axis of variation (Table 1) that scales central places as autocratic or collective along the dimensions of political economy, governance, and architecture (Feinman and Carballo, 2018, 2022; Carballo et al., 2022). We coded centers along these axes so that a score of 1 signified the most collective and 0 signified the least, with half-point scores awarded for intermediate cases; the collectivity score for each center sums the values for political economy, governance, and architecture and ranges from 0 to 3.

Two of us (Feinman and Carballo, 2018, 2022; Carballo et al., 2022) have employed these criteria to compare modes of governance at more than thirty of prehispanic Mesoamerica's better-documented central places. To a degree, collective governance correlated with longer apogee lengths, although the relationship did not hold for all cases. Our previous comparisons included centers from three millennia (*ca.* 1500 BCE–1520 CE) of the prehispanic era. When comparing apogee length to governance, we excluded the late prehispanic centers as most if not all indigenous polities of that era were truncated by the sixteenth-century Spanish invasion and associated epidemics.

Early central places in non-Maya Mesoamerica: The sample

Here, we limit our sample to settlements that were in either the first or the second wave of center emergence in their respective regions. All of the centers in the present sample began their apogees as primary settlements at some point between 1000 and 300 BCE. Primary centers are the largest settlement in their respective regions, and for inclusion, they had to have estimated populations of 1000 people or more. Apogee lengths were calculated as the period in which a center was the principal one in its region and maintained a population above the stated size. We restricted the sample to the western half of Mesoamerica where the authors have extensive research experience and familiarity. Our assessments of each center rely strictly on the reports of the center's principal researchers (Table 2). The 24 sites (Figure 1; Supplemental materials) that are included in this analysis are the most

extensively reported for the focal temporal range. They stretch from the Gulf Coast (La Venta, Tres Zapotes) across the Central and Southern Highlands (a majority of cases) to West Mexico (Los Guachimontones). Although this sample does not represent all known centers, it does include those for which published reports are sufficiently detailed to assess regional contexts and key central place variables. The sample does not include the Central Mexican metropolis of Teotihuacan as its apogee as a regional center began after 300 BCE (Cowgill, 2015). Nevertheless, in its collective governance, apogee length (*ca.* 600 years), high degrees of inter-household cooperation, and resilience in response to climatic (Kennett and Marwan, 2015) and geophysical (Ramírez-Urbe et al., 2022) perturbations, Teotihuacan's history (Feinman and Carballo, 2018, 2022; Carballo et al., 2022) parallels other centers in the sample.

We lack detailed climatic and environmental data for western Mesoamerica, so we cannot assess the impact of (or response to) singular events. Yet, we do know that the people had to deal with challenges of water (sometimes too little, other times too much), erosion, earthquake, volcanism, and other environmental perturbations (e.g., Kirkby, 1973; Plunket and Uruñuela, 2008; McClung de Tapia, 2012; Nichols, 2015; Carballo, 2016, pp. 21–36). In the face of this range of challenges, environmental and also socioeconomic, we agree with Costanza and Patten (1994, p. 194) that “sustainability ... always concerns temporality and, in particular, longevity.”

Apogee length was highly variable for the centers in the sample. Monte Albán (Valley of Oaxaca), with an apogee length of 1,300 years, remained a primary center longer than the others, but Cantona (eastern Puebla) persisted as the principal settlement in its region for 1,050 years. This apogee assessment for Cantona represents a small adjustment from our figure in an earlier publication (Carballo et al., 2022), based on newly reported findings (Martínez Calleja, 2018). The apogee lengths of the other central places range between 200 and 850 years, with an overall mean duration of just more than 600 years (Table 2). In general, the apogee lengths of these places as principal centers in their respective regions are not indicative of great fragility (*cf.* Kennett and Marwan, 2015; Yoffee, 2022). And many highland Mesoamerica centers in this sample endured during and beyond a period of intense climatic volatility (*ca.* 375–400 CE).

Assessing governance (degree of collectivity) for these early centers can be challenging. Nevertheless, based on the published information, clearly the great majority depended economically on internal resources (local farming and utilitarian craft production), had relatively “faceless” modes of leadership, lacked elaborate palaces at the core of the settlements or highly elaborate individual burials. Centers had open, public spaces, though of differing scale and type. Most monumental architecture consisted of temples or buildings associated with other civic-ceremonial activities. The most prominent exceptions to these general patterns were

TABLE 1 Axes of collectivity* coded for Mesoamerican cases.

| Variable/Score | 1 – More collective | 0 – Less collective |
|-------------------|---|--|
| Political economy | Internal financing with greater focus on staple goods and market exchange; more muted socioeconomic differentiation | External financing with greater focus on prestige goods derived from long-distance exchange or control of spot resources; palace-centric production; more heightened socioeconomic differentiation |
| Governance | “Faceless” rulership; low mortuary differentiation; secular and bureaucratized political offices | Highly conspicuous rulers in burials and iconography; individualized rulers; divine kingship |
| Architecture | Emphasis on communal architecture over palaces, including temples, plazas, accessways; art emphasizing public goods | Emphasis on palaces so that their elaboration and centrality matches or exceeds more communal architecture; art emphasizing exclusive access |

*Summed scores for each case range between 0 (least collective) and 3 (most collective).

TABLE 2 Sample of 24 early central places in western Mesoamerica.

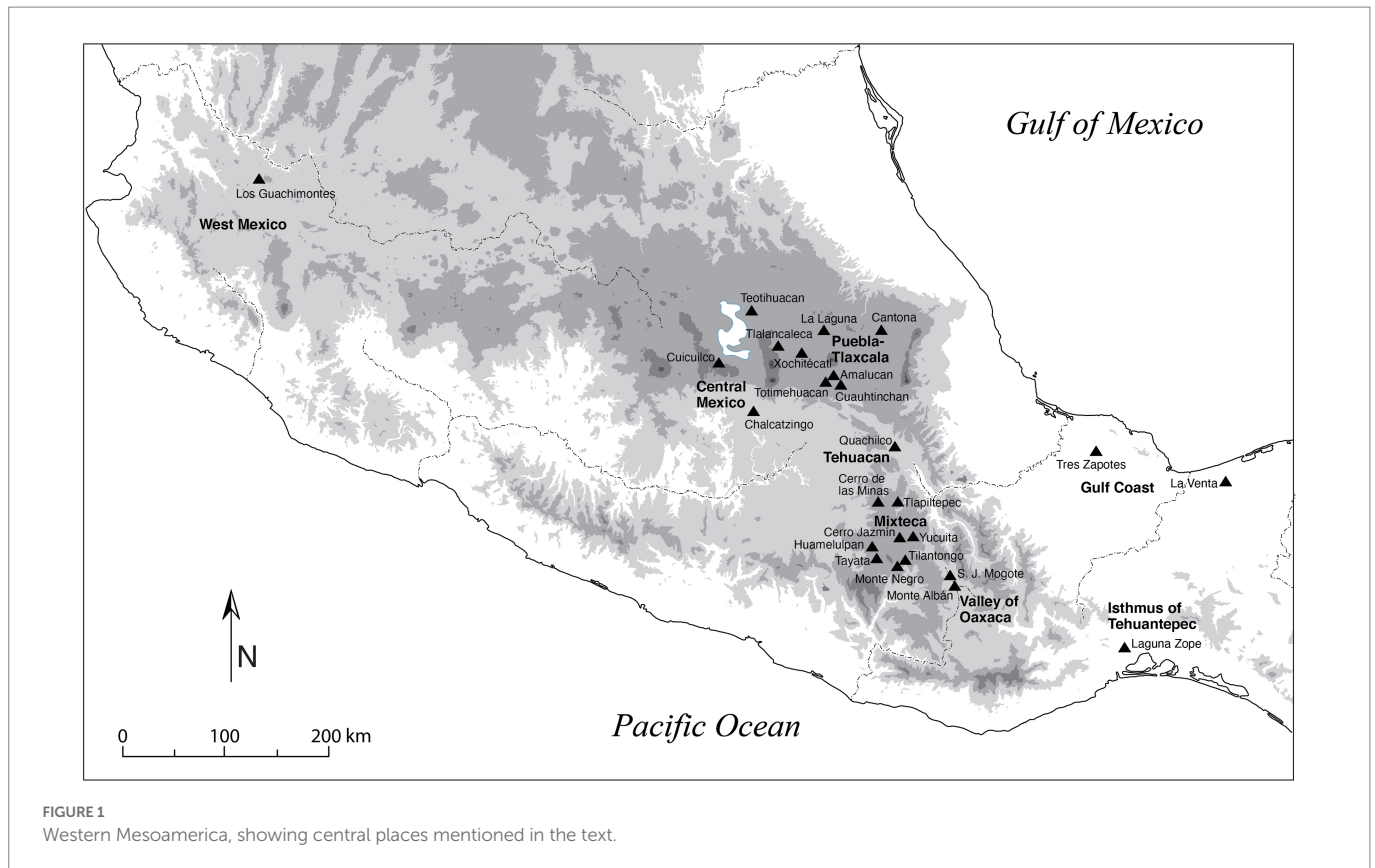
| Region | Central place | Earliest date as center | Apogee (years) | Collectivity score | Source |
|-----------------|---------------------------|-------------------------|----------------|--------------------|--|
| Puebla-Tlaxcala | Amalucan | 700 BCE | 350 | 2.5 | Freeman (2014) and Carballo (2016) |
| Puebla-Tlaxcala | Cantona | 300 BCE | 1,050 | 2.5 | García Cook (2003, 2004), Martínez Calleja (2004, 2018) |
| Mixteca | Cerro de las Minas | 400 BCE | 600 | 2.5 | Alvarez (1995) and Winter (2017) |
| Mixteca | Cerro Jazmín | 300 BCE | 600 | 2.5 | Heredia Espinoza et al. (2008), Pérez Rodríguez et al. (2011), and Joyce (2022) |
| Central Mexico | Chalcatzingo | 1000 BCE | 500 | 2 | Grove (1987, 1999) and Grove and Gillespie (2009) |
| Puebla-Tlaxcala | Cuauhtinchan | 800 BCE | 700 | 2.5 | Sieferle-Valencia (2007) and Carballo (2016) |
| Central Mexico | Cuicuilco | 800 BCE | 700 | 3 | Pastrama and Ramírez (2012) and Plunket and Uruñuela (2012) |
| Mixteca | Huamelulpan | 300 BCE | 700 | 2.5 | Balkansky (1998) and Joyce (2022) |
| Puebla-Tlaxcala | La Laguna | 600 BCE | 700 | 2.5 | Carballo (2016) |
| Gulf of Mexico | La Venta | 700 BCE | 300 | 0 | Rust (1992, 2008) and Pool (2007) |
| Oaxaca | Laguna Zope | 500 BCE | 700 | 2 | Zeitlin (1993) |
| Jalisco | Los Guachimontones | 300 BCE | 750 | 2.5 | Heredia Espinoza (2020) |
| Oaxaca | Monte Albán | 500 BCE | 1,300 | 2.5 | Blanton (1978) |
| Mixteca | Monte Negro | 300 BCE | 200 | 2.5 | Balkansky et al. (2004) and Joyce (2022) |
| Tehuacan | Quachilco | 500 BCE | 400 | 2.5 | Alden (1979) and Drennan (1979) |
| Oaxaca | San José Mogote | 1000 BCE | 500 | 2 | Flannery and Marcus (1983, 2005) and Marcus and Flannery (1996) |
| Mixteca | Tayata | 1000 BCE | 700 | 2 | Balkansky (1998), Kowalewski et al. (2009), and Meissner et al. (2013) |
| Mixteca | Tilantongo La Providencia | 700 BCE | 400 | 2 | Balkansky et al. (2004) and Kowalewski et al. (2009) |
| Puebla-Tlaxcala | Tlalancaleca | 500 BCE | 700 | 2.5 | García Cook (1981), Carballo (2016), Murakami et al. (2017), and Murakami (2022) |
| Coixtlahuaca | Tlapiltepec | 500 BCE | 200 | 3 | Kowalewski et al. (2017) and Kowalewski (2021) |
| Puebla-Tlaxcala | Totimehuacan | 650 BCE | 500 | 2.5 | Carballo (2016) |
| Gulf of Mexico | Tres Zapotes | 400 BCE | 600 | 2 | Pool (2008, 2010) and Pool and Loughlin (2015, 2016, 2022) |
| Puebla-Tlaxcala | Xochitecatl | 750 BCE | 850 | 3 | Serra Puche and Palavicini Beltrán (1996), Serra Puche and Lazcano Arce (2008, 2011), and Serra Puche (2012) |
| Mixteca | Yucuita | 300 BCE | 600 | 2.5 | Plunket (1983), Balkansky et al. (2004), and Joyce (2022) |

the two Gulf Coast centers, where there are massive carved-stone heads (La Venta, Tres Zapotes) and thrones (La Venta), which were seemingly tied to more individualized modes of leadership and personalized power (e.g., Pool and Loughlin, 2017). These two Gulf Coast centers have the lowest collectivity scores in this sample; based on new syntheses (Pool and Loughlin, 2022), we slightly adjusted the value for Tres Zapotes.

Although indicators of personalized, concentrated power arrangements were rare in this sample of centers, outside the Gulf Coast region, the manifestations of more collective forms of governance were anything but uniform. In some instances, the settlements had one relatively central and accessible principal plaza (e.g., Cuicuilco, Monte Albán), while others had polycentric urban layouts featuring several discrete architectural complexes (e.g., Cantona, Cerro Jazmín, Monte Negro), seemingly indicative of shared power arrangements between different, semi-autonomous factions (Table 3). At early Tlapiltepec, there was almost no monumental construction.

Sustainability and governance

For the early Mesoamerican central places in this sample, we find that governance does have a relationship (Figure 2A) with apogee length (persistence as principal centers), although the relationship was not determinative in the sense that not all collectively governed settlements had extended apogee durations. The persistence of three collectively governed centers (Monte Albán, Cantona, and Xochitecatl) stood out from the rest of the sample. When we looked at the dates when the centers were founded, there was minimal difference overall between centers established before 500 BCE and those that became central places on or after that date (Figure 2B). But the two longest lived central places, Monte Albán (*ca.* 500 BCE) and Cantona (*ca.* 300 BCE), were established as regional centers after 500 BCE.



Monte Albán and Cantona shared commonalities from early in their histories, although their urban footprints were in some key ways dissimilar. Both grew rapidly in size once they became centers (Martínez Calleja, 2018; Feinman et al., 2022; Nicholas and Feinman, 2022). They each had compact, dense settlement plans, albeit with differences. Cantona had multiple civic-ceremonial architectural complexes and more than 20 ballcourts. Sectors of that site were interconnected by an array of internal paths and causeways (García Cook, 2003, 2004; Martínez Calleja, 2018). Hilltop Monte Albán had a large centrally situated Main Plaza, around which most of the public buildings were situated, including a ballcourt (Marcus, 2009). This central precinct was laid out when the hill was first occupied (Levine et al., 2021), and the settlement also was interconnected by a series of foot paths and trails (Blanton, 1978). Both sites also rapidly eclipsed the civic-ceremonial monumentality of settlements in their respective regions, yet neither had clear indicators of individualized power such as a single, large, central palace or exceptionally lavish tombs.

Of the five macroregions that we consider in this sample, none stand out from the others in terms of the central place apogee duration (Figure 2C). Monte Albán persisted much longer as a center than the other Oaxaca settlements in the sample, while Cantona and Xochitecatl endured longer than the other centers that were included for Puebla-Tlaxcala. The Gulf Coast centers had a somewhat lesser degree of sustainability, perhaps reflective of their more individualistic systems of governance. Given that the time of emergence as a center, geographic location, and governance alone cannot account for sustainability, we broaden our analytical lens to a wider suite of variables that are focused on the emergent conditions associated with each center and the potential impact of those organizational factors over time.

Historical institutionalism and key emergent conditions

How people organize themselves and the institutions through which they cooperate structure responses to perturbations and hazards, both natural and social, affecting sustainability (e.g., Barrios, 2016; Latham and Layton, 2019). “The relationships and processes that put communities on the map...shape the ways they are exposed to hazards, and their possibilities for recovery” (Barrios, 2016, p. 28). To put it another way, the multiscale footprint of a settlement from early in its history can either impinge on or enhance cooperation, and these conditions, including infrastructural elements, have an outsized role in shaping and constraining future practice and response (Mahoney, 1990; Greener, 2005). Nevertheless, although the past (and its structural elements) matters, it does not tightly cage what follows (Arroyo Abad and Maurer, 2021). Shifts in institutions and their financing can effect change. For example, governance at Tres Zapotes shifted from personalized leadership to a more collective mode of governance during its time as a regional center (Pool, 2008; Pool and Loughlin, 2022), while toward the end of Monte Albán’s 1,300-year areal dominance, the settlement’s governance transitioned to more individualized rule as its regional hegemony fragmented (Feinman and Nicholas, 2016).

In prior comparative studies of prehispanic Mesoamerican settlements, population (Feinman and Carballo, 2019) and population density (Feinman and Nicholas, 2012a) were correlated with more collective governance and higher degrees of collective action. The relationship between city density and more collective governance also holds for a global sample of premodern polities (Blanton and Fargher, 2011, 2012; Fargher et al., 2019). Although demographic size and density alone are not necessary and sufficient for collective governance or high

TABLE 3 Population and other values for the 24 early central places in western Mesoamerica.

| Central place | Maximum* population | Single regional center or peer polity | Density (per ha) | Density value | Domestic labor value | Architecture value |
|---------------------------|---------------------|---------------------------------------|------------------|---------------|----------------------|--------------------|
| Amalucan | 11,500 | Peer polity | 16.4 | 0 | 1 | 1 |
| Cantona | 60,000 | Single center | 48 | 2 | 2 | 1 |
| Cerro de las Minas | 1,000 | Peer polity | 20.0 | 1 | 2 | 2 |
| Cerro Jazmín | 18,000 | Peer polity | 81.0 | 2 | 2 | 1 |
| Chalcatzingo | 1,000 | Single center | 23.3 | 1 | 1 | 2 |
| Cuauhtinchan | 1,750 | Peer polity | 17.5 | 1 | 0 | 2 |
| Cuicuilco | 20,000 | Single center | 40.0 | 2 | 1 | 2 |
| Huamelulpan | 13,745 | Peer polity | 67.0 | 2 | 2 | 2 |
| La Laguna | 2,250 | Peer polity | 22.5 | 1 | 1 | 2 |
| La Venta | 3,000 | Single center | 6.0 | 0 | 0 | 2 |
| Laguna Zope | 2,000 | Single center | 22.2 | 1 | 0 | 2 |
| Los Guachimontones | 9,540 | Single center | 17.7 | 1 | 1 | 1 |
| Monte Albán | 25,000 | Single center | 35.7 | 2 | 2 | 2 |
| Monte Negro | 3,889 | Peer polity | 50.0 | 2 | 2 | 1 |
| Quachilco | 1,180 | Single center | 17.7 | 1 | 1 | 2 |
| S. J. Mogote | 1,200 | Single center | 15.2 | 0 | 0 | 2 |
| Tayata | 2,173 | Peer polity | 28.2 | 1 | 1 | 2 |
| Tilantongo La Providencia | 1,602 | Peer polity | 17.4 | 1 | 1 | 2 |
| Tlalancaleca | 13,750 | Peer polity | 27.5 | 1 | 1 | 1 |
| Tlapiltepec | 23,324 | Peer polity | 17.9 | 1 | 1 | 0 |
| Totimehuacan | 2,625 | Peer polity | 17.5 | 1 | 0 | 2 |
| Tres Zapotes | 7,000 | Single center | 14.0 | 0 | 0 | 1 |
| Xochitecatl | 17,500 | Single center | 17.5 | 1 | 2 | 2 |
| Yucuita | 3,500 | Peer polity | 20.0 | 1 | 2 | 1 |

*The midpoint of population ranges is listed for all sites.

degrees of cooperation, the relationship tends to hold especially in those contexts in which settlement density co-occurs with social practices and community infrastructures that enhance communication and interpersonal interaction (Friedkin, 2004, pp. 419–420; Hipp and Perrin, 2009). Across time and space, higher densities both foster and demand more intensive communication, greater degrees of interpersonal activity, and the forging of inter-household horizontal ties (Bettencourt, 2013; Smith, 2019; Feinman, 2022). Collective forms of governance, financed through internal resources, thrive when institutional principals are proximate to subaltern taxpayers (Blanton and Fargher, 2011, pp. 506–507). At the same time, both strong ties and collaborative arrangements among householders build bonds of collective action and domestic investments in infrastructural sunk costs or landesque capital (Widgren, 2007; Carballo et al., 2022). If maintained, these investments provide economic benefits that become disincentives to community dissolution and out-migration (Freeman et al., 2021). In prehispanic Mesoamerica, intra-community, household collaborations were significant as both agricultural and craft production were situated in domestic units (e.g., Feinman, 1999). Likewise, there is ample evidence, from both the deep (Nicholas and Feinman, 2022) and more recent pasts (Jensen and Ramey, 2020) that early infrastructural investments in public goods and the creation of civic spaces for contemplation (Green,

2022), information exchange, and communal expression (Amin, 2008; Latham and Layton, 2019) foster well-being and sustainability.

The sustainability of nodal centers in their respective regions also reflects the interaction of principals and their competitors, and the degree of adherence to institutional contracts and constitutions (e.g., Goldstone, 1982; Blanton et al., 2020). For that reason, our consideration of structural conditions extends beyond indicators of domestic cooperation, sunk costs, and settlement density, to a central place's footprint, public spaces, and the larger socio-spatial contexts in which it arose. Are there differences between centers that from their foundations had one predominant central plaza (Monte Albán) as opposed to central places that were more polycentric, with multiple monumental complexes (Cantona), even in those cases where power was seemingly shared through confederation or rotations of power?

At the macroregional scale, a comparative analysis (Bandy, 2008) of 36 global sequences of settlement pattern change, starting with the advent of sedentary communities, has illustrated the importance of path dependence. In those regions where a single large community arose in the absence of equivalent peer settlements, early urban settlements followed. But where communities remained roughly equivalent in size, no urban community was established as the smaller settlements jockeyed for preeminence. In our analysis, we gauge whether central

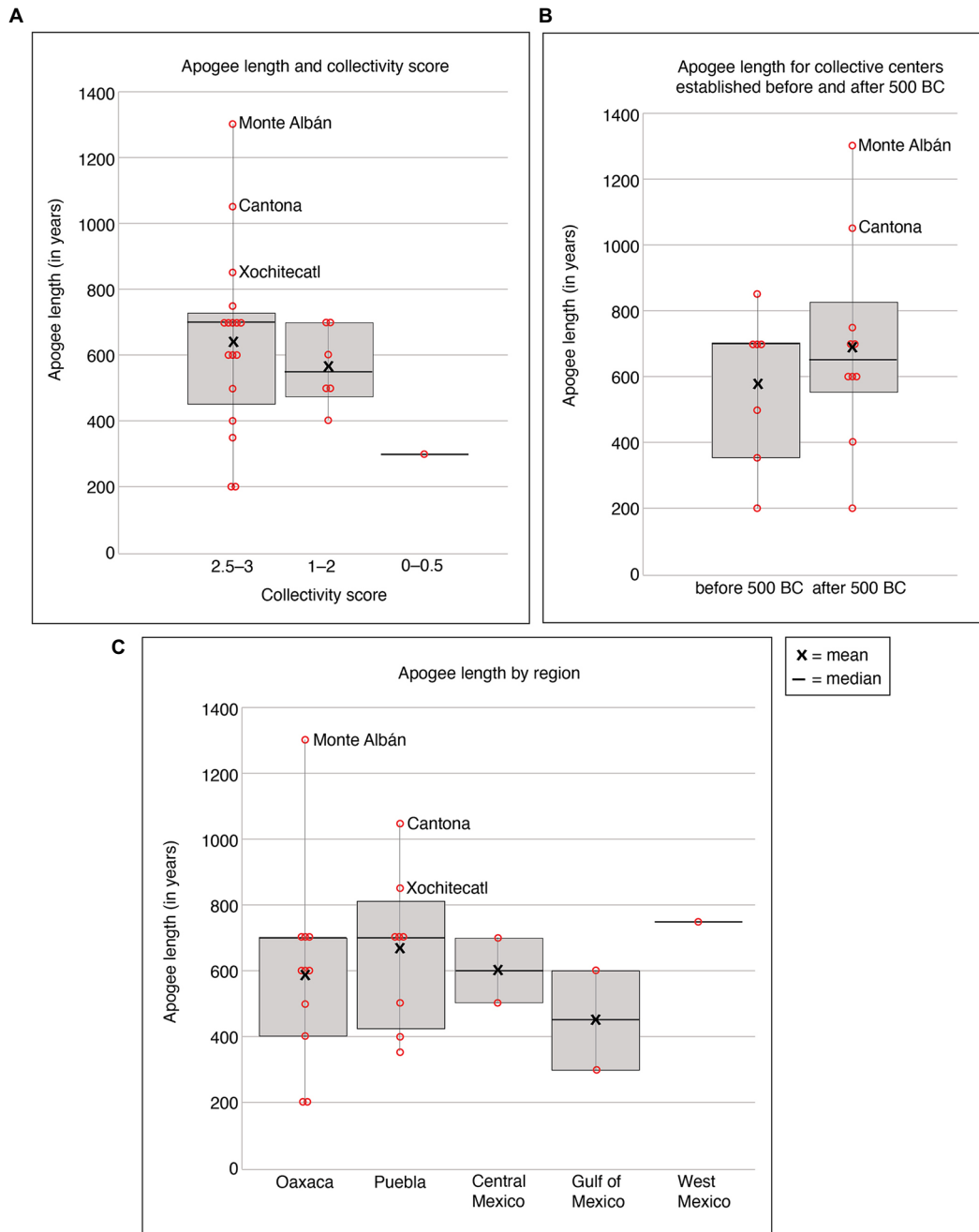


FIGURE 2 Relationship of apogee length to collectivity score (A), date of establishment as a central place (B), and geographic location (C). Labeled sites have the longest apogees and are specifically referenced in the text.

places were singular in their region or whether the patterns of center emergence were more “peer-polity.”

Supra-household relations, path dependence, and sustainability

If institutions and the people who compose them are the “carriers of history” (David, 1994, p. 205), then it is the differential and shifting articulations of these organizational units that create divergent outcomes. In the prior section, we described four institutional factors or analytical dimensions, from households to the macroregional articulations between

settlements and their governors, that we suspect underpin the sustainability of the early central places in this sample. None of these factors is simple to assess archaeologically. Perhaps the most straightforward is settlement density, which for each case can be derived from published sources. The second is labor cooperation as indicated by agrarian features and other material indicators of household cooperation, pooled labor, and connectivity. A third factor is city-wide governance. Was the socio-spatial footprint of political organization focused on one central location or more spatially polycentric? We also take into account whether the settlements arose as part of a non-primate network of closely spaced central places or whether they were more distantly situated from places of roughly similar size and monumentality. A final analysis examines these factors jointly.

Our assessments of settlement densities were calculated based on published estimates of maximal settlement area and population (Table 3). Although the figures (Figure 3A) reflect these settlements at their peaks, there is no evidence that densities changed markedly after they first became regional centers. In fact, the demographic estimate for Monte Albán at the end of its first phase of occupation (Blanton, 1978) would give the site a slightly higher density than we calculated for its population peak. In each case, the numerical density figure (Figure 3A) corresponds with the topographic setting and basic settlement plan established early in its history, and the basic site layout was followed through the apogee period. The lowest densities were found at valley floor settlements that generally were dispersed across flat or gently sloping terrain. Middling densities mostly were recorded at settlements that either were situated on valley floors, yet were compact, or were located on low hills with some terracing. The centers with the highest densities were on hilltops or ridgetops, and these were compact and nucleated with extensive residential terracing. For this sample, we found weak relationships between settlement densities and collective governance (Figure 3B) and between density and apogee length.

In prehispanic Mesoamerica, where beasts of burden were absent and there was minimal use of metal outside of ornamentation (all Mesoamerican metal post-dates the focal period of this analysis), infrastructural investments and agrarian intensification were almost entirely dependent on domestic cooperation and labor (Feinman and Nicholas, 2012b; Carballo, 2022). Truly large-scale water-control projects were rare, mostly limited to near the end of the prehispanic era, such as the dikes, causeways, canals, and other lake manipulation projects associated with the Aztec empire (Whitmore and Turner II, 1992). Instead, neighborhood and household collaborations were fundamental for getting things done or producing goods that could help sustain either the broader community (public goods, such as infrastructural features that enhance defense) or narrower interests and constituencies (Blanton and Fargher, 2012; Carballo and Feinman, 2016; Fargher et al., 2019; Carballo, 2022).

To evaluate the extent of domestic collaboration and who was likely to benefit from such labor investments, we set up an ordinal scale for degree of collectivity. We gave compact, extensive residential terracing the top value of two. Here, residential terracing, even if each terrace only houses a single domestic unit, entails significant demands for pooled labor because front terrace walls were generally shared by multiple residential units (Hard et al., 1999; Feinman and Nicholas, 2004). Drains often were situated in the narrow spaces between individual terraces. Construction, drainage problems, retaining wall maintenance, and rebuilding episodes all required cooperation and inter-household labor collaborations (Kowalewski et al., 2006; Nicholas and Feinman, 2022). Overall, the labor costs of residential terrace construction and maintenance are ample (Hard et al., 1999; Kowalewski et al., 2006). Settlements with agricultural terracing or other small-scale water control infrastructural investments (e.g., Pérez Rodríguez and Anderson, 2013) were given a value of one. Such agrarian features are indicative of sunk costs (Janssen et al., 2003; Fisher and Feinman, 2005) and intensified production, both of which foster community persistence, but are less likely to necessitate supra-household cooperation. Communities where there are no reported or only minimal investments in residential terracing or agrarian infrastructure were scored zero (Table 4).

Despite considerable variation, we find that greater domestic cooperation and infrastructural investment is related to apogee length (Figure 4A). Sustainability has a social component (e.g., Scheffer et al., 2021). The three sites with the longest apogee lengths (Monte Albán, Cantona, and Xochitecatl) all have extensive residential terracing and

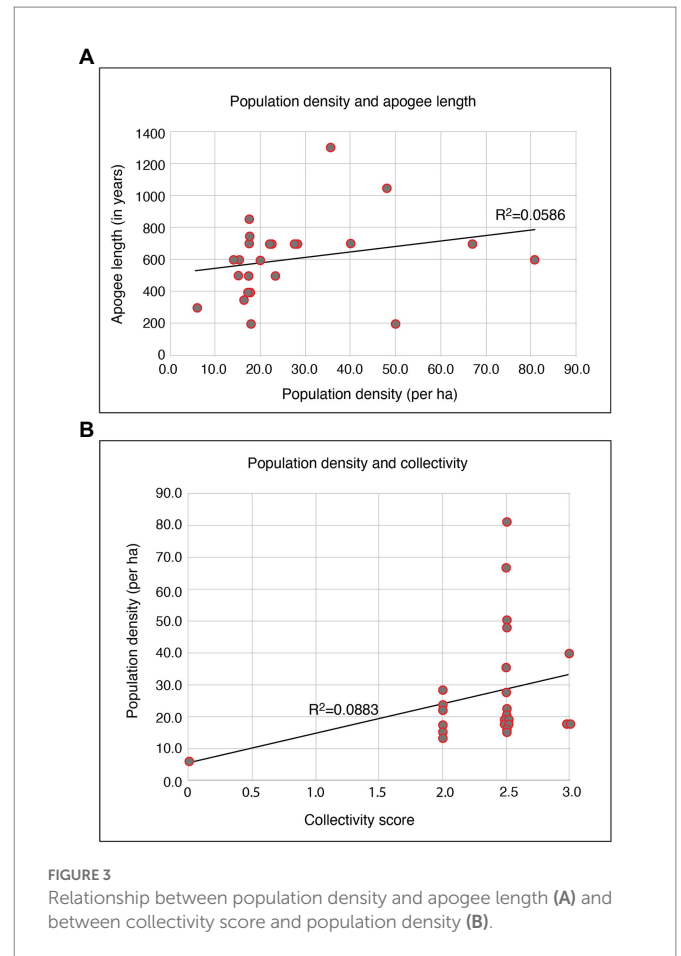


FIGURE 3 Relationship between population density and apogee length (A) and between collectivity score and population density (B).

domestic-level investments in infrastructure (Figure 4A; Tables 2, 4). The one settlement that deviates most notably from this pattern is Monte Negro, a compact, hilltop settlement with residential terracing in the Mixteca Alta (Balkansky et al., 2004). Although Monte Negro was founded (*ca.* 300 BCE) a few centuries after Monte Albán's establishment to the southeast in the Valley of Oaxaca, its apogee length was much shorter, only 200 years (Table 1). Beyond the parallels in the layout of these two centers, both hilltop centers are thought to have drawn much of their founding populations from their immediate vicinities (Balkansky et al., 2004; Nicholas and Feinman, 2022; Blanton et al., 2022b).

Nevertheless, several key differences between these sites also seem relevant to their markedly different histories. In its early centuries, Monte Albán was at least 100 km (over high, rugged mountains) from any comparable center; Monte Negro was only 25–30 km from other Mixteca Alta central places, including Cerro Jazmín and Huamelulpan (Figure 1). During its early occupation, Monte Albán was surrounded by many smaller settlements within a 5–10 km radius (Nicholas and Feinman, 2022; Blanton et al., 2022b), and agrarian produce from these smaller communities helped sustain the larger center, especially during abnormally dry years (Kowalewski, 1980; Nicholas, 1989). Few rural settlements surrounded Monte Negro (Balkansky et al., 2004), which, perhaps, left the center vulnerable. Monte Albán had a large focal central Main Plaza that was established early in the site's history; Monte Negro lacked such a shared, accessible central or focal space and rather had multiple, discrete, architectural complexes, which may have been associated with separate social segments (Balkansky et al., 2004; Kowalewski et al., 2009; Joyce, 2022).

Socio-spatial competition, path dependence, and sustainability

In contrasting the durations of Monte Albán and Monte Negro, we hypothesized that the socio-spatial competitive contexts between governing principals (both intra-community and between neighboring settlements) may be an important consideration. To assess these factors, we first compared civic-ceremonial architectural arrangements and investments for the sites in the sample (Table 4). In all but one settlement (Tlapiltepec), which we scored as zero, significant non-residential construction was built early in each center's occupational history. Inter-elite cleavages, which could potentially endanger collective forms of governance and community sustainability, would more likely emerge in contexts where factional competition was deeply embedded and materially symbolized (e.g., Brumfiel, 1994; Blanton et al., 1996, 2020). Competition need not rise to the level of militarism, but may manifest in polarized contests for resources and power that diminish effective collective response (e.g., Blanton, 2015; Feinman, 2021). Settlements with multiple, discrete architectural complexes (polycentric civic-ceremonial plans) were coded a value of one, while settlements with a single focal architectural complex were given a score of two, indicative of greater collectivity (Tables 3, 4). In this sample, these unicentric layouts generally included large, open, accessible plazas. Wide ranges of variation in apogee length characterize the central places with focal as opposed to polycentric architectural arrangements (Figure 4B). But settlements with a single, focal architectural complex did endure as centers somewhat longer on average than centers with polycentric plans.

A somewhat stronger axis of difference was noted between settlements that arose proximate to other contemporary centers, in what might be considered peer polity emergence (e.g., Renfrew and Cherry, 1986; Renfrew, 1994) as opposed to contexts in which central places were primate or arose in regions without nearby or peer settlements (Figure 4C). Centers that were founded without proximate competitors had (on average) apogee durations that were more than two centuries longer. And all settlements that persisted as centers for longer than 700 years were preeminent in their regions, spatially buffered from peer, potentially competitive, communities.

To this point, we have identified a series of conditions that enhance but do not guarantee the sustainability of prehispanic Mesoamerican central places. Compact and dense community settlement patterns, high degrees of domestic cooperation and shared labor projects, a focal civic-ceremonial complex with accessible, open public space, and spatial distance from potential competitors all have a relationship to

longer-term apogees. Yet, it is also clear that no initial condition or singular factor is determinative, nor an assurance, of central place resilience.

Nevertheless, when these factors are examined together, provocative patterns are evident (Figure 4D). Because we lack detailed chronological sequences of change for the great majority of communities in this sample, our analytical procedures are admittedly a bit basic. We calculated a cumulative index for each center in the sample. Settlement densities were recoded to an ordinal scale (Table 4) and this value was summed with the scores for domestic labor cooperation and architectural layout. The cumulative scores range from one to six.

When these three factors are combined, the mean differences in apogee duration are several centuries between centers with values of 5–6, those at 3–4, and those with a score of 1–2 (Figure 4D). We then considered a fourth factor, whether the central places grew along with others nearby or were more regionally primate. This distinction did not have a marked effect on the samples of centers with summed scores of 1–4. But among the centers with cumulative scores of 5–6, the regional context clearly separated the three central places with the longest apogees in the sample (Monte Albán, Cantona, and Xochitecatl). The only other central place that had a cumulative score of five or greater and was a singular center in its region is Cuicuilco, which persisted as a major central place for 700 years. Though its apogee was somewhat shorter than the three most long-lasting centers, Cuicuilco's ultimate decline was prompted by two major challenges that arose late in its occupational history, volcanic eruptions, which first resulted in migration from the region and later covered much of the city (Urrutia-Fucugauchi et al., 2016; Ramírez-Urbe et al., 2022), and the rapid rise of the Teotihuacan metropolis across the Basin of Mexico (Cowgill, 2015). Thus, in this sample dense communities with a high degree of inter-household cooperation and a focal civic center where there was opportunity for collective voice and expression tended to be resilient when potentially competitive centers were not immediately proximate.

Future directions and prospects

Several key observations and patterns are clear. Most notably, early centers in the western half of Mesoamerica had diverse and divergent historical paths. Some persisted as regional centers for no longer than a few centuries, while the duration of others lasted a millennium or more. Overall, they were seemingly more resilient than fragile in the face of a range of socioenvironmental perturbations (the average time of apogee is 600 years).

These major settlements were organized with markedly different spatial layouts, public buildings, and monuments (Supplementary materials). Some had massive architectural constructions and others had little. The sizes and distribution of plaza spaces varied, as did the population densities and city plans. Most of these early central places were not organized by or for highly personalized aggrandizers; rather, they had more collective forms of governance. We found that the collectively organized centers had greater sustainability than did the centers with more personalized forms of leadership, although governance alone did not account for apogee duration.

We defined several other factors (community density, domestic labor cooperation, architectural layouts, and interregional competition) that had relationships to apogee length. There was not one prime mover or determinant of central place longevity. Furthermore, in some cases, conditions or practices changed over time, affecting sustainability.

TABLE 4 Factors in path dependence.

| | |
|---|--|
| Density values (population per ha) | |
| 0 = 6.0 to 16.5 | |
| 1 = 17.4 to 28.2 | |
| 2 = 35.7 to 81.0 | |
| Cooperative domestic labor investment | |
| 0 = no or minimal investment in residential terracing or agricultural infrastructure | |
| 1 = considerable investment in agricultural infrastructure, limited residential terracing | |
| 2 = significant investments in residential terracing | |
| Nature of public architecture | |
| 0 = none reported or only minimal investment | |
| 1 = polycentric, 2 or more mound/plaza complexes, none are principal | |
| 2 = 1 large, principal mound/plaza complex, usually with large open, accessible plaza | |

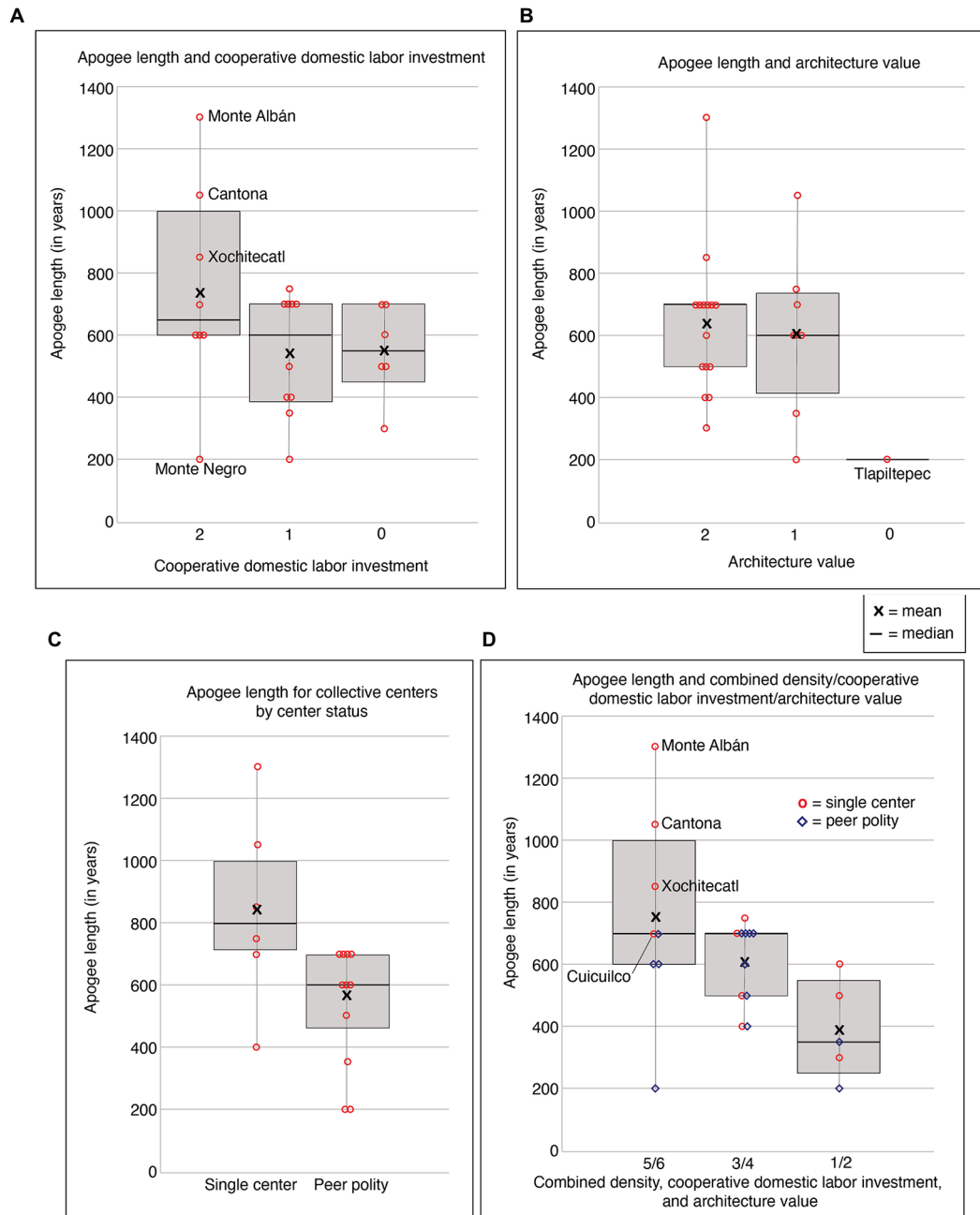


FIGURE 4 Relationship of apogee length to cooperative domestic labor investment (A), architecture value (B), center status (C), and combined density/domestic labor/architecture value (D). Labeled sites are specifically referenced in the text.

Underlying structural conditions, though important, are not immune to change.

Taken together, community density, domestic labor cooperation, architectural layout, and interregional competition correspond with those central places that were longest enduring. This means, at the minimum, that how people were organized and their practices and institutions at foundation underpinned their relative resilience to perturbations. This conclusion may suggest important analytical directions to explore further. The recurrent patterns described here are provocative and provide paths for investigation. Nevertheless, at this point, we would not want to imply that these findings should be generalized for eastern Mesoamerica, later temporal periods in

prehispanic Mesoamerica, or more global contexts. This study also points to gaps in our empirical record, both environmental and archaeological, that require redress to sharpen our understanding of long-term central place sustainability. Only with much finer empirical resolution at multiple scales will we be able to draw fuller lessons from our collective past.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The reviewer TC declared a past collaboration with the author GF to the handling editor.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fevo.2023.1076740/full#supplementary-material>

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