VITAL TOPICS FORUM

Cooperative Bodies: Bioarchaeologists Address Nonranked Societies

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Introduction: The Bioarchaeology of Cooperation and Nonhierarchical Power

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Human behavior and human societies are always complex, arguably the most complex social arrangements of any known species, and organized in an infinite number of ways. This organization often relies on cooperation, a form of human interaction that is deeply rooted and at times more useful than working individually (Coelho and McClure 2016; Mead 1937). Mead (1937, 8) defines cooperation as "the act of working together to one end," and cooperative relationships have been at the center of many ethnographic accounts of small-scale communities as well as nation-building attempts (Anderson 1983). Despite this obvious reliance on cooperation, scholars have often ignored cooperation when thinking about large groups in the past. Traditionally, anthropologists and archaeologists have focused on ranked or hierarchical systems of organization built on competitive relationships, imagining a vertical distribution of power, building from small egalitarian bands through vertically arranged states (Service 1962). This focus on hierarchy and a linear progression of social organizations diminishes the diversity of human societies, essentializes human groups in limited stereotypes, and relies on patriarchal and colonial classifications (Appadurai 1988; Henry, Angelbeck, and Rizvi 2017). The flaws in Service's descriptions of power organizations are numerous and apparent, yet this model of power persists.

In 1979, Crumley introduced the idea to archaeology that organizational systems can take forms other than control hierarchies, instead suggesting that heterarchy is just as common and works in flux with hierarchy. Heterarchy is built on elements that are unranked in relation to each other or ranked in various nonlinear ways (Crumley 1979, 1987, 2007). Heterarchy can vary by scale and time, producing different power relationships between individuals, communities, or groups of people that shift in power depending on material, topic, etc. In fact, heterarchy and hierarchy are often in flux, as power circulates through networks of people and places (Crumley 1995, 2007). To address moments of heterarchy and cooperation between groups, any researcher needs to account for spatial and temporal flexibility in the dynamic nature of human organization (Crumley 1995). Unfortunately, identifying heterarchy archaeologically is at times difficult because of this flexibility and because heterarchy may not be reflected through accumulations of wealth and health, as is commonly associated with elite classes.[1]

In addition to heterarchy, archaeologists have begun to investigate anarchy in the past (e.g., Angelbeck 2016; Angelbeck, Borck, and Sanger 2018; Henry, Angelbeck, and Rizvi 2017). Anarchy is social organization that explicitly rejects dominating or coercive control but instead relies on individual and cooperative acts (Angelbeck, Borck, and Sanger 2018). Societies lacking a central governing force are thus anarchies and are regularly identified in the past, if not explicitly labeled as such. Approaching interpretations of past societies from an anarchism framework is therefore an important way to understand decentralized networks and social organizations (Angelbeck and Grier 2012; Borck and Sanger 2017).

Notably, cooperation and consensus are often crucial to heterarchical, hierarchical, *and* anarchical systems, as people invest in cooperative (rather than competitive) relationships to achieve common goals (Angelbeck 2016; Crumley 1979, 1987; DeMarrais 2016). While not all heterarchy involves cooperation, since the publication of Crumley's work, archaeologists have shown that perhaps nonhierarchical forms of order and cooperative acts may be more common than strict vertical hierarchies and competition. Contributors to

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a special issue of *World Archaeology* in 2016 investigated the archaeological correlates of consensus and coalition and how, when, and why societies shifted toward or away from competitive relationships (DeMarrais 2016). Drawing on practice theory and ideas of political and economic complexity, authors in this special issue explored how identity, emotion, ritual, and other social institutions led to coalitions and cooperative relationships in the past in a variety of social settings. Other archaeologists have explicitly looked at the role of cooperation as a part of state development and in urban settings (e.g., Angelbeck 2016; Ingold 1986; Jennings and Earle 2016; Jones et al. 2020; Smith [1911] 2007). For example, Jennings and Earle (2016) investigated how cooperation contributed to urbanization and state development in diverse regions, such as the Andes and Polynesia, showing how small-scale cooperative units operated within larger urban settlements as part of the complex state organization. Building on a long history of social and biological evolutionary thought (e.g., Giri 2011; Ingold 1986; Kropotkin 1902; Rousseau 2006; Sri Aurobindo 1962), Stanish (2017) explored how human cooperation has deep evolutionary advantages and was likely the basis of many small-scale societies globally, driven by ritual investment and shared religious beliefs and obligations. Thus, archaeologists have begun to identify archaeological correlates of nonhierarchical power and the social and environmental circumstances that promote cooperative rather than competitive relationships. However, these analyses operate on group-level material culture, leaving the individual involved and their experience of power relationships in the dark. In order to address this gap, this Vital Topics Forum demonstrates how bioarchaeologists are well situated to investigate cooperation and nonhierarchical power in the past, from a variety of levels (from the individual to the group) and in varied social settings (small-scale foragers through imperial states).

BIOARCHAEOLOGY, STATUS, AND POWER

Bioarchaeology provides means to investigate an individual's life history, and as a part of that, their experiences with power and their community. Both hierarchy and heterarchy impact human bodies as our daily lives, access to resources, mobility, cultural identities, and social interactions become embodied and inscribed on our skeletons in various ways (e.g., Juengst and Becker 2017; Klaus, Harvey, and Cohen 2017; Sofaer 2006). In particular, risk and experience of stress and disease, access to resources, ability to move across the landscape, trauma experiences, labor, and cultural body modifications are linked with power relationships. Studies of past and present peoples show experiences of trauma and disease are correlated with social status due to many factors, including: substandard housing, limited access to clean water, sanitation practices, adequate nutrition, the psychosocial stress of uncertainty, the increased workload of lower social classes, and the experience of being a socially sanctioned target of violence (e.g., Farmer 2003; Goodman and Martin 2002; Klaus, Harvey, and Cohen 2017; Martin, Harrod, and Pérez 2012; Sapolsky 2004).

Social structures associated with status impact people's ability to access key resources and, in turn, affect their biology. The exact structures and policies vary over time and space. However, each of these larger processes may increase the *risk* of disease and trauma and overall exposure to more physical labor and social stress. The repeated nature of these lifelong experiences with status can be recorded on the skeleton through the presence of lesions associated with nutrient deprivation, chronic infection, repetitive labor, and skeletal trauma (i.e., cribra orbitalia, porotic hyperostosis, linear enamel hypoplasia, periosteal reactions, osteomyelitis, osteoarthritis, and skeletal fractures). Additionally, human skeletons can be intentionally modified into distinct forms linked with social status, power, and cultural identity (e.g., cranial modification and foot binding) (e.g., Berger, Yang, and Ye 2019; Stone 2020; Torres-Rouff 2002). However, human skeletal remains do not perfectly reflect one's lived experience. Severe and acute infections or extreme nutritional stress may cause death prior to formation of diagnostic skeletal lesions, complicating bioarchaeological interpretations (DeWitte and Stojanowski 2015; Wood et al. 1992). Conversely, individuals who present skeletal and dental lesions may have been more resilient over the long term, experiencing disease and nutritional insults but rebounding from these insults for long enough to have bony reactions. To limit the impact of this "osteological paradox," it is important to investigate skeletal pathology within the archaeological context and with as much chronological control as possible (DeWitte and Stojanowski 2015).

Chronic morbidity may be a more productive measure of stress and status as opposed to mortality because the chronically ill represent individuals who regularly encountered disease and nutritional insults, whether or not they ultimately died from these insults (Goodman and Martin 2002; Reitsma and McIlvaine 2014; Temple and Goodman 2014). Careful considerations of multiple indicators of chronic stress across skeletal samples, and accounting for individual frailty, allow bioarchaeologists to reconstruct stress profiles for populations without overreaching (Reitsma and McIlvaine 2014). Using this framework of stress and morbidity in conjunction with archaeological and mortuary indicators, methods in bioarchaeology, including lesions indicating chronic disease, stress, trauma, and labor, can be helpful in reconstructing moments of cooperation in the past.

Chronic stress during adulthood and childhood may be measured in several ways. Periods of stress and nutrient deficiency in childhood can have effects on the skeleton and dentition that persist into adulthood. These lesions are all generally considered to be indicative of stressful episodes in childhood, stemming from insufficient nutrient intake, disease episodes, and/or high levels of bodily parasites (e.g., Hillson 2008; Walker et al. 2009). Hence, bony reactions to stresses such as these provide a measure of lifetime health and accumulated insults. As demonstrated in this Vital

Topics Forum, in studies of Kayenta and Mimbres societies, assessing burial populations for patterns of these lesions may demonstrate relative stress risk, or lack thereof. In addition, periosteal reactions (i.e., new bone growth on the outer periosteal layer of bone) in either childhood or adulthood can stem from many causes, but the presence of these lesions is generally tied to systemic infections. Remodeling or healing of these lesions can indicate the ability of the person to recover from these stressful events, thereby providing a commentary upon overall individual resilience (Ortner 2008). As discussed above, these lesions are chronic; individuals with periosteal lesions may be more resilient than those without, given that they survived the stressor long enough to allow these lesions to form. However, DeWitte (2014) shows that periosteal lesions are positively correlated with increased mortality. Accordingly, while individuals may be initially more resilient, it seems that the chronic stress associated with these lesions erodes individuals' bodily and immune capabilities to respond to insults over time, leaving them increasingly vulnerable to future events.

Associated with status and nutritional resources is access to desired food items. Isotopic studies of diet in the past can show individual- and group-level consumption, allowing identification of eating patterns across time and space. Many foods have distinct ratios of the stable isotopes of carbon ($^{13}C/^{12}C$), measuring dietary contributions from particular types of plants, and nitrogen ($^{15}N/^{14}N$), a good indicator of proteins or trophic level. When foods are eaten, the isotopic composition of the diet is incorporated into body tissues, such as collagen (e.g., Ambrose 1993; Schoeninger and Moore 1992). For example, exotic foods or foods associated with ritual may be limited to certain groups in society. In this Vital Topics Forum, case studies on Napoleon's army, Copper Age Iberia, and Maya peoples at Chan effectively use isotopic analyses to show how diets changed over time and how people cooperatively shared food. Thus, stable isotope analyses allow bioarchaeologists to see who had adequate nutrition and who had access to diverse types of foods.

Other isotopic analyses ($^{86}Sr/^{87}Sr$, $^{18}O/^{17}O/^{16}O$) can help track movement across the landscape (e.g., Knudson 2009; Knudson and Tung 2011). Individual mobility is often limited by power; those with more power may be able to move more readily or have others transplanted at their discretion. Strontium and oxygen isotopes vary according to local geology and water sources and precipitation, respectively, and are incorporated into the human skeleton over the course of our lifetimes. This ability to study how individuals and groups moved across a landscape can inform us about larger power relationships between communities (e.g., Knudson and Tung 2011; Matthew 2012; Mumford 2012; Wernke 2007).

Violence and trauma make up another valuable line of bioarchaeological inquiry to understand status and power. Skeletal injury may result from accidents or moments of intentional violence, caused by a range of behaviors, including both socially sanctioned and external violence (e.g., Martin, Harrod, and Pérez 2012; Walker 2001). Violence is often tied to ideological and social control and usually is not equally distributed across society. Not limited to warfare or large-scale conflict, violence may permeate daily life through socially sanctioned targeting of certain individuals or ethnic groups, through social structures that put some at higher risk of violence and disease than others, or through ritualized violence, such as cannibalism or ritual fights, as clearly shown in this forum's study of Wari peoples. The visual impact of broken bodies (living and dead) is culturally dependent but has been used as a way to manipulate the living and reinforce power relationships (Crandall and Martin 2014; Tung 2014). Violent conflict also happens outside of "normal" social bounds and often increases during times of changing socio-political relationships and environmental stress. In these cases, larger-scale violence, such as warfare and systemic raiding, may occur. However, even in chaotic violent landscapes, violence is not random. Certain groups (typically those with less power) are generally targeted as victims of violence (e.g., Martin, Harrod, and Pérez 2012; Walker 2001). Low-status individuals can be targets of violence in instances of daily structural violence, socially sanctioned punishment, and episodes of large-scale war. By evaluating different patterns of skeletal injury, bioarchaeology can help reveal the experience that produced these traumatic lesions (Walker 2001). For instance, trauma to the facial or frontal bones often results from face-to-face conflicts, while injuries to the posterior portion of the skull may occur while fleeing an attacker. Fractures on the ulna are often associated with defense, as they may result from raising an arm to ward off a blow. Thus, the location and type of cranial and arm fractures can help distinguish between accidental and violent trauma, patterns that can be traced across a group of people in order to see if certain people were at higher risk of sustaining intentional injury.

Cultural body modification is often linked to power and group demarcation, as people physically alter bodies to mark identity and belonging. Skeletally, this can be observed through practices such as cranial and dental modification, foot binding, corsetry, and labret piercings. These practices are permanent markers of identity, in life and observable after death, and often tied to gender roles, ethnic group, and social status (e.g., Berger, Yang, and Ye 2019; Blom 2005; Stone 2020; Torres-Rouff 2002, 2012). While not necessarily tied to hierarchy, bioarchaeologists can interpret these identity indicators in context with patterns of material remains and skeletal lesions to suggest group affiliations and lived experiences associated with those identities.

Finally, labor varies with power. In hierarchical settings, we often see the heaviest loads on the literal shoulders of those without power. In heterarchical settings, we might expect to see patterns of activity-related skeletal changes that map differently, perhaps related to neighborhood or ethnic group performing different but complementary tasks (Becker 2017). The case study included here on Tiwanaku peoples clearly shows that cooperating to achieve tasks such

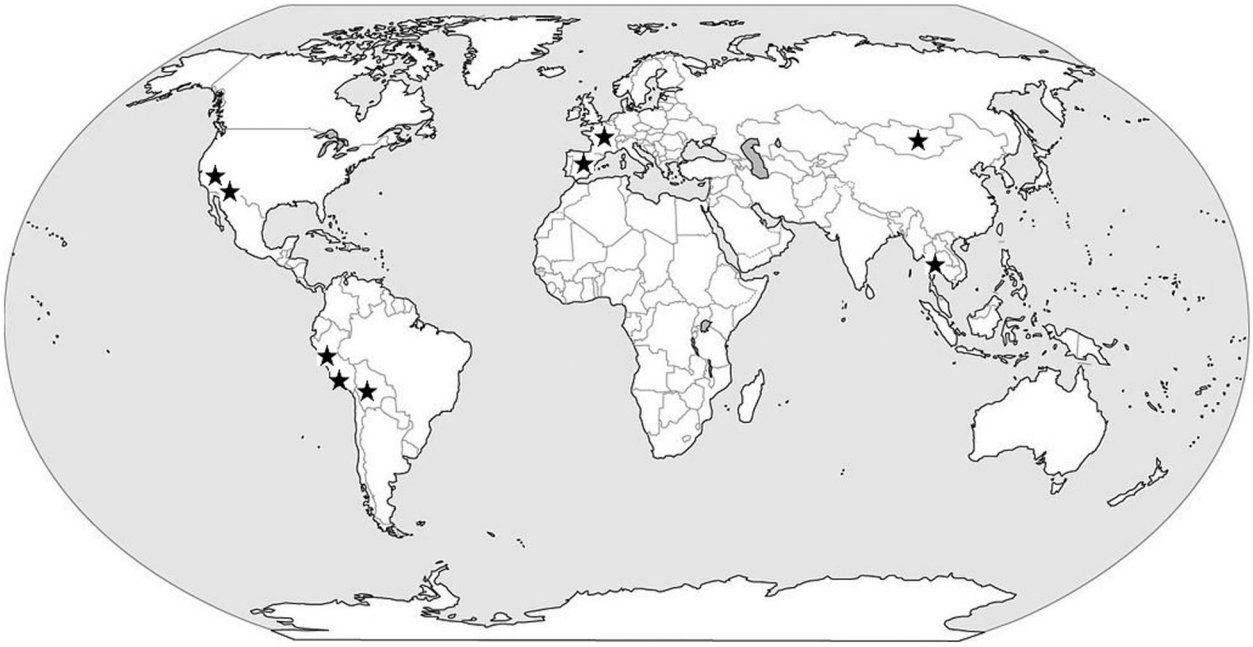


FIGURE 1. *Global locations of case studies included in this Vital Topics Forum.*

as harvesting or trading goods across regions was a common way to facilitate complex society that does not necessarily involve hierarchy. Therefore, bioarchaeological measures of activity, such as osteoarthritis, cross-sectional geometry, and entheseal changes, may provide interesting patterns of evidence to show power and status differences.

COOPERATION, HIERARCHY, AND BODIES

In cases of hierarchy, marginalized peoples may be readily observable through unorthodox burials, fractured bones, and extensive pathological lesions. Even more subtle types of power disparities may be visible through lesions of systemic stress and limited access to resources. While more difficult, identifying instances of cooperation (outside of hierarchy or within larger hierarchical complexes) and/or heterarchy is also possible. Since archaeologists are "well-positioned to contribute to debates about cooperative action in the past, making use of ethnographic and historical evidence to assess its contributions to long-term trajectories of change" (DeMarrais 2016, 8), then bioarchaeologists can add even more nuance to this conversation by investigating individual experiences of power and distribution across individuals, demographic groups, and larger social clusters. By using a combination of methods (skeletal lesions and indicators in conjunction with archaeological materials), bioarchaeologists gain insight into both childhood and adult immunonutritional insults, risk of intentional violent trauma, and workload patterns for different peoples, allowing identification of patterns of cooperative resource use, violence, and labor. While the cultural context may vary, the embodied experiences of power are still identifiable.

The following papers in this Vital Topics Forum are brief case studies that demonstrate some of the ways that bioarchaeological methods and skeletal remains can help us access the individual and investigate cooperative power in the past in new and innovative ways. Following Mead (1937) and more-recent archaeological approaches, we loosely define cooperation as noncoerced, collective action to achieve a particular task or to broadly organize society. The authors in this volume identify cooperation within both hierarchical and heterarchical systems of power, underscoring that even if power is broadly vertically distributed, the individual may experience more cooperation than competition. Several contributions identify both cooperation and heterarchy, seeking to understand the factors that drive these types of relationships over hierarchy and competition. Throughout the Vital Topics Forum, we define heterarchy as horizontal power distribution—that is, systems of social organization where power is not accumulated in one individual, city center, or corporation. We purposefully leave the definitions of cooperation and heterarchy broad in order to capture the greatest variability in social organization and structure in the past.

The case studies included here examine instances of past cooperation and/or heterarchy, as suggested by material and skeletal remains. Taking a global perspective (Figure 1), this Vital Topics Forum investigates power, cooperation, and shared social identities across time. Notably, many of the chapters discuss state or imperial societies, which are most often associated with hierarchy. The cooperation demonstrated in these case studies is not limited to mobile foragers but instead deployed strategically in a variety of social settings. Consequently, we recommend that bioarchaeologists (and anthropologists more broadly) intentionally question situations of assumed competition and hierarchy, and employ a variety of methods in order to understand the nuanced relationships of power and people throughout time.

Note

1. Notable exceptions exist to this pattern, usually linked to consumption of toxic metals from eating utensils or overconsumption of certain exotic or elite foods. For example, Roman elites were more susceptible to gout and lead poisoning compared to nonelites because of diet and access to high-end cutlery (see Nriagu 1983; Scott et al. 2020)

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The Labor of Building a Community: Exploring the Divergent Trajectories of Complex Sites in Copper Age Iberia

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A growing body of literature in public health and epidemiology is focused on the concept of "embodiment": "how we literally incorporate biologically—from conception to death—our social experience and express this embodiment in population patterns of health, disease, and well-being" (Krieger 1999, 296). Today, the majority of embodied inequalities are linked to living in a globalized economy deeply rooted in colonial and imperial histories. Because of the effects of economic and political changes on contemporary bodies, we often anticipate that past social transformations entailed similar somatic costs and that increasing social complexity goes hand in hand with biocultural trade-offs.

Bioarchaeological approaches to human social change are key for testing these assumptions because the field has the unique ability to embed the biological and cultural factors that shape human bodies within the deep time perspective of archaeology (Zuckerman and Armelagos 2011).

One pivotal social transformation in human prehistory is the appearance of larger-scale and more complex aggregations, a phenomenon that occurred in Iberia during the Chalcolithic period. Stretching from approximately 3250–2200 BC, the Spanish and Portuguese Copper Age witnessed a suite of interrelated social, political, and economic changes (for a broad overview, see Chapman 2008). This period represents the culmination of the Neolithic transition from a hunting-and-gathering economy to a more intensive focus on agriculture, with domesticated animals exploited for both meat and secondary products, such as dairy, wool, and traction. The Chalcolithic record testifies to an explosion of evidence for long-distance exchange of materials, such as amber, ostrich eggshell, and ivory, which came to Iberia from the western Mediterranean, Africa, and Asia. Importantly, almost all of the evidence for long-distance exchange, especially elaborately crafted items made on exotic materials, comes from mortuary areas. Copper Age mortuary practices built upon earlier Neolithic collective practices, with individuals still typically buried communally but now interred in human-made locations, such as artificial caves and rock shelters or *tholos*-type megalithic chambered tombs.

Perhaps the most striking transformation during the late fourth to mid-third millennium is the appearance of new kinds of settlements on the Iberian landscape. These sites are distinguished from their Neolithic predecessors by either a marked increase in size or a substantial investment of communal labor in infrastructure such as ditches, walls, and fortifications (Díaz-del-Río 2013). Such sites include the fortified settlements of Los Millares and Zambujal, the ditched enclosures of La Pijotilla and Perdigões, and the ditched mega-sites of Valencina de la Concepción and Marroquíes (Díaz-del-Río 2013; Hurtado 1997; Sangmeister and Schubart 1972, 1981). The immense amount of human labor marshaled to build the last two mega-sites—400 hectares and 113 hectares in size, respectively—has no parallel in the Iberian prehistoric record and would not be witnessed again in the region until Roman times.

Constructing and inhabiting these complex sites would have necessitated finding solutions to new problems, including mediating ownership of property and territory, organizing collective labor, and navigating novel politico-economic relationships. An important anthropological question is thus the extent to which such changes would have precipitated the emergence of new kinds of economic, ideological, and political inequalities, especially as archaeological evidence suggests that complex sites followed trajectories that were both regionally and historically variable. While all known complex sites show evidence for foundational investments of collective labor, some show signs of attempts to solidify emerging forms of social differentiation through distinctions in mortuary treatment, while others appear to have stressed communal inclusivity in both life and death.

Human skeletal remains, valuable because they provide evidence of both the embodied or "lived" experiences that materialize osteologically and the "performed" roles and identities displayed in funerary practices, provide a key line of evidence with which to assess the variable emergence of inequalities at complex sites of the Iberian third millennium (Quinn and Beck 2016). While human skeletal remains do not perfectly encode evidence of all lived experiences, as Juengst (this forum) underscores, osteological data still provide key information about social identity, diet, and mobility at both the individual and the community level. Moving forward, I will briefly document the available bioarchaeological and mortuary evidence at three key complex Copper Age sites—Los Millares, Valencina de la Concepción, and Marroquíes (Figure 1)—to argue that the Iberian record shows evidence for a variety of organizational strategies that led to either the amplification or moderation of institutionalized inequality.

LOS MILLARES

Discovered in the late nineteenth century, Los Millares (Santa Fe de Mondújar), dated to c. 3200–2300 cal BC, is one of the most famous prehistoric occupations in Spain. The seven-hectare site is organized as an inner citadel surrounded by four lines of fortifications. The exterior wall line contained internal structures, external bastions, and an impressive barbican entrance that limited access to the settlement interior (Esquivel and Navas 2007). These physical fortifications may have been bolstered by symbolic fortifications, as at least eighty-five circular burial chambers were located in a delineated funerary area extending thirteen hectares beyond the walls of the settlement.[1] As Oliveira Jorge (2003, 114) highlights, "Anyone from another community approaching Los Millares, even before reaching the third, external, so-called defensive line, would first have had to cross a virtually 'dangerous' space, one charged with meanings which not only identified the community inhabiting the settlement, but also may only have been fully understood by those inhabitants." The cemetery has been well studied, in part due to the wealth of exotic grave goods uncovered during early excavations, which include ivory, ostrich eggshell, jet, amber, callaïs, variscite, seashells, fine pottery, and copper objects. Mortuary analyses reveal a marked disparity in the frequency and range of prestige goods included in the sample of tombs that have been analyzed (Chapman 1981).

A complete bioarchaeological analysis of all human remains from the tombs has yet to be published. However, a recent pilot study of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and oxygen ($\delta^{18}O$) isotopes for twelve individuals from four tombs points to a diet similar to that at other Late Prehistoric sites in the Iberian Peninsula, likely reflecting a regional pattern of mixed agricultural production supplemented with limited wild and aquatic resources (Waterman

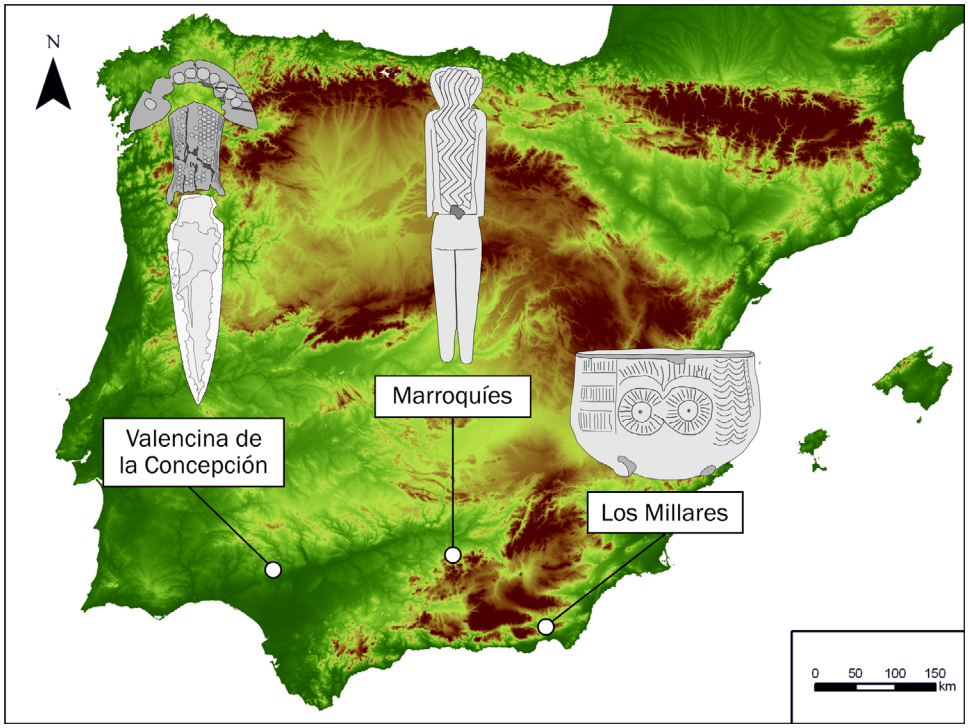


FIGURE 1. *Location of sites referenced in text, including a depiction of examples of Copper Age material culture that are characteristic of each site. This includes the crystal dagger and ivory halberd from Valencina de la Concepción, an anthropomorphic idol from Marroquíes, and an "eye bowl" from Los Millares. Base cartography: SRTM 90m Digital Elevation Data (Jarvis et al. 2008). (Courtesy of Antonio Uriarte, Instituto de Historia, CSIC). [This figure appears in color in the online issue]*

et al. 2017). Intriguingly, the Los Millares sample showed larger-than-expected standard deviations for both carbon and nitrogen isotope ratios, suggesting dietary heterogeneity with individual variation in both protein sources and plant intake. The oxygen values from this study likewise exhibited a broad range, indicating variability in water sources or milk consumption, with one strongly divergent $\delta^{18}O$ value revealing the likely presence of an immigrant into the region.

Overall, the mortuary and bioarchaeological evidence at Los Millares shows marked inter-tomb disparities in the quantity and quality of grave goods and some evidence for inter-individual dietary heterogeneity, while at least one of the twelve individuals sampled was likely nonlocal.

VALENCINA DE LA CONCEPCIÓN

At 450 hectares and dating to c. 3200–2300 BC, Valencina de la Concepción[2] (Seville) is the largest site known for the Iberian Copper Age. More than one hundred excavations have revealed that the majority of documented archaeological features are pits variously interpreted as "hut floors," "silos," or "rubbish dumps," though to date there is no clear evidence of buildings or households in the portion of the site that has been excavated. In contrast to Los Millares, there does not seem to have been a spatially delimited area of mortuary activity at Valencina; instead, depositions of human remains are distributed throughout the site. Archaeologists who excavate at the site have suggested that the massive area may not have been occupied simultaneously, but that its contiguous features instead represent "a dense and continuous footprint of human activity" (García Sanjuán, Scarre, and Wheatley 2017, 250).

In addition to its size, Valencina is well known within European prehistory for the number of elaborately crafted artifacts made on exotic materials that have been found in its tombs such as La Pastora, Matarrubilla, and Montelirio. Montelirio, a forty-four-meter-long chambered tholos tomb, is particularly remarkable due to the staggering variety of elaborately crafted artifacts found in this collective mortuary space. Burials in both the tholos corridor and chamber were associated with ceramics, lithics, shell, metal, amber, worked and unworked ivory, and ostrich eggshell (Fernández-Flores, García Sanjuán, and Díaz-Zorita Bonilla 2016). As at Los Millares, these kinds of mortuary distinctions provide evidence for increasing social differentiation between the individuals and groups who occupied the site.

Dietary isotopic analyses of a sample of human and faunal remains from Montelirio revealed that people buried at Valencina consumed the regionally typical C_3 terrestrial diet (Fontanals-Coll, Díaz-Zorita Bonilla, and Subirà 2016). No individuals showed statistically significant deviations from the mean for either $\delta^{13}C$ or $\delta^{15}N$, though researchers underscored two cases suggesting a higher consumption of animal protein. The enriched values came from the oldest females in the sample and could reflect either a higher social status

related to age or a pregnancy-related reduction in nitrogen values for younger females. In addition to possible dietary differentiation related to adult age, there is also evidence of differentiation in the mortuary treatment of subadults. A recent analysis focused on the thirty-nine subadult individuals currently known for Valencina, which make up only 21 percent of the analyzed mortuary sample at the site (Cintas-Peña et al. 2018). Statistical analyses of age category relative to burial location revealed that subadults were preferentially buried in negative structures such as pits rather than megalithic structures, were always accompanied by adult burials, and were not granted the high-status treatments that periodically occurred through the site.

To summarize, the archaeological and bioarchaeological record for Valencina shows marked disparities in grave goods and mortuary treatment, evidence for differential mortuary treatment related to age, and tentative indications of inter-individual dietary differences that relate to adult age.

MARROQUÍES

The site of Marroquíes was revealed during the northward expansion of the city of Jaén in the 1990s and dates to circa 2800–2300 cal. BC. Over 270 excavations exposed a complex settlement that included six concentric ditched enclosures, portions of an adobe wall, and extensive evidence for both domestic architecture and funerary activity throughout the site (Zafra de la Torre, Hornos Mata, and Castro López 1999). The mortuary record attests to a wide variety of funerary practices, ranging from interment in artificial funerary caves to burial in circular underground mortuary features and secondary depositions within the enclosure ditches. Individual burials, however, were rare, and most people were buried collectively. Preliminary analyses of material culture indicate that Marroquíes had few elaborate grave goods or exotic raw materials when compared to contemporaneous complex sites, and there was no evidence for wealth disparities between burials or mortuary structures.

Bioarchaeological analysis of the human remains from three mortuary areas documented individuals of almost all ages and both sexes receiving similar mortuary treatment, with very low levels of trauma and skeletal pathology (Beck 2017). Dietary isotopic analysis ($\delta^{13}C$, $\delta^{15}N$) of two of the three necropolises showed no significant differences in diet between the mortuary areas, with consumption patterns that did not diverge substantially from the characteristic Iberian mixture of terrestrial resources and C_3 plant consumption. The Marroquíes sample did, however, show a relatively large inter-individual spread in nitrogen values; comparing the lowest adult values to the highest adult values revealed a difference of between 3 and 4‰ (Beck et al. 2018). Analyses of $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ were used in tandem with radiocarbon dating of human skeletal remains to characterize the tempo and magnitude of mobility at the site (Díaz-Zorita Bonilla et al. 2018). Results suggested that at least 6 of the 115 individuals sampled (5 percent) can be considered nonlocals, with the majority buried at Necropolis 1, the mortuary area contemporaneous with the peak of the aggregation process at the site. Importantly, all nonlocals were given the same mortuary treatments as locals and buried in mortuary spaces that were shared with local individuals.

DISCUSSION AND CONCLUSION

The Iberian Copper Age was a time of social experimentation. Communities were expanding beyond the social, economic, and political constraints of the Neolithic, with the first substantial evidence for long-distance exchange of exotic materials, the appearance of novel and more elaborate forms of material culture, and the emergence of a number of sites of such pronounced infrastructural complexity or spatial extent that they would likely have necessitated concomitant changes in social organization. While all complex third-millennium sites show evidence for cooperative foundations, materialized in either the communal labor required for the construction of fortifications and ditches or the surplus necessary to support elaborate craftsmanship, recent archaeological and bioarchaeological research suggests that the organizational trajectories of such sites are variable.

One trajectory seems to have entailed punctuated attempts to solidify emerging forms of social differentiation. Mortuary studies of Los Millares and Valencina suggest periodic emphases on particular individuals or groups who were singled out for specialized mortuary treatment, even within funerary contexts that were technically collective in nature. The 800 ostrich eggshell beads found in Tomb 12 at Los Millares, and the 2,000 perforated beads and numerous worked ivory artifacts from structures 10042–10049 at Montelirio, are examples of this trend. While bioarchaeological studies have been limited, both Valencina and Los Millares show a moderate amount of inter-individual dietary differentiation and signs that the most specialized mortuary treatments are restricted to either adult individuals or to particular tombs.

Marroquíes appears to have followed a different path. While Valencina and Los Millares show marked organizational differences to simpler contemporaneous sites, the structure of Marroquíes replicates the structure of other smaller-scale enclosure sites throughout Iberia, as if its inhabitants copied and expanded upon an existing architectural template. The same can be said of the site's social template, as bioarchaeological and mortuary analyses indicate that people were treated similarly in life and death, without the marked material distinctions between individuals or tombs that emerged at Los Millares and Valencina. Although isotopic analyses of diet show that inter-individual differences in consumption patterns at Marroquíes did exist, the collective bonds of group affinity appear to have dampened the expression of social asymmetries at death. Similarly, the indistinguishable mortuary treatment of nonlocal individuals implies that institutions at Marroquíes were socially inclusive, and had developed mechanisms that integrated newcomers in both daily life and mortuary practice.

While bioarchaeological research at complex third-millennium sites in Iberia is ongoing, the results of initial

analyses reveal that during the Copper Age, increasing social complexity and institutionalized inequality did not always go hand in hand. Instead, complex sites appear to have followed multiple trajectories that were regionally and historically variable. Indeed, in many ways the complex settlements of the Iberian Copper Age are exemplars of the enduring tension between cooperation and competition that Crumley (this forum) identifies as a key structuring principle in all human social institutions. In some places, individuals and groups were able to build upon the backdrop of collective labor to experiment with self-aggrandizement and social differentiation, while in others, cooperative foundations were maintained through the development of social practices that facilitated inclusivity in life and death. Evidence from Copper Age Iberian sites thus suggests that while the labor of building a community was inherently cooperative, the strategies used to maintain such communities were more variable, with groups experimenting with both differentiation and inclusivity as solutions to the problems posed by living in more complex aggregations.

NOTES

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1. One tomb is located within the settlement itself, close to the exterior wall.
2. While the archaeological literature refers to this site as both "Valencina-Castilleja" and "Valencina de la Concepción" (Díaz-Zorita Bonilla 2017; García Sanjuan, Scarre, and Wheatley2017), in order to be concise, it is simply referred to hereafter as "Valencina."

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Situational Power in Cooperative Communities: Indicators from Bioarchaeology in the Mimbres Region of Southwest New Mexico

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Hierarchical relationships in prehistoric contexts are sometimes easily identified through patterns in vastly different material qualities or quantities, architectural structures, and burials. For communities that lack obvious indicators of stratification and differential access to resources, archaeological investigations may benefit from consideration of data that trace coordinated efforts to maintain equity within society. Subtle exploration of such data can reveal individuals and social groups with situational power who otherwise participate in cooperative community structures that reject vertical hierarchy. The data discussed here exemplify this scenario at work in the Mimbres region of southwestern New Mexico. We suggest that ritual and land management played a role in elevating the status of some community members, but this did not contribute to increased violent competition or marginalization of subgroups. Further, those with higher standing were integral to societal function and organization. Our interpretations draw on primary data from our own excavations of structures and burials in the region, analysis of human remains from collections, and supporting findings from other scholars. Specific data related to situational power include "wealthy" infant burials, seated mortuary positions, ritually important grave goods, and skeletal indicators of health and morbidity.

The Mimbres region is a subset of the larger Mogollon culture area and was occupied from approximately AD 200 to AD 1450 (Anyon et al. 2017). The majority of Mimbres sites are located along the Mimbres and Gila Rivers during peak occupations prior to AD 1130 and closer to the Rio Grande after AD 1130 (see Figure 1). People in the region transitioned from a mixed hunter-gatherer and agricultural subsistence strategy to a more intensified agricultural strategy by AD 800 (Diehl 1996). These changes were accompanied by major shifts in cultural patterns—in particular, ritual activities—that we argue were related to maintaining a cooperative social structure.

Research focused on social status and hierarchy in Mimbres communities has been brief given that no obvious stratification is apparent in archaeological and bioarchaeological data. Gilman (1990) most notably explored mortuary indicators of status during the Classic Mimbres (Pueblo) period (AD 1000–1130, see Table 1), finding that vertical status was not supported for most burials but that a select few "wealthy" burials (i.e., those with several mortuary goods) may have held some horizontal status. Creel (1989) has made a similar suggestion for cremated individuals, but cremations are rare and more difficult to interpret. More recently, Russell (2016) has completed an extensive comparison of mortuary patterns and architectural associations across age and sex categories and at individual, room, and site-locus scales. His review of more than 3,100 Mimbres burial contexts supported varying domains of social inequality within communities and across time. Specifically, Russell argues that unequal status of some is related to ritual access or (what he calls) "antecedence," the appearance of being a founding member of the community. Mortuary indicators used to infer status include ritual items (quartz crystals, ceramic ladles, fossils,

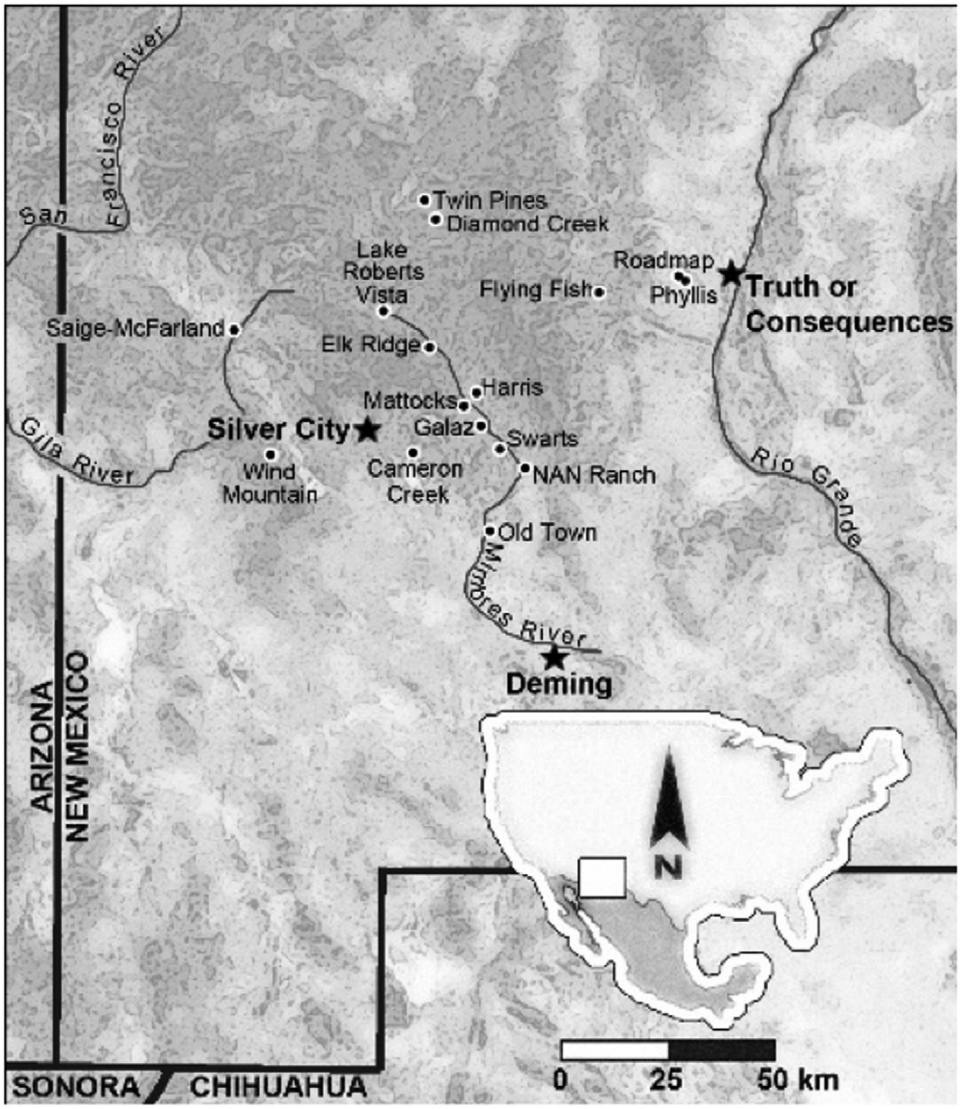


FIGURE 1. *Mimbres region and sites.*

cloud blowers, speleothems, and turtle plastrons), ceramic vessels depicting ceremonies, and burial in ceremonial locations. He concludes that competition for ritual access peaked in the Late Pithouse period (AD 550–1000) and tapered off during the Classic period and that shifts in social organization around AD 1000 corresponded to a need for reducing that competition and thus inequality. Finally, Diehl (2012) has used paleobotanical data to suggest that agricultural surpluses at the end of the Late Pithouse period could have been used in ritual feasts that contributed to power and status of those organizing such activities.

From our own research, excavations at the Harris site in the Mimbres Valley suggest that Mimbres community social structure during the Late Pithouse period was linked intrinsically to founding lineages (Roth 2019; Roth and Baustian 2015). These extended family households reinforced their founding status through land tenure and permanence of place, which generally was marked architecturally by building multiple houses within the same architectural footprint and through strategically placed burials. These inhumation burials would be located in extramural areas outside of houses prior to AD 900 but afterward were more commonly in intramural contexts, specifically beneath house floors. Bodies were placed in a flexed or semi-flexed position on the side or back and generally had a single ceramic vessel near or over the head (most common in the Classic period), occasionally shell and turquoise jewelry, but sometimes no items at all.

Mortuary data from the Harris site begin to show evidence of status differences around AD 650 as the occupants became more agricultural and sedentary. A cluster of four pithouses inferred to represent an extended family household (perhaps a founding family) had burials both around and within the houses. The houses surrounded a central work area containing several processing features, a large (communal) storage pit, and three burials with high numbers of grave goods. Two of these burials (Burials 9 and 10) had at least four pots each, and the third burial (Burial 13) had shell

TABLE 1. *Chronology of Mimbres Region*

Period	Date Range (AD)
Early Pithouse	200–550
Late Pithouse	550–1000
Georgetown Phase	550–650
San Francisco Phase	650–750
Three Circle Phase	750–1000
Classic	1000–1130
Post Classic	1130–1450

bracelets, shell beads indicating a sash, and lithics. A child burial (Burial 15) beneath a pithouse floor in this house cluster had several pots, turquoise pendants, and shell bracelets. We argue that the practice of burying "wealthy" infants beneath house floors began as an effort to mark social memory and establish their place in the community.

Additional mortuary traits observed at the Harris site further strengthen our interpretation of situational status within Mimbres communities. At Harris, we observed eight adult burials, including both men and women, interred in a seated upright position. These often included higher-than-average mortuary items for adult inhumations. The locations of these burials included extramural areas with ritual significance, such as outside of kivas and in plazas and in the fill of abandoned pithouses. We have suggested that adult females buried in this way could have been matriarchs of their lineage groups and marked their families' status and land access (Roth and Baustian 2015). The placement of their burial pits in superimposed pithouses was intentional to demonstrate social memory. Seated male burials at the Harris site (Burials 29 and 32) and NAN Ranch (Burial 127) in the southern Mimbres Valley may represent situational status related to ritual. These burials were either located in extramural plazas where rituals took place or were interred with items consistent with Russell's (2016) designation as ritually significant (e.g., shell beads, stone pipe, quartz crystal, turtle plastron).

Skeletal analysis is also key to investigating differential status and access to resources in the past. Baustian's (2015) analysis of pathology rates, robusticity patterns, trauma from interpersonal violence, and stature lend support for a more cooperative social system in the Mimbres region rather than a competitive one. Skeletal data from adults and children suggest that most people were healthy Stature was used as an indicator of the ability to attain maximum growth potential. Stature results showed that both males and females maintained similar statures over the course of the Mimbres occupation. Furthermore, there was little intersite variation, so it does not appear that any community had differential access to subsistence resources. Although maize dependence was heavy and large game such as deer became depleted over time (Cannon 2000), protein intake seems to have been sufficient for the Mimbres people given the low rates of anemic diseases. Bacterial infections were not common and did not vary over time as population density increased, nor did changes in labor roles result in differential robusticity on the skeleton. Analysis of musculoskeletal stress markers indicated that both males and females were equally physical in their activities, whether those were related to agriculture, daily tasks, or craft production.

Finally, traumatic injuries were assessed to interpret levels of competition and participation in violence. Baustian (2018, 2015) reports that cranial trauma was observed on twenty-eight adults (11 percent of the sample of 247). All but two of the injuries were nonlethal and most were quite small (less than 1 cm in diameter), which indicates minor severity. Most of the individuals with trauma were male, but females were not excluded from violent injury altogether. Injuries were most frequently located on the forehead and top of the skull, suggesting face-to-face conflict rather than fleeing from attackers. Given these patterns and the lack of archaeological indicators of warfare, trauma from interpersonal violence was not likely associated with raiding activities. Instead, it was probably related to everyday arguments and/or low-level competition within or between communities.

In sum, skeletal data do not suggest any major status differences between Mimbres groups either spatially (across different sites in the valley) or temporally. We do see differences between individuals and households manifested in the archaeological record, however, including burial placement and mortuary content. Thus, it appears that although there were differences between groups that resulted in unbalanced social power, this did not extend to differential resource access or increased violent conflict that would result in trauma. For those individuals with elevated status, power was function- or identity-specific, which was not germane to increased morbidity or mortality.

Situational power in Mimbres society does not appear to have stifled cooperation between individuals or communities. Rather, those who held leadership or status roles may have functioned as key members of the community and shared responsibilities in subsistence and ritual activities. These activities were vital for successful land management and ideologies during the Pithouse period and into the Classic period. Even as agriculture intensified and ritual shifted from kivas to plazas, Mimbres communities limited competition among themselves. Unlike neighboring regions that experienced more-frequent raiding and violence, Mimbres groups maintained cohesion in social organization even when select individuals held situational power. Our assessment of mortuary and bioarchaeological data demonstrate that, whether maintained by a ritual leader or a member of a founding lineage, identity and power contributed to a unique social dynamic for the American Southwest. Thus, power does not always equate to stark differences in a social group and may simply be one of many aspects of variation in identity and interaction.

NOTES

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Familiar Foundations: Multi-Generational Tomb Use, Collective Identities, and Cooperation Practices in the North-Central Andes during the Late Preceramic

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Over 4,500 years ago, the body of an elderly female was interred within a tomb hewn into bedrock on a low ridge, located 2,897 meters above sea level in the north-central highland Andes. Sometime shortly after her burial, an infant and a young to middle-aged male were placed alongside her. Disarticulated bones of at least four other people were left just outside this initial grave over six generations later. More than two millennia passed with no evidence of additional human activity in or near the tomb until a new group settled at the site, forming perhaps its first permanent settlement, known today as Queyash Alto. Members of the new community built houses and held feasts directly above the tomb, separated today by roughly 30 cm of fill.

The burial events occurred during the third millennium BC—a period of large-scale transformations in community development, religious traditions, and economic production across the Andes. People at this time transitioned to more sedentary lifeways and spent considerable energy building ritual architecture and engaging in community ceremonies. Some of the temple complexes erected along Peru's coast during this time represent the earliest monumental constructions in the Western Hemisphere (Burger 1992, 28). Increased aggregation of sites and people, in both coastal and highland regions, raise questions about how labor investment in public building projects was organized. In the highlands, the apparent absence of institutionalized hierarchies and coercive forms of power in an era of marked social complexity has intrigued archaeologists for some time. Collective construction efforts likely relied on kin networks and placed new emphasis on familial obligations (Aldenderfer 2004).

The material remains of common family-centered activities, such as burying loved ones and building a home, are

evident across a 4,000-year period in the excavation context at Queyash Alto. The domestic detritus of households deposited above the bodies of individuals long since deceased speak to the legacies of families in the archaeological record. Since Mead (1937), anthropologists have recognized that notions of kinship and relatedness play integral roles in fostering cooperation both within and among families. Evolutionary studies have found that biological relatedness or innate instincts of reciprocity among kin are insufficient to account for all forms of cooperation in complex societies. Therefore, we cannot assume that genetic affinities explain why, or how, human groups cooperate. Insights from archaeological research call attention to the institutions people create to help manage collective resources or mitigate risks (Blanton and Fargher 2016; Carballo 2013). Less emphasized in these works are explicit considerations of family (although see Stanish 2017). The lived experience of cooperation may be first understood through familial social obligations, where solidarity may be forged through both daily and sacred ritual practice.

This case study provides a complementary reflection on cooperative bodies and power relations from the perspective of a collective identity and the ritual treatment of the dead. As Juengst's overview and other contributions to this forum demonstrate, the embodied nature of many daily practices related to food consumption, labor obligations, and interpersonal conflicts tell us much about an individual's life lived—a strength of bioarchaeological research. When paired with examinations of how those individuals were remembered after death and the actions of their mourners, we gain a deeper understanding of the person's identity and their impact on collective structures, such as institutions or communities. The group dynamics of cooperation invite us to consider these interactions in tandem.

I take an explicitly social approach to family by foregrounding its status as a small-scale institution people create that structures norms of interaction and practice (after Johnson and Paul 2016, 75). For example, in a case study from Mead's volume, Goldman (1937, 162) describes family as "the most precious thing in all Ifugao social life," in part because the strength of intrafamilial cooperation ensures lineage longevity and success. Families are constituted through continual, interpersonal interactions throughout a person's lifespan, and membership may be manipulated even beyond one's death. In a recent Vital Topics Forum, Ortner (2019) reminds us that kinship can have a "dark side"; people may take advantage of family members in particularly deleterious ways. The security (or insecurity) that comes with this membership should not be overlooked, but recognizing these social ties in the distant past can be difficult, especially in contexts with a poor understanding of lineage structure. A recent review article on kinship studies in the contemporary Andes noted the diverse familial organizations evident in the twentieth and twenty-first centuries (Weismantel and Wilhoit 2019). The permanence or fluidity of this institution is not often explored in the distant past; yet, it can be a fruitful contribution for bioarchaeological work (Johnson 2019).

Johnson and Paul's (2016, 95) consideration of family as a "multiscalar collective identity" is ideally suited for bioarchaeological research on cooperation because people must physically enact and practice these social ties. It is an identity with power implications; one's kin group may determine their access to quality land or other essential resources, their ability to weather disasters, and their network of trade or marriage partners. Since familial position often delineates cooperative partnerships, then investigating how this identification impacts individual actions reveals the intersection of social relatedness and institution building. Our analyses of the "paleopolitics" (see Crumley, this forum) of cooperation benefit from frameworks that incorporate the way both social identities and institutions overlap.

REMEMBERING THE DEAD AND FORMALIZING FAMILY TIES

For cooperation studies, families should be an essential research focus because they facilitate the learning and socialization of cooperative behaviors (Johnson 2019, 202). But, how do people create or foster within-family unity so cooperation can flourish? The work of Stanish (2017) on the evolution of cooperation and ritualized economies underscores the power of rituals to encode cultural norms. In this reflection, I focus on another potential avenue for social cohesion—the ritualization of mortuary practices—to interrogate what co-residence in death tells us about the constitution of families and social order in the Late Preceramic (3000–1800 BC).

The case study briefly described here takes place in the highlands of Peru, in a region known as the Callejón de Huaylas (Figure 1). This narrow valley runs 165 km north to south, insulated along the east and west by two mountain ranges that contain some of the tallest peaks in Peru. In the center of this valley lies Queyash Alto, along a narrow ridge at the western foothills of the Cordillera Blanca. It is a relatively small settlement, only 100 m long east to west, covering roughly two hectares. Joan Gero directed excavations at the site in 1988, and her work provided significant insights to understanding the role women played in ancient Andean politics (see Gero 1992). From the total 80 m^2 area of her excavations, I focus my analysis on a 20 m^2 unit placed on a domestic terrace.

This small area yielded a series of superimposed occupational sequences, initially thought to encompass 1,000 years of history, from 200 BC to at least AD 800 (Table 1). Fieldnotes from Gero and archaeologist Steven Wegner describe an abundance of cultural material related to feasting in the upper strata attributed to the Middle Horizon (AD 700–1000), including butchered camelid remains intermixed with diagnostic ceramics. Below these Middle Horizon levels, excavators found evidence of prior occupations extending from 200 BC to AD 700, with more intense activity and household use occurring early in this sequence from

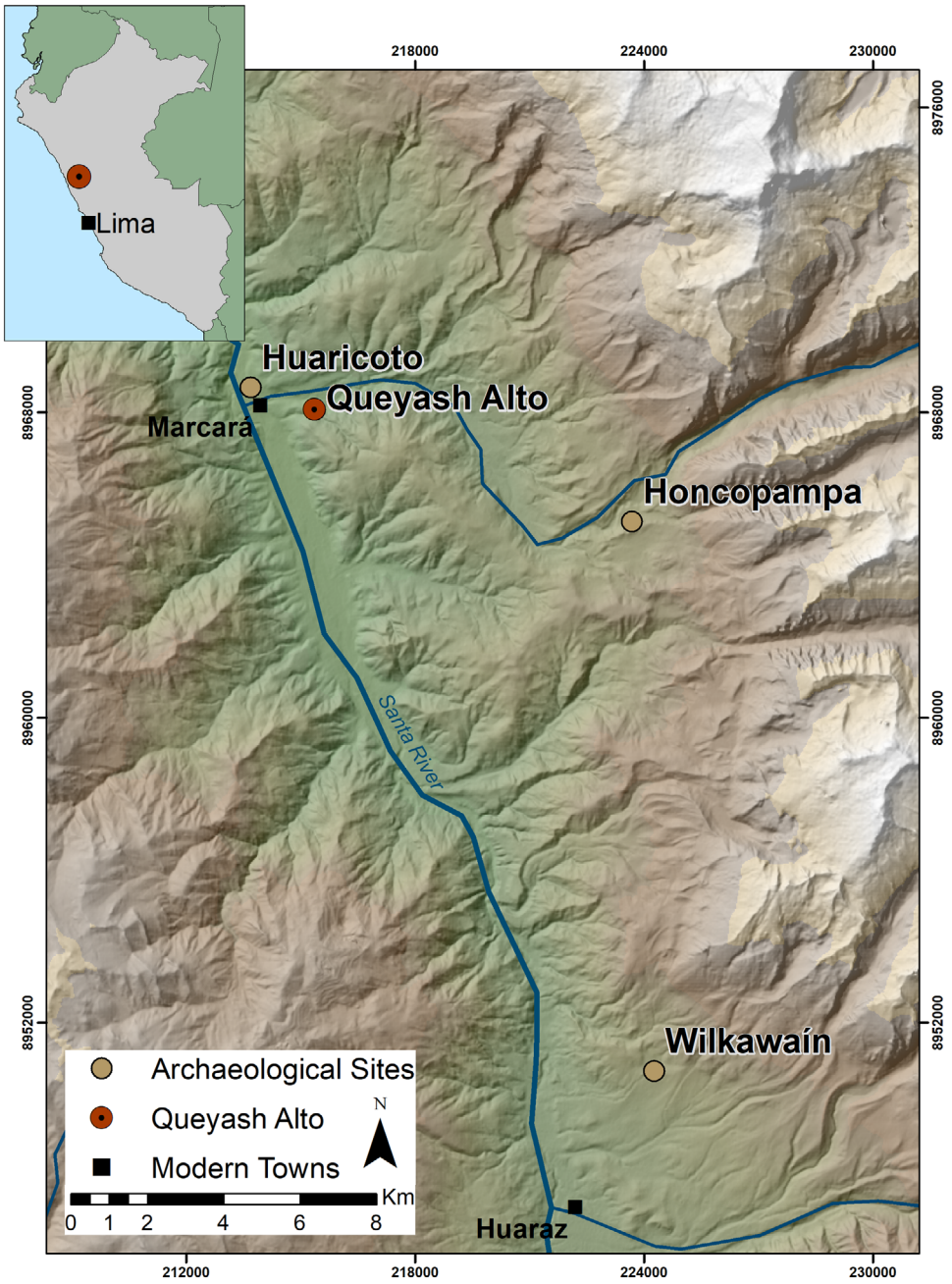


FIGURE 1. *Map of the study area in the central Callejón de Huaylas, Peru. [This figure appears in color in the online issue]*

200 BC to AD 200 (Gero 1991). This early era is distinguished by the emergence of the white-on-red ceramic style known as Huarás, which primarily includes geometric decorative motifs painted on bowls. Beneath the lowest strata of Huarás households, dated to ca. 170 BC, excavators encountered a tomb cut into bedrock (Gero 1992). Inside the chamber were two distinct clusters of human remains, comprising close to 800 fragments in varying states of preservation. I examined the remains in 2016, nearly three decades after they were excavated.

In the first levels inside the tomb, disarticulated bones from at least four people were found, including a probable adult male, a juvenile around six years of age, and two infants. The scattered position of the bones and the number of missing elements suggest these remains represent secondary burials. Farther back and deeper within the tomb was a more well-defined area, described as a stone box chamber, that included the remains of three individuals. Inside this chamber, archaeologists encountered two complete adults and one infant. The lowermost burial was a female who died during older adulthood. The more superiorly placed adult was a young to middle-aged male. There was no evidence of postburial disturbance of this group. New accelerator mass spectrometry (AMS) radiocarbon dating on two individuals revealed, surprisingly, that both the primary and secondary cluster date to the third millennium BC. The secondary

TABLE 1. *Time Periods Discussed in This Study*

Date Range	Phase	Activity in 20 m^2 Unit at Queyash Alto
3000–1800 BC	Late Preceramic	Multiple episodes of human burial
200 BC–AD 200	Early Intermediate Period	Habitation atop tomb during Huarás occupation
AD 200–700		Continual settlement post-Huarás (Recuay-era)
AD 700–1000	Middle Horizon	Feasting events

burials at the entrance of the mortuary space, however, date to at least 150 years later than the primary interments in the back, based on Bayesian modeling of the calibrated dates. Prior work at the site had not found any evidence of a Late Preceramic occupation. These results demonstrate that this specific landscape chronicles the lives of ancient Andeans across four millennia, from the first use of the site as a burial ground to later periods of prolonged habitation.

As mentioned previously, the Late Preceramic in the highlands is commonly acknowledged as a time of widespread cooperation operating without coercive power structures. Some communities witnessed the emergence of ranked groups, possibly in the form of lineages, which controlled ceremonial building projects (Aldenderfer 2004; Burger and Salazar-Burger 1986). For example, at La Galgada, 113 km northwest of Queyash Alto, archaeologists documented collective burials of richly adorned individuals that could indicate the existence of high-status kin groups (Grieder et al. 1988). Despite these elaborate interments, many highland sites, like Queyash Alto, still lacked sociopolitical hierarchies (Quilter 1991). This does not indicate a lack of complexity, however. In egalitarian societies, a complex array of institutions exist that facilitate exchange and reciprocity, while also constraining emergent hierarchies of power (Wiessner 2002). For the Late Preceramic, family units were likely one of many overlapping institutions that structured individual actions.

The mortuary component at Queyash Alto elucidates the constructive capacity of funerary rituals to enact social order. Postmortem events by mourners are a venue to reproduce, and potentially redefine, the collective family unit. The final disposal of the secondary burials in the same mortuary space as those individuals that died over a century earlier could indicate the desire of the mourner(s) to physically associate their loved ones to ancestral bodies. They expanded a family identity—one tied to an emplaced lineage. The timing of this practice is also significant. As sedentism grew, landscape ties may have become increasingly important. Therefore, making an ancestral link to land through mortuary rituals could have legitimized their claims and, in turn, contributed to new meanings surrounding family membership and lineage history. This multigenerational tomb illustrates the potential for a bioarchaeological approach to bring to light the individuals that peopled past institutions.

ANCIENT BODIES, MODERN VALUES

One may ask why the call for bioarchaeological approaches to cooperation is happening now. At a time when institutional failures, political partisanship, and heightened wealth disparities are glaring, the need for alternative models of human sociality and cooperation may be particularly acute. A recent study by the Pew Research Center (Rainie, Keeter, and Perrin 2019) of over 10,000 US adults assessed people's feelings about their confidence and trust in institutions and their fellow citizens. The data paint a depressing picture of the current decline of communal life in this country. One of the study's main findings showed a lack of trust in institutions correlates with lack of trust in other people. Young adults, in particular, report much lower levels of trust, as compared to the responses of older adults. The deepening distrust in others and institutions also affects confidence in our ability to improve societal problems. Reestablishing trust is a multifaceted, interdisciplinary challenge necessary for sustainable civic and political life. Bioarchaeologists have recently been called upon to "speak out" about how our research addresses contemporary issues (Buikstra 2019). The investigation of ancient cooperation strategies and dissemination of this bioarchaeological work is one avenue open to us as educators who draw on the past. Like the founders of Queyash Alto, our society is built not only on big institutions but also on smaller-scale groups and families that find ways to work together in the face of dramatic sociocultural change.

This pattern of a Preceramic burial near much later Huarás construction is unique. The fact that families several millennia later decided to build their houses atop this collective tomb makes Queyash Alto a palimpsest of collective building, use, and decay. The filling in of this familial mortuary space made room for new families that lived and worked on the same landscape. The skeletal bodies of the seven individuals interred in the bedrock cave endured through time, even as the memories of these individuals as people with distinct life histories were lost. To me today, the ancient remains in this tomb are potent reminders of the integrative social arrangements common nearly 5,000 years ago in the highland Andes. They effectively embody the cooperative ideals of that era and provide a timely message of hope in today's environment of increasing anxiety, despair, and violence.

NOTES

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Bioarchaeology of Prehistoric Central Thailand: A Heterarchical View

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Early studies of prehistoric Mainland Southeast Asia struggled to apply the hierarchical model to a context that the model could not adequately encompass. White (1995), grounded in Crumley (1979, 1987), proposed to move the region's social structure narrative away from the traditional hierarchical approach to a more dynamic heterarchical approach to better capture the flexible and ever-changing relationships evident in the process of social development. By reviewing the archaeological record from core areas in Mainland Southeast Asia, White (1995, 104) characterizes the

early social development of the region through four themes: (1) cultural pluralism; (2) decentralized production, specialization, and distribution of household/community-based indigenous economies; (3) flexible social status, including personal achievements; and (4) periodically renegotiable alliance formation based on cooperative/competitive dynamics. Since then, the heterarchical approach was incorporated to contextualize archaeological findings in the northeast (e.g., Eyre 2010; O'Reilly 2001) and central Thailand (White and Pigott 1996). This approach, however, has not been applied to data derived from human skeletal remains.

Studies on prehistoric central Thailand have been scarce compared to their northeastern and northern counterparts, despite the area's strategic location in mainland Southeast Asia and a long history of prosperous cultural developments leading up to the Dvaravati entity (Rispoli, Ciarla, and Pigott 2013). Inferences on human lifeways and social structure derived from human skeletal remains in this region are particularly scarce. Elements of human lifeways such as dietary behavior, resource utilization and distribution, and relationships with the landscape are critical dimensions in the construction of human history. Accordingly, mortuary practices can offer insight into an individual's social position and, on a larger scale, changes in social complexity. As the Metal Age (ca. 1500 BC–ca. AD 600) in central Thailand progressed, evidence of changing social complexity became more apparent in the form of marked mortuary variation within a site. In addition to variation in the categories and placement of grave items, degrees of mortuary elaboration among individuals often exhibited discrepancies (Higham 2002).

With a few emerging projects underway, a study combining skeletal and stable isotopic analyses on seven ecologically and temporally diverse central Thai sites (six inland, one coastal) remains the most comprehensive (Liu 2012). This study was designed to assess the impacts of social-complexity changes on human skeletal health and dietary patterns. Here I use a portion of the aggregate data from this study based on the inland sites (Non Mak La, Nil Kham Haeng, Ban Mai Chaimongkol, Promtin Tai, Ban Pong Manao, and Khao Sai On-Noen Din) to argue that aspects of human lifeways further support the heterarchical structure of prehistoric Thailand.

CENTRAL THAILAND

Central Thailand is bound by mountain ranges in all directions except for the south and southeast boundaries, where the Gulf of Thailand receives the flow of the Chao Phraya River. Within this region from west to east, there are three geographic areas: the West Continental Highlands, the Central Plain, and the Central Highlands. Making up parts of the Thai–Myanmar border, the West Continental Highlands has yielded evidence suggesting human occupation occurred as early as the late Pleistocene (Higham 2002). Sloping westward and southward, the Central Plain is a catchment of tributaries that eventually drain into the Chao Phraya River just north of modern-day Ayutthaya. Five of the six sites listed above are located in this area. The Central Highlands, where Ban Pong Manao can be found, is characteristic of an undulating terrain, with an ever-increasing elevation that ultimately converges with the Phetchabun Ridge to the east, leading to the Khorat Plateau. With the landscape of central Thailand crisscrossed by complex river systems amid the drastic elevation differentials, the effects of seasonal monsoon manifest as uneven and somewhat unpredictable rain/drought cycles, creating pockets of ecozones that furnished an assortment of resources and cultural diversity in prehistory (Higham 2002; White 2011). Seed remains from millet (*Setaria*) appeared as early as the third millennium BC in central Thailand, whereas rice remains did not appear until about two millennia later (Weber et al. 2010). Supplementing through hunting and gathering for terrestrial and riverine resources even to this day, people have used the management and cultivation of millet, rice, and root plants to sustain the region's settlement, expansion, and population growth over time (Higham 2002).

The six sites have a combined temporal range from the late Neolithic (ca. 2000 BC) to the early historic period (ca. AD 600), with some overlap among sites. Among them, Non Mak La, Nil Kham Haeng, and Promtin Tai yielded significant amounts of metalworking tools and byproducts (e.g., crushed ore, slag) indicating the existence of site-based metal processing and production (Lertcharnrit 2014; Pigott, Weiss, and Natapintu 1997). For the rest, grave goods and habitation artifacts included items acquired from exchange with other communities in the region (Pryce et al. 2011). Combined with the fact that central Thailand is where one of the two main heavily exploited ore belts (the Khao Wang Prachan Valley) is located, it is clear that occupants of these sites were collectively involved in various stages of metallurgy, from ore harvesting, production, and usage to distribution.

MATERIALS AND MAJOR RESULTS

The bioarchaeological data considered here include results of dental pathology and stable isotope analyses. Four dental markers (dental caries, calculus, periapical abscessing, and antemortem tooth loss) were assessed and analyzed based on tooth/alveolar count (sample sizes range from 227 to 461, depending on the marker). Valid $\delta^{13}C$, $\delta^{15}N$, and $\delta^{18}O$ data from bone and bulk dental enamel tissues from seventy-seven individuals were used to assess dietary patterns. In addition to intersite comparisons, data from each site were further analyzed for intrasite temporal patterns when possible. Major bioarchaeological trends observed are listed in Table 1.

A BIOARCHAEOLOGICAL PERSPECTIVE ON THE LONG-TERM DEVELOPMENT OF CENTRAL THAILAND

Prevalence of dental pathologies/conditions, while uniformly low, fluctuates among sites. In other words, no

TABLE 1. *Major Bioarchaeological Trends Observed in this Study*

	Intersite Comparison	Intrasite Variation
Dental Markers		no significant difference in prevalence of dental markers between earlier and later periods in sites with temporal subdivisions
	a. uniformly low prevalence (by tooth/socket count) of all dental markers assessed across all sites	
	b. most common: dental calculus (prevalence ranges from 1.1 percent to 14.5 percent) least common: dental caries (all below 5 percent)	
Stable Isotopes		statistically insignificant fluctuations of C_4 vs. C_4 contributions to diet over time
	a. individuals in each site share similar dietary (food and water) composition	
	b. each site exhibits a locale-specific dietary pattern with minimal overlap among sites	
	c. all sites exhibit low- to mid-trophic terrestrial diets with varying degrees of C_4-C_4 admixture, all consistent with each site's ecological parameters	

particular site has the highest prevalence for more than one dental marker. With the wide temporal span of these sites combined, impacts of the region-wide changes in social structural complexity and the advances of craft production were not clearly visible in individual dental health. These findings suggest that community dental health and its contributing factors were a site-specific, instead of a region-based, phenomenon. Furthermore, there was no marked temporal changes in prevalence of dental pathologies/conditions on the intrasite level. Overall, prehistoric central Thai communities maintained a satisfactory dental health pattern that remained stable despite the changes seen on other aspects of social life.

In terms of diet, the degree of variation across sites greatly surpasses the intrasite variation. The tightly clustered data distribution by site means most individuals from the same site had very similar diets, consisting of terrestrial and riverine proteins with a mixture of C_3- and C_4-derived resources. Dietary patterns in each site were distinct and were consistent with the expectations based on the local environmental baseline. Within the sites with temporal subdivisions, some fluctuations of C_3/C_4 admixture in diet were observed, though they were not statistically significant. For example, in Non Mak La, the influence of C_3 foodstuffs became more apparent on the $\delta^{13}C$ spectrum in the later period of site occupation, while C_4-derived foodstuffs continued to be incorporated into people's diets. This change echoes results from Weber and colleagues' (2010) paleobotanical study, where the authors established that rice remains first appeared in the first millennium BC in central Thailand.

One central tenant of the heterarchical framework is the flexible and multidimensional view of social complexity, where horizontal or lateral interrelationships among entities (e.g., polities, communities, individuals) can manifest fluidly and situationally (Crumley 1979; White 1995; see also Juengst, this forum). In prehistoric central Thailand, as regional social complexity increased over time, there was a lack of swooping changes and patterned fluctuations in human dental health and diet. Indeed, one of the explanations could be methodological limitations, where preferential treatment toward particular social groups or individuals may not be morphologically or isotopically detectable. While not impossible, this is unlikely considering the multimarker and multi-isotopic approaches utilized in this study.

This leads to two other scenarios that could explain the bioarchaeological findings, either of which would support a heterarchical social structure on the site level. First, human diet was simply not an element of social-complexity change or was not impacted enough to register on skeletal and dental tissues. It may be the case that differentiation in individual social position was expressed by means of moderate material accumulation (in life or in burial) or power negotiation instead of control of or restrictions on resource accessibility.

This is a marked departure from a traditional hierarchical regime, where most aspects of life would be structured in a patterned and prescribed manner, including resource procurement/production and distribution (White 1995).

Second, the diverse landscape of central Thailand was the determining factor when it came to resource exploitation and food choices. The isotope data suggest a broad-spectrum subsistence anchored by C_3 items, supplemented by terrestrial and freshwater resources, and mixed in with C_4-derived foods. With its ecological pockets resulting from a combination of monsoonal and topological factors, the landscape could afford a wide array of abundant food resources sufficient to support the populations within. To utilize nature's bounty, people had to collectively employ multiple categories of knowledge, labor, skill sets, and tool kits to navigate and modify the landscape. The need for diverse specializations and cooperation would have likely weakened the constitution of a centralized resource-allocation structure (if any) within a community, leading to homogenous and temporally stable dental health and diets.

On the intersite level, good dental health and locale-based diets across prehistoric central Thailand over time can again be best interpreted as products of a steady regional development trajectory rooted in environmental heterogeneity. Reviewing the archaeological record and competing views of Mainland Southeast Asian prehistory, White (2011) posits that the region's long and continuous history of cultural diversity was deeply anchored on ecological mosaics. While unidirectional flow of certain resources due to habitat or mine distribution may have existed, reciprocal or negotiated flows of other resources necessary for sustaining a population and craft production (e.g., raw materials, food, knowledge) were definitely an integral part of community interaction. It was this network of interrelationships that provided a stable foundation for long-term cultural and population development for the region.

Prehistoric central Thailand was by no means free of any hierarchical structure or competition. However, the lack of cultural homogeneity, archaeologically detectable monopolies and centralized economies, and punctuated social changes point to a more fluid heterarchical intercommunity structure that sustained the region's steady and prosperous development. The bioarchaeological data provide further support to this view and highlight the need to apply the human dimension to the hierarchy–heterarchy continuum.

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Cooperation and Resilience at the Ancient Maya Site of Chan, Belize

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Our unique ability to coordinate large groups of people and to teach each other to survive in diverse environmental settings enabled global human success (Fuentes 2004). The unique edge given by human cooperation, physically and culturally, deserves critical attention. We are all, hopefully, leveraging that evolutionary edge by participating in the widest-reaching cooperative endeavor in our history—social distancing—to slow the spread of the COVID-19 pandemic. Ironically, our social nature, usually our greatest strength, is suspended. Humans must cooperate not only to avoid global health crises but also to ensure safety, reproduction, education, and many other processes necessary for our species to thrive. A bioarchaeological perspective can help us understand these processes by providing a critical deep-time perspective on the effect of cooperation on human bodies. For example, acquiring food is crucial for human survival; its acquisition and production are much more efficient when efforts are collaborative. The sociopolitical and ritual aspects of food are equally important to consider and hold further evidence of human cooperative endeavors. A contextualization of cooperative acts (Juengst, this forum) and their impact is discussed for the ancient Maya residents of the Chan site, located in the Belize River Valley (BRV), Belize. I argue the farmers and artisans of the Chan site cooperated with each other in their farming practices, with their neighbors through feasting, and with extra-regional contacts through trade to sustain themselves over their 1,800-year occupation. In the following, I detail agricultural, faunal, and paleobotanical data from Chan and stable isotope values from human remains to paint a more robust picture of food resources at Chan: what was produced, what was shared, and what was consumed (Robin 2012).

THE BELIZE VALLEY AND THE CHAN SITE

Geographically and culturally adjacent to the ancient Maya heartland in Guatemala, the BRV has been populated since at least the Middle Preclassic period (~1000–600 BC) through the present day. The river supported this long occupation by depositing high-quality agricultural soil along its banks and connecting people living in the interior to the Caribbean coast. The BRV experienced a population increase in the Late Classic period, around AD 600, at about the same time as a major urban center, Xunantunich, rose to power nearby (Robin 2012). The ancient Maya experienced a sociopolitical reorganization starting in the late ninth century AD, evidenced by warfare and site abandonment in the eastern Maya region. Severe droughts contributed negatively to the sociopolitical reorganization at the end of the Classic period (AD 820–900). Belize Valley sites resisted what is colloquially known as the "collapse" until roughly AD 900 (Robin 2012).

The BRV featured a tiered settlement hierarchy supported by geographically dispersed farmers and craftspeople. An intermediate tier of elites and nonelites resided in minor centers, of which Chan was one, which were small to medium in size but featured administrative structures, plazas for gathering, and smaller temples. Divine kings and apical elites occupied major centers with monumental architecture, temples, ball courts, and roads to support their theatrical displays of power (Ashmore 1981). In the BRV, the intermediate settlements were the most consistently occupied, suggesting success in collaborative relationships with both apical elites and commoners (Walden et al. 2019).

As settlement patterns show, the ancient Maya were sociopolitically hierarchical; however, scholars continue to debate the degree to which power was centralized (summarized in Iannone 2002). Particularly during the Classic period apogee, a distinct tension existed between centralized, hierarchical leadership of divine kings and the temporally and geographically deep bonds of kinship and lineage authority resulting in cycles of more- or less-centralized power (McAnany 2013). Maya political power at the highest levels was likely tenuous because divine kings never completely controlled centralized food production due to the fragile tropical environment and little surface water—critical resources that supported other early states (Demarest 1992). The power of divine kingship was in part ideological (McAnany 2013), but, in practice, there was space for power and collaborative relationships with nonroyal, intermediate elites and nonelite sites like Chan. Given these power dynamics, the coexistence of hierarchical and heterarchical relationships follows (Iannone 2002). Archaeologically, we can identify cooperative action through the presence of public and ritual spaces as well as portable material culture, such as figural representations of individuals or groups (DeMarrias 2016).

First occupied around 800 BC, Chan featured public and ritual spaces like temples, administrative structures, and marketplaces, albeit at a smaller scale than major centers (Robin 2012). Ritually, the Chan Maya shifted from

emphasizing individuals to the community over time. The Chan Maya practiced ancestor veneration by sequential interment of the deceased in nested platforms on the eastern side of the core architectural group. Single individual interments of ancestors were common earlier in time, and by AD 600–900 interments were commonly of multiple individuals. The nature of ritual offerings also changed, from offerings in graves of individual ancestors to offerings made as caches. Figural representations also demonstrate a shifting ritual emphasis away from individuals. Heirloom figurine heads interpreted as portraits of early Chan leaders were recovered only in Late Preclassic mortuary contexts. Ritual venues were not the only ones that featured cooperative or nonhierarchical acts. At various points in their history, the Chan Maya also produced chert bifaces, limestone blocks, shell ornaments, and obsidian blades. Evidence for production was found in households outside the central architectural group, suggesting nonhierarchical economic strategies (Robin 2012). In addition to ritual activity and crafting, the Chan Maya were farmers, and the following explores the role that foods played in collaborative behavior over time.

PALEODIET AT CHAN

Agricultural terraces weaving across the hillsides were a major defining feature at Chan as early as about 800 BC. Terraced fields were maintained, remodeled, and expanded through the Late Classic period, approximately AD 800. Placement of residences along terraces suggests a degree of cooperation in farming, a behavior that persisted during the Late Classic population increase. Archaeobotanical analysis confirms maize, beans, and squash were planted in these terraces, in addition to assorted fruit trees that likely grew among the Chan residences (Robin 2012).

Faunal remains recovered from the Chan site center were generally scant, with the exception of a Preclassic midden of freshwater snails, predominantly *Pachychilus indorium*, a common river snail found in ancient Maya middens and ritual contexts in the BRV. The densest deposit, covering over 100 m^2, contained approximately 2.7 million snails, amounting to the remains of 23,000 meals, or 115 gatherings of about 200 people (Keller 2012, 257–59). As the settlement density was relatively low in the Preclassic, the midden is almost certainly indicative of Chan hosting feasts.

Faunal material from the settlement surrounding Chan was found mainly in the Late Classic Special Deposit 1. The deposit contained burned deer bones, whitetail (*Odocoileus virginianius*) and brocket (*Mazama americana*), white-lipped peccary (*Tayassu tajacu*), rabbit (*Lagomorpha*), bony fish (*Osteichthyes*), skunk (*Mustelidae*), squirrel (*Sciuridae*), and turtle (*Testudines*); artifacts included shell, lithics, and two stacked ceramic vessels (Blackmore 2012, 181). Remains such as the bones of small mammals or fish may be underrepresented in archaeological samples due to excavation bias or poor preservation. Stable isotope analysis of human remains constitutes crucial information on foods not visible archaeologically and speaks to which foods were actually consumed.

Stable isotopes of carbon (^{13}C) and nitrogen (^{15}N) reflect dietary choices (Ambrose and Krigbaum 2003). A recent meta-analysis of ancient Maya isotopic data (Somerville, Fauvelle, and Froehle 2013) found ancient Maya commoner diet changed little over time, suggesting they had resources despite droughts and political reorganization. Carbon values from BRV collagen are consistently more negative than other parts of the Maya area for unknown reasons; however, this suggests a more diverse diet less reliant on corn (Freiwald 2011). Recent research at the BRV site of Cahal Pech found statistically significant difference in human δ15N values between Preclassic and Late Classic periods (Ebert et al. 2019). They attribute the enriched Late Classic nitrogen values either to a difference in the ability of certain groups (elites/commoners) to acquire terrestrial meat or as a reflection of drought stress (Ambrose and Krigbaum 2003). In sum, previous isotopic analysis of ancient Maya commoner paleodiet suggests we would expect to see a consistently diverse diet over time at Chan, but δ15N values should be interpreted carefully. These archaeological data provide some insight into what foods were available and likely consumed; stable isotope analysis speaks to the actual diet of the ancient inhabitants of Chan.

SAMPLE AND ANALYSIS

Twenty-three samples of bone were sent to Beta Analytic for analysis. Mann–Whitney *U*-tests of independent samples was used to compare the results by time period; sample sizes were too small to compare results by burial location. Preservation of bone collagen was assessed through collagen yield, element concentration, and the ratio of carbon to nitrogen (C/N). The average C/N ratio for values included in this analysis was 3.4 with average element concentrations of 44.5 (C) and 15.2 (N). The final analysis consisted of seventeen values ranging in time from the Middle Preclassic to the Late Classic (Tables 1 and 2).

RESULTS

When all time periods and burial locations are considered, the $\delta^{13}C$ isotope values of bone collagen yielded an average of −14.5‰ with a range of −19.5‰ to −11‰ (Table 1, Figure 1). Notable is the consistent ^{13}C values over time. The mean carbon value for the Chan Preclassic period is −14.78‰ and the mean for the Late Classic is −14.6‰ (Table 1). A comparison of Preclassic and Late Classic $\delta^{13}C$ values was not statistically significant (Mann–Whitney $U = 34$; $p = 0.89$; $\alpha = 0.05$). While it is not possible to speak to specific foods consumed, it is worth noting that freshwater fish and snails have depleted $\delta^{13}C$ values, and it is possible that consumption of freshwater snails at Chan contributed to the depleted carbon values in Preclassic individuals. The Preclassic value is generally consistent with other Preclassic burials in the BRV, but the Late Classic value (−14.68‰) is much more negative than the rest of the Valley, which has a mean $\delta^{13}C$ of −10.6‰ (Freiwald 2011, 282), suggesting a diet not overly focused on corn consumption.

TABLE 1. *$\delta^{13}C$ Values from Collagen for Chan and the Chan Settlement (Chan NE) by Time Period*

	N	Mean	Median	s.d.	range	Min.	Max.
Preclassic							
Chan	8	−14.78	−14.75	1.55	4.5	−17.3	−12.8
Late Classic							
Chan	4	−14.68	−13.9	2.13	8.5	−19.5	−11
Chan NE	5	−14.32	−14.1	1.8	4.5	−17.3	−12.8

TABLE 2. *$\delta^{15}N$ Values from Collagen for Chan and the Chan Settlement (Chan NE) by Time Period*

	N	Mean	Median	s.d.	range	Min.	Max.
Preclassic							
Chan	7	9.48	9.1	1.19	3.6	8.3	11.9
Late Classic							
Chan	5	9.06	9.5	1.11	2.7	7.1	9.8
Chan NE	5	10.26	10.2	0.76	1.8	9.5	11.3

The total sample $\delta^{15}N$ isotope values from bone collagen yielded an average of 9.6‰, which is high compared to the Late Classic BRV mean of 8.7‰ (Freiwald 2011), suggesting Chan residents, including those in the outlying settlement, consumed a greater proportion of terrestrial animals or fish (marine or freshwater). The $\delta^{15}N$ values range from 8.3‰ to 11.9‰, indicating individual variation in access to animal or fish meat. There was no statistically significant difference between time periods (Mann–Whitney $U = 20$; $p = 0.13$; $\alpha = 0.05$). The sample sizes by burial location were too small to compare statistically, but the Chan settlement nitrogen values were slightly higher than those of the site center (Table 2), suggesting a diet possibly enhanced by animal or fish meat. Enriched nitrogen values can also indicate other processes, including drought (Ambrose 1991). The Maya experienced climate fluctuations (Ebert et al. 2019); however, all of the Preclassic and Late Classic individuals predated the most severe droughts (Robin 2012). Although sample sizes are small and results refined by comparing collagen and apatite, the Chan data suggest food sources remained broad over time and included meat consumption in the Late Classic. In the following, the isotopic data are interpreted alongside archaeological data to argue for sustained cooperation as a successful strategy for Chan.

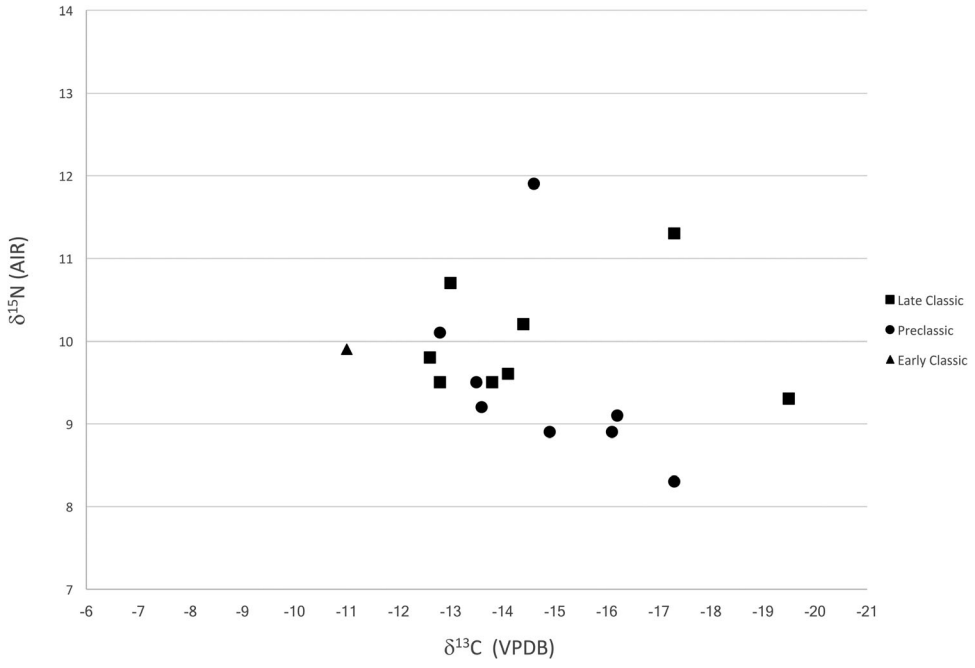


FIGURE 1. *Chan paleodiet over time.*

DISCUSSION AND CONCLUSION

The Chan Maya moved more toward than away from coalition building and cooperative acts over their 1,800-year history when ritual and economics are considered. The dietary data support those previous results. Cooperation is evident in the shared responsibilities of living among the terraces they farmed (Robin 2012). They successfully practiced intensive maize agriculture, but their isotopic assays suggest that, while they consumed corn, they consistently had access to other resources. These findings are consistent with Somerville, Fauvelle, and Froehle's (2013, 1546–47) meta-analysis of ancient Maya diet and status, which found ancient Maya commoner diets generally changed very little over time, likely due to their ability to supplement the corn in their diet with foods from managed forests and household gardens.

Preclassic feasts were hosted in the Chan site center proudly featuring snails. Perhaps the Chan Maya graciously provided meals, although neighbors may have contributed to the meal to form or reinforce alliances. At least one Preclassic individual was born or spent their childhood elsewhere but was interred in a prominent location at Chan, perhaps emphasizing these long-distance connections. Feasting was an activity not limited to the site center. Late Classic households also hosted feasts, again suggesting a cooperative ethos and heterarchical political structure.

It takes cooperation to make decisions about land use, and the Chan Maya clearly chose to maintain standing forests near their homes that persisted into the Late Classic period. Consistent access to forest fauna may explain their elevated $\delta^{15}N$ values in the Late Classic. The possible consumption of marine resources by Preclassic and Late Classic Chan Maya potentially speaks to connections outside the BRV. Interestingly, a Late Classic individual from the settlement had the highest nitrogen value (11.3‰). A BRV local (Novotny 2015), their family was likely a relatively new arrival, suggesting Late Classic settlers may have maintained distant connections.

Although the Chan farmers practiced intensive agriculture, we cannot know exactly what Chan's tribute requirements may have been or how they changed over time. They surely produced enough corn, or other products, to meet tribute obligations. Importantly, ceramic data suggest Chan was never fully drawn into Xunantunich's orbit in the Late Classic. Other minor centers like Chan that have ceramics consistent with an economic relationship with Xunantunich do not have such luxury items such as jade and shell ornaments as equitably distributed among residences (Robin 2012). If tribute requirements were low, perhaps Chan used the agricultural products to create or reinforce relationships outside the Belize Valley and were thereby able to acquire jade and shell.

In closing, the bioarchaeological data from Chan are important for demonstrating that the labor of farmers in complex societies was not always exploited in service to apical elites. A close look at sources of power and the activities of people other than divine kings shows that there was room for nonhierarchical, collaborative relationships that led to stable and thriving communities. Food facilitated cooperative behavior over time and in different contexts at Chan, from Preclassic feasting to Late Classic trade relationships. It took cooperation to farm and to maintain access to standing forests over 1,800 years, including late in their occupation when droughts were imminent. A social network reaching outside the BRV, built and sustained cooperatively, may have contributed to adaptation and resistance to calamitous change. Maya values of reciprocity and loyalty are evident and were likely important strategies to which the Chan Maya owe their long history.

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In Flux: Exploring Hierarchy and Heterarchy in the Past through Diet

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It has been forty years since Carole Crumley (1979) dethroned hierarchy as the dominant paradigm in archaeological research. Archaeologists have since built on her work to explore how different forms of heterarchy in the past leave traces on the landscape and material culture. Bioarchaeologists are increasingly contributing to this literature, drawing evidence directly from the bones of once-living people to explore the variety of ways people organized themselves in the past and flexible shifts between different organizational patterns (Wengrow and Graeber 2015). In our current research, we are reconstructing the diets of soldiers to explore the "historical and contextual flux" (Crumley 1995, 4) between hierarchy and heterarchy in a nineteenth-century state-level army.

HIERARCHY, HETERACHY, AND THE FLUX

Hierarchy emerged as a research paradigm in anthropology in the 1960s with typological linear models of human social organization (see Juengst, this forum, for definition). In this research paradigm, hierarchy became synonymous with order (Crumley 1995). Hierarchy, however, is woefully inadequate at capturing the complex ways humans have organized ourselves throughout evolutionary history. Heterarchy offers an alternative viewpoint to explore the complex and shifting ways people organize themselves (see Juengst, this forum, for definition). Crumley (1995) urged archaeologists to explore the *flux* between hierarchy and heterarchy in past societies, which can provide greater insight into power relations and value systems at multiple scales. Here, we define flux as continuous change, the shifting interlinkages between hierarchy and heterarchy. Even within what she termed control hierarchies, where people at higher levels hold decision-making power that shapes the lives and experiences of people at lower levels, there is room for agency and cooperation (Crumley 1995). Here we follow Gero's (2000, 37) definition of agency as "an opportunity to act" that occurs within a "discursive mix of context, capability, and timing."

Bioarchaeologists are uniquely positioned to explore the flux between hierarchy and heterarchy in past societies because bioarchaeological evidence is direct, meaning that it comes from the skeleton rather than by proxy. Additionally, while archaeological evidence can provide insight at the group level (e.g., community or household), the human skeleton provides information on a single person. This direct and individual evidence allows bioarchaeologists to explore heterarchy at multiple spatial scales and over time (i.e., a person's life course). One avenue that offers potential insight into the crossing between hierarchy and heterarchy is the examination of diet, as diet provides insight into social organization, power, control, and agency (Hastorf 2017). Diet is the result of the complex interaction between nutritional needs, environment, preference, and socio-political-economic factors. Diet can be reconstructed from the human skeleton using stable isotope analysis.

CASE STUDY: INVESTIGATING PROVISIONING OF NAPOLEONIC SOLDIERS

Here we explore the flux between hierarchy and heterarchy in the rigidly structured Napoleon's Grand Army (NGA) by reconstructing soldier diet though stable carbon and nitrogen isotope analysis. NGA is an example of a control

hierarchy, where decisions were made by Napoleon and his generals, and those decisions became orders that were carried out by lower-ranking officers and soldiers. Despite this rigid power structure of decision-making, oversight of soldiers' daily actions varied, particularly on distant campaigns. This tension between army power structure and soldier agency is reflected in what individual soldiers consumed (i.e., diet).

Historical evidence provides insight into the different feeding strategies of NGA. Soldier rations were distributed by the Ministry of the Administration of War based on corps (e.g., infantry, cavalry, imperial guard) and rank through supply battalions that accompanied the army on campaign (Rothenberg 1981). However, during the numerous and distant campaigns of the Napoleonic Wars, adequate provisioning of soldier rations was a recurring problem (Nafziger 1988). To overcome this problem, French soldiers supplemented their rations through "living off the land" strategies, which included cooperative foraging, purchasing, and stealing of local populations' food during distant campaigns (Rothenberg 1981). Cooperative foraging entailed organized and systematic extraction of local resources by small groups of soldiers that would split off from the main column of the army. On one hand, the army's ration provisions followed the hierarchical structure of the army; on the other hand, living off the land required heterarchical strategies as soldiers worked together regardless of rank to extract dietary resources. This leads to the question: Was cooperative foraging a long-term strategy frequently employed by soldiers on campaign or was it employed only in the direst provisioning situations?

Stable isotope methodology complements historical evidence regarding soldier diet by providing an empirical means to measure the extent to which provisioning of rations and cooperative foraging coexisted. Stable isotope analysis of archaeological bone and teeth is a well-established method of diet reconstruction. The underlying principle of this method is that atoms from food become incorporated into consumer tissues, with the isotopic ratios between atoms in food varying in systematic ways. Stable carbon isotope ratios generally reflect the photosynthetic pathways of plants, stemming from the fact that different classes of plant metabolize CO_2 in systematically different ways (Smith and Epstein 1971). More-negative carbon isotope ratios indicate consumption of C_3 plants, such as most cereals (e.g., rice, wheat, barley, rye, oats) and vegetables, whereas less-negative ratios indicate consumption of C_4 plants, such as maize, sugarcane, sorghum, or millet. Stable nitrogen isotope ratios generally reflect an organism's position in the food chain (Minagawa and Wada 1984): the higher the value, the higher an organism in the food chain. Stable nitrogen isotope ratios also can indicate whether an organism's diet consists of primarily marine or terrestrial resources (Schoeninger, DeNiro, and Tauber 1983). Stable isotope ratios use delta (δ) notation and are reported as per mil values (‰) relative to international standards.

Comparing stable isotope ratios in different bones allows bioarchaeologists to explore changes in diet over the course of a person's life. Bones remodel throughout a person's life; however, different bones capture different periods in a person's life, depending on factors such as the amount of cortical versus trabecular bone (Clarke 2008). Stable isotope ratios in femora of NGA soldiers provide information on diet during the final 10–30+ years of life (Hedges et al. 2007). Stable isotope ratios in soldier ribs are believed to provide information on diet during the final 2–5 years of life (Cox and Sealy 1997). Isotopic ratios in femora and ribs can be compared to examine changes in diet with military service. This approach allows us to examine whether heterarchical strategies were a major contributor to individual soldier diet during their time in NGA, and by extension, the operation of the army overall.

Previous analysis of femora from seventy-eight Napoleonic soldiers revealed considerable dietary variation between soldiers compared to other European and contemporaneous military samples (Holder et al. 2017). The range in carbon isotope ratios was greater than 7‰, and the range in nitrogen isotope ratios was greater than 6‰. The authors attributed this high degree of variation in long-term diet to the multinational and multiethnic composition of the army, participation of soldiers in various military campaigns, rank and role during military service, and possible nondietary contributions, such as stress, to the isotope ratios of mineralized tissues, which are known to affect isotope ratios. Using rib samples, we are currently examining whether the isotopic variability of femora was maintained during military service through cooperative foraging or whether diet became more homogenous due to the provisioning of rations.

Our historical research and previous bioarchaeological case studies led us to hypothesize what we might expect to see in the isotopic data if provisioning of rations was the primary influence on diet. Although rations varied by corps and rank (e.g., greater access to meat by imperial guardsmen; Rothenberg 1981), rations prescribed to soldiers would likely be isotopically indistinguishable, as they consisted of C_3-based plants in the form of vegetables and bread made from grains, and meat. If provisioning was the dominant practice contributing to diet, then we expect that isotopic ratios of ribs of Napoleonic soldiers to be relatively similar, reflecting an isotopic signature of an "army diet." Such a change, from a more varied to a more similar diet, was reported in a study on British Royal Navy servicemen (Roberts et al. 2012).

Other historical research led us to hypothesize what we might expect to see if cooperative foraging was an important strategy for diet. NGA was embattled in campaigns throughout Europe and in Egypt during the late eighteenth and early nineteenth centuries, each with differing local dietary resources. Thus, if cooperative foraging was consistently practiced during these campaigns, then we would expect that isotopic ratios in ribs will exhibit considerable

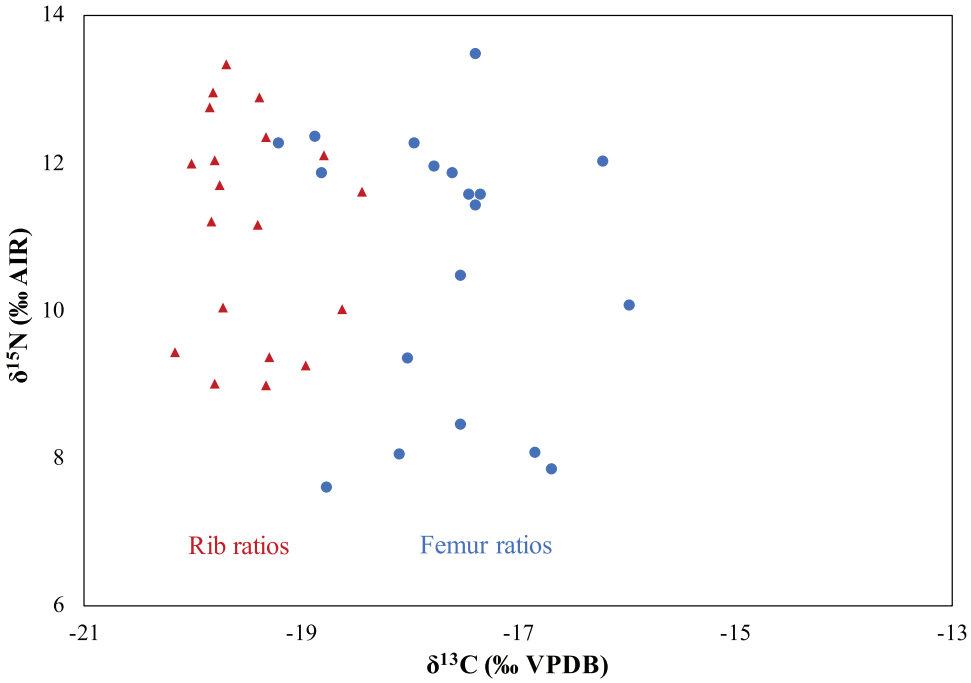


FIGURE 1. *Scatterplot of stable carbon and nitrogen isotope ratios of rib (red triangles) and femoral (blue circles) collagen from nineteen Napoleonic soldiers. [This figure appears in color in the online issue]*

variation, similar to the variation previously discovered in soldier femora.

Initial analysis of nineteen ribs with matching femoral data revealed that, on average, carbon isotope ratios were lower in ribs than femora, and less varied (see Figure 1). Nitrogen isotope ratios increased slightly, and variation was similar between ribs and femora. These preliminary results demonstrate the complexity in exploring heterarchy through diet. Whereas nitrogen isotope ratios support the hypothesis that a high degree of variation was maintained during military service due to cooperative foraging, stable carbon isotope ratios support the hypothesis that diet became more homogenous during military service through provisioning of rations. There are several possibilities for these seemingly conflicting results.

The shift to a more negative average $\delta^{13}C$ ratio in ribs indicates a diet that included more C_3-based foods later in life. Historical documentation indicates NGA was composed of the French army, along with allied and annexed nations and mercenaries from across Europe and possibly North Africa, from vastly different socioeconomic backgrounds. Soldiers from coastal regions, such as Spain, France, and Italy, may have consumed significant amounts of marine resources during childhood and early adulthood, resulting in less-negative femoral $\delta^{13}C$ ratios. Additionally, millets are the dominant C_4 plant consumed in historic and prehistoric Europe, which also contributes to less-negative $\delta^{13}C$ ratios. A shift from millet and/or marine resources as dietary staples for some soldiers to C_3-based rations during military service may explain both the shift to more-negative $\delta^{13}C$ ratios and changes in $\delta^{13}C$ ratio variation.

Alternatively, patterns in $\delta^{13}C$ ratios could be indicative of cooperative foraging. Europe is a temperate region, dominated by C_3 plants. While there is historical and isotopic evidence of C_4 plant consumption throughout Europe, particularly during the Medieval period, historical evidence indicates that millet was typically grown in smaller quantities than C_3 domesticates like wheat, rye, and barley (Abel 2013). Thus, soldiers may have encountered primarily C_3 plants during their foraging excursions, and changes in $\delta^{13}C$ ratios may reflect this practice. A related explanation of cooperation is that soldiers shared available foods, including rations. In this latter case, the shift and less varying $\delta^{13}C$ ratios in ribs reflect both hierarchy through rationing and heterarchy through sharing.

The higher average $\delta^{15}N$ ratio in ribs reflects a possible increase in animal-protein consumption during military service, particularly in five soldiers with the lowest femoral $\delta^{15}N$ ratios. Military service may have allowed greater access to animal protein. Alternately, these trends could be the result of recurring bouts of protein stress (e.g., Fuller et al. 2005) experienced by lower-status soldiers during military service, particularly conscripts. Inadequate rationing (particularly of animal dietary protein) was a recurring problem throughout the campaigns of the Napoleonic Wars (Nafziger 1988; Rothenberg 1981). Inadequate food supplies likely did not affect all soldiers equally, with officers and imperial guardsmen having greater access to rations during periods of inadequate supplies. Whether they are the result of diet or protein stress, changes in $\delta^{15}N$ ratios with military service reflect how the hierarchically organized structure of NGA

shaped access to, and consumption of, animal protein by soldiers.

Taken together, the most likely explanation for the isotope results is that army rationing was the primary contributor to diet, and heterarchical strategies such as cooperation and sharing were secondary. Although inadequate provisioning of rations was a recurring problem throughout the Napoleonic Wars, it was the predominant strategy shaping soldiers' diets in the final years before their deaths. Historical evidence supports this interpretation. Cooperative foraging was a strategy employed in more-dire circumstances (Nafziger 1988), and thus was not a long-term strategy that contributed significantly to stable isotope ratios in the bones of these soldiers.

There are several challenges to an isotopic approach to exploring the flux. First is the issue of equifinality. Different dietary, physiological, and environmental factors may lead to similar isotopic signatures in human tissues. This challenge makes the interpretation of stable isotope results from a heterogeneous sample particularly difficult. Second is the issue of time. Isotopic data from bones reflect an average over the last several years of an individual's life. Because of this, fluctuations and short-term changes in diet are not captured in the isotope ratios of human bone. The averaging effect limits the potential for us to detect cooperative foraging strategies among Napoleonic soldiers. A third challenge is the nature of the site, a mass gravesite without indications of individual soldiers' identities. While comingling of individuals was not a major issue, distinguishing soldiers by rank or other dimensions of identity linked to status and access to food resources is not possible given their burial context.

CONCLUSIONS

Exploring heterarchy in past human groups using stable isotope methodologies is complex due to the challenges of equifinality, long turnover time in bones, and burial context. Using historical evidence to untangle these complexities, our current research is beginning to uncover the linkages between heterarchy and hierarchy through the everyday eating habits of soldiers. Our preliminary analysis indicates that army rationing, indicative of hierarchical structures, was the primary contributor to Napoleonic soldier diet later in life and cooperative foraging was secondary. However, even within control hierarchies (Crumley 1995), which is certainly the case in Napoleon's Grand Army, opportunities for individual choice and cooperation exist. Focusing on the flux between hierarchy and heterarchy allows (bio)archaeologists to explore complex and fluid relationships within and between human groups. As isotope methodology advances, new potentials exist to address equifinality and the time-averaging effects of bone (re)modeling in stable isotope analysis of human skeletal material. Together, theory building and improved methodologies offer the potential to provide greater insights into how people organized themselves in the past and the flexibility in human behavior.

NOTES

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Heterarchy and the Creation of Nomadic States in Mongolia: The Bioarchaeological Evidence from the Xianbei Period (AD 93–234)

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The rise of nomadic states in Central Asia has been interpreted through the written documents of their neighbors, such as China and Persia. The origin of these states, the identities of their citizens, and how were they organized are still mysterious, as they did not leave behind written documents. The results of previous archaeological investigations in the region (Mongolia, Kazakhstan, northern China, and Siberia) were not widely accessible because they were published in Russian and Chinese. Presently, multiple international collaborations (with scholars from Germany, France, Russia, Japan, Korea, China, and the United States) have contributed to our growing knowledge of this region.

Evidence for large-scale organized nomadic populations in Mongolia started from the late Bronze Age (1300–400 BC). The Xiongnu (209 BC–AD 93) are the first nomadic state documented by the Chinese, who built the Great Wall to unsuccessfully keep them out of China (Barfield 1989). Nomadic domination culminated in the Mongol Empire (AD 1206–1368) under Genghis Khan and his armies. At its largest extent, the empire covered 9.15 million square miles from Korea to Hungary and included an estimated 110 million citizens. The mechanism of complexity in nomadic society does not follow the trajectory of their agrarian neighbors (China, Korea, and Japan). China has developed a long and early history of a rigid hierarchical society controlled by clan lineages and imperial exams. Settlement patterns, military and governmental control of movement and resources, multiple layers of socioeconomic status, heritable wealth and status, and a small lineage-driven elite are evidenced through archaeological and written evidence for at least 4,000 years. The rise and maintenance of nomadic societies, in contrast to China, appears to have followed a different set of rules. The Central Asian nomadic pastoralists, while maintaining some social hierarchy, had a history of decentralized authority, ethnic and religious inclusiveness, and more fluidity through social-economic classes (Honeychurch 2014).

Nomadic societies may be inherently more egalitarian than agrarian societies. Nomadic pastoralists must have intimate knowledge of their herd animals (horses, cattle, sheep, goats, and camels), the environment that provides their food, and the yearly seasonal conditions of the terrain. While personal wealth is defined by the size, composition, and quality of the animals in their herd, there are many equalizing factors, which restrict creating a large gap between the wealthy and the poor. Nomads must share access to seasonally suitable grassland and water. A reasonable herd size must be maintained for enough food to be available for animals to fatten up and survive the long, harsh winter, where temperatures regularly dip to -40°C. In order to assure the best pastureland for their herds, all nomadic families made a yearly migration from summer pasture to winter camp across communal lands (Chang 2012; Wright 2012).

The pattern of social-political development did not follow an expected linear trajectory of continuing complexity in Mongolia. This background of interdependence in a harsh landscape has created a unique blend of hierarchy and heterarchy among the succeeding nomadic states of Mongolia. Succeeding periods fluctuated in the level of governmental centralization and social stratification. Even in periods of heightened consolidation of power, ethnic and religious inclusion was practiced, with noticeable social mobility. This paper will review previous archaeological evidence for heterarchical organization in Mongolian nomadic states and explore new bioarchaeological evidence.

PREVIOUS EVIDENCE FOR HETERARCHY IN NOMADIC STATES IN MONGOLIA

Heterarchy can be defined as a lateral/horizontal ranking of differences or a circumstantial flexible hierarchy (Crumley 1995). So what are the conditions for a heterarchical state? White (1995) proposed several conditions in the examination of Bronze Age burials (2000–200 BC) in Thailand.

(1) No centralized economic control.
(2) No centralized military control.
(3) No centrally located small elite group.
(4) No settlement hierarchy.
(5) Variability in social differentiation from site to site, possibly representing multiple local cultures/ethnicities, not wealth or status.
(6) Evidence for a combination of personal achievement and ascribed status in burials. For instance, children with grave goods but adults with little differentiation.
(7) Cultural, linguistic, and ethnic diversity.
(8) No striking distinction between rich and poor burials. Grave goods are on a continuum of number of goods, not type of goods.
(9) Individually distinctive burials may be evidence that certain individuals provided specific services or technical abilities as opposed to a symbol of wealth.

BRONZE AGE (1800–600 BC)

During the Bronze Age in Mongolia, there were two distinctive burials traditions. In Western Mongolia, thousands of monumental stone mounds called *khirigsuurs*, stone fences, satellite smaller mounds, and deer stones appeared. The stone fences can be round or square, facing cardinal points. Khirigsuur complexes extend from Western Mongolia and overlap with Slab Grave burials in central Mongolia. It was originally assumed they were burial grounds like the kurgans of neighboring Kazakhstan. Kurgans have elaborate stone mounds on top of a burial chamber. These are elite burials with exotic goods and displays of wealth. The size of the kurgan is proportional to the importance of the individual buried underneath. Khirigsuurs only intermittently have a burial under or beside the main mound. These burials are sometimes only a partial body. There are no accompanying grave goods or food offerings. Therefore, khirigsuur complexes may not primarily function as burial grounds.

Wright (2011) proposes that khirigsuurs are evidence of social heterarchy, not hierarchy. Mongolia has a very monotonous landscape. Bronze Age Mongolia had a low population density with no previous history of territorial rulership. Exotic goods show long-distance trade and shifting alliances with neighboring populations. Khirigsuur complexes necessitated large and consistent organized labor. The placement of the main mound, fences, and satellite mounds were specific to the landscape. The size and elaboration of each khirigsuur complex was a representation of the site's importance to the community, not an individual's status. These monumental mounds were a gathering place for a sparse and spread-out population. These mounds reinforced social ties and the ability to organize labor. The small satellite mounds with buried horse-head offerings are evidence for repeated long-term use as memorial centers. The differences among khirigsuur sites show adjustments to the needs of that local community over time. In contrast to the hierarchical kurgan burials of Kazakhstan glorifying an individual, Mongolian khirigsuurs are a record of heterarchical social events. The purpose of a khirigsuur was to commemorate an important place and its relation to the local people, not the resting place for an elite individual.

XIONGNU (209 BC–AD 93)

The first nomadic empire in Mongolia was the Xiongnu (209 BC–AD 93). They were able to consolidate various tribes and conquer neighboring populations to their east, west, and north. The Chinese defended themselves by building the earliest version of the Great Wall. The Xiongnu broke through these defenses and extracted tribute from the Chinese in the form of silks, bronze mirrors, and imperial brides. They created a system of ranked clan lineages, hereditary leadership, and a centralized seat of economic and military power. While the ruling nobility was one homogeneous ethnicity, the population they ruled was heterogeneous (Barfield 1989). Xiongnu society was strictly hierarchical. The head of the group was the khan/king. Below the khan were several hereditary noble families, the non-Xiongnu nobility, commoners, and then non-Xiongnu commoners, including agriculturalists. This hierarchy is present in Xiongnu-period burials. While neighboring China had a state policy of assimilation of non-Chinese populations, the Xiongnu did not actively practice cultural assimilation (Kradin 2011). The Xiongnu buried in family and lineage groups. Some married couples were buried side by side but in separate coffins. In a few cemeteries, burials are centered on a focal male, although probably still along familial/clan lineages. Xiongnu burials traditionally align with the head at north and the feet pointing south (Yang 2011). Grave goods in these burials show a complicated social stratification, including bronze mirrors, iron arrowheads, bronze knives, horse equipment, silk and cotton clothes, wool rugs, animal bones, lacquerware, glassware, and wood boxes. Exotic objects provide evidence of long-distance trade from Syria, Bactria, Persia, Korea, and China (Atwood 2004).

XIANBEI (AD 93–234)

The Xianbei originated as a population from eastern Mongolia, Siberia, and northeast China (Manchuria). They may be descended from the Bronze Age Slab Grave burials in eastern Mongolia and Siberia (second to first millennium BC). They were defeated by the Xiongnu (third to second century BC) and incorporated into their empire. The Xianbei were nomadic pastoralists from forested regions, raised dogs and pigs, and practiced limited agriculture (Atwood 2004).

The Xianbei were organized as clans/tribes based on political, economic, cultural, and weakly familial lineages. Clan leaders were elected based on personal ability. The Xianbei did not use family names. Clan leaders organized communal building projects, the timing of animal shearing, and festivals/wedding/funerals, as well as settled disputes. In sharp contrast to the Xiongnu, the Xianbei maintained a heterarchical social organization (Kradin 2011).

The Xianbei (AD 93–234) were the first foreign dynasty in Mongolia. They incorporated some of the governmental organizations of the Xiongnu but never adopted centralized economic or military control. The fragmented leadership was able to organize raids on Xiongnu and Chinese settlements, establish long-distance trade relationships, and move large numbers of people across long distances. The Xianbei unsuccessfully tried to incorporate hereditary leadership, which was not supported by the majority of the population (Kradin 2011). The Xianbei were a fragmented confederacy, with the western branch (Tuoba Xianbei) incorporating Chinese cultural influences over time and the eastern branch (Murong Xianbei) absorbing Korean (Koguryo) cultural influences (Dien 2007). Burial customs of the Xianbei were distinct from the previous Xiongnu. Burials face east/west with the head west and the feet east. The Xianbei have multiple family members buried together within the same tomb (Dien 2007; Jian 2003; Yang 2011).

HUMAN SKELETAL RESEARCH

Central Asian nomadic states have incorporated multiple ethnicities since the Bronze Age (1300–400 BC). These populations maintained their distinctiveness over hundreds of years of interaction. The presence of several separate ethnicities supports that cultural differences can survive despite shared social and geographical spheres. Multiple cultures/ethnicities can maintain their distinctiveness within a larger polity (Barth 1969). In contrast to the required cultural assimilation throughout many periods in China, nomadic states in Mongolia have incorporated other cultures/ethnicities without requiring them to change their overall identities. Within some nomadic states through time (Bronze Age, Xianbei period, Mongol period), non-Mongolian ethnicities were not considered ranked lower than ethnic Mongolians. This tendency toward a heterarchical view of ethnicity has some support in the mortuary and human skeletal studies from Mongolia

Cranial metric traits were used to look at population continuity in Mongolia. Population continuity was found from the Bronze Age, Xiongnu, and Mongol to modern Mongolian populations (Tumen 2004). However, at the time of this study, no populations were included from the foreign dynasties, including the Xianbei. This is because the Mongolians have only recently started excavating archaeological sites dating to the foreign dynasties (the period between the Xiongnu to Mongol period). Earlier excavations were focused on finding populations ancestral to modern-day Mongolians. It was assumed these foreign dynasties did not contribute significantly to the modern Mongolian population. This is an interesting assumption considering foreign interaction and intermarriage has a long history in Mongolia.

Dental nonmetric traits were used to look at population affinities from six large geographic regions in China and Mongolia. Four large, distinct populations were detected that could be synonymous with ethnic/cultural groups. The first group consisted of European-derived populations from Central Asia (Western Mongolia and Xinjiang Province). The second group represented an ethnic Mongolian cluster of Xiongnu, Qidan, and Medieval Mongol samples. The third group centered in Inner Mongolia with Xianbei samples. The final group had three ethnically Chinese samples. This study demonstrates a biological distinction among Central Asian, Xiongnu, Xianbei, and Chinese population samples (Lee and Zhang 2011).

DNA studies support the fluid ethnic/cultural organization of nomadic states in Mongolia. Two studies on Xiongnu-period burials found that their cemeteries included Xiongnu and Turkic (European-derived Central Asian) individuals (Keyser-Tracqui, Crubezy, and Ludes 2003; Kim et al. 2010). A study of a Xianbei burial revealed they are related but still distinct from Xiongnu and Mongol samples (Li et al. 2018).

Finally, evidence from a Xianbei cemetery is presented. The Airgiin Gozgor archaeological site is located in Jargalant sum, Orkhon aimag, in north-central Mongolia. The cemetery has been radiocarbon dated to the Xiongnu–Xianbei transition (first to second century AD). The cemetery consists of ninety circular stone tombs built over underground wooden chambers. This overall construction is similar to Xiongnu burials. However, in contrast to Xiongnu burials, the Xianbei burials are all oriented east–west and contain several multiple individuals buried together in a single tomb. The cemetery is in a hidden location, surrounded by low mountain peaks, far from any source of water or habitation. A contemporary Xiongnu cemetery is located a few kilometers away. While all of the tombs look to have been looted in antiquity, grave goods indicate they had access to long-distance trade from China and Central Asia.

Although only ten burials have been excavated so far, this cemetery appears to be unique in Mongolia. This is the first cemetery excavated in Mongolia with multiple burials. In addition, several ethnicities are represented in the burials, based on grave goods, burial patterns, dental and cranial nonmetric/metric traits, and dental modification. It appears that Xianbei, Qidan, Turkic, and a previous unidentified ethnicity (with dental modification) are already present at Airgiin Gozgor. In addition, the multiple burials have been male/female and male/female/female. This is a change from previous and later periods, where individuals are buried separately. Many of these multiple burials may be married individuals buried together. This also may be evidence of the Uighur/Qidan practice where high-ranking women were required to accompany their husbands in death (Dien 2007).

Airgiin Gozgor possibly represents a heterarchical-organized Xianbei cemetery. At this time, no other excavated cemetery in Mongolia has such a variety of ethnicities represented. The individuals buried in this cemetery do not represent a familial or clan lineage. While immediate family members are buried in the same tomb, the tombs next to each other do not appear to be related family. In addition, the individuals buried together within a tomb may represent married individuals and therefore were not blood related (there is one exception). The purpose of this cemetery appears to be unique. The individuals buried at Airgiin Gozgor are somehow connected and ranked by some unknown commonality. How are these individuals connected when they differ in ethnicity, culture, and language? I posit that this may be evidence of a nomadic state's heterarchy ranking system in death. Some possible avenues to explore are whether they are related by occupation, service, or religion.

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Bioarchaeological Approaches to Understanding Conflict and Collaboration: The Circulation of Violence as a Heterarchical Structure

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By reconfiguring the human body from a malleable form acted on by monolithic forces to an agentive instrument, the emerging bioarchaeology of cooperation can help us understand how bodies respond to and perpetuate multiple, overlapping kinds of power imbalances. In the past decade, archaeologists have focused on understanding how our human past has been shaped not only by conflict and competition but also by the complementary processes of collaboration, cooperation, and consensus building (DeMarrais 2013; DeMarrais and Earle 2017). Among the bottom-up approaches that shed light on the multiplicity of power inequalities in communities, the concepts of heterarchy and anarchy, as summarized by Juengst (this forum), illustrate how multiple forms of inequality are simultaneously at play in decentralized societies (organized along gender, age, occupation, or other social identities and practices). Heterarchical and anarchical organizations promote communal benefit, within and between neighboring groups, even as socially differentiated actors carry out specialized roles to benefit corporate welfare. Importantly, as Juengst notes, heterarchy need not preclude hierarchy, but these forms of organization can flux back and forth, coexist, or play out at various scales. Recently, social bioarchaeologists have critiqued skeletal data in light of these nonhierarchical models, reevaluating biological markers for physiological health, nutrition, and violence as embodied by historically contingent power and the identities that they negotiate throughout diffuse and intricately interwoven social systems (see contributions in Klaus, Harvey, and Cohen 2017).

The bioarchaeology of violence is subject to reconfiguration under these new theoretical paradigms. Myriad studies link high rates of skeletal trauma to increasing sociopolitical complexity, often characterized as a ruling class sanctioned to perform violence and an underclass of bodies receiving violence. While recognizing the incredible power of violent interactions to change drastically social positions and health outcomes, we must also consider violent action as a tool for (re)negotiating ritual, socioeconomic, and sociopolitical power. The losers of a violent encounter might become a permanent underclass, but they are equally as likely to revolt, launch revenge attacks, or migrate away from areas of endemic violence. We are unable to determine from wound characteristics whether the injured won or lost the encounter, how many encounters they were involved in during their lifetime, or whether those encounters led to or arose from a life of tortured servitude, a glorious military career, or (as was probably often the case) social identities that were constantly transformed throughout life. Agent-focused interpretations based on empirical bioarchaeological data from discrete life course phases enable us to consider possible life trajectories leading up to and following a violent event, rather than prescribing fixed outcomes that place the victims of violence in a permanent underclass. I argue here that violence, even when carried out by a hierarchically dominant subgroup of skilled combatants, is a powerful way to enact communal and regional agency. Violent practices can create highly visible linkages between communities that can help achieve shared goals and cosmological balance diffused within regional networks of power.

Nonhierarchical power conceptualizations enable us to understand how violence, an often disjunctive force, can be generative; indeed, it can facilitate social harmony and level imbalances between and within groups. For example, DeMarrais and Earle (2017, 189) emphasize the collective solidarity required to organize violence—how "volunteeristic communities operated as corporate groups led by warriors." Raiding for human and material capital enhanced social status for successful individual combatants, but the organization and execution of a raid would have required community buy-in and long-term planning—that is, it takes a village to raise an army (or a militia). Households needed contingency plans for defense, agricultural productivity, child-rearing, and political, economic, and ritual continuity in the event important combatants or leaders never came home. Decimated communities had to be prepared to handle the cosmological significance of loss and the negative consequences to agricultural fertility and the balance of spiritual power. Victor communities needed to be prepared to carry out the ritual and logistical responsibilities of winning—planning for increased population size as captives were integrated into the community or for the rituals needed to mitigate the spiritual power of enemy dead (Scaffidi, in press).

In addition to exploring the cooperation inherent in the pursuit of violent collective action, we must consider how the motivations of violence are not always purely

competitive. As Nielsen (2009, 220) argues, violence is never merely a "mechanical response to environmental stress" or "an aggrandizing strategy implemented by war leaders alone in a cultural and social vacuum." Instead, violence is an elaborate performance made meaningful by the historically contingent and local circumstances that inform how those who enact, suffer, and perceive violent acts interpret those acts (Scaffidi and Tung 2020; Whitehead 2007). Violence, whether blows between living combatants or the violent dismemberment and defleshing of the decapitated head of a trophy-taker's opponent, can simultaneously function to order and reframe relationships between community members and between communities.

In Andean worldviews, violence between communities can be a means to achieving cosmological balance and social balance rather than merely fighting over access to resources. For example, the practice of *tinku* (or *tinkuy*), festive combat between communities or their representatives, is a type of ritual battle that allows communities to resolve conflicts among the living while also restoring agricultural fertility, regenerating the earth, and promoting the prestige of combatants. Tinku is ideologically related to the union of complementary things, particularly when that union is generative—the union of rivers, the coming together of masculine and feminine, or the coming together of opposing communities in violent battle to spill blood for *pachamama*, or mother earth (see summary in Topic and Topic 2009). Death and bloodshed are the goals of this ritual combat, but they are celebrated as divine acts beyond human agency (Topic and Topic 2009). In addition to tinku, sacrifice and violent decapitation or trophy-taking are types of ritual killing practiced throughout the pre-Hispanic Andes (see, among others, contributions in Klaus and Toyne 2016). While bioarchaeologists cannot determine the precise events that led to human sacrifice or decapitation, the physical conflicts that led to ritual killing and cycles of attack, retreat, and revenge attacks between communities over the years were certainly part of the continuum of ritual violence carried out between ancient groups.

Andeanists often differentiate between ritual and "actual" warfare in pre-Hispanic and ethnohistoric contexts. For example, Platt (2009, 1986) distinguishes the balanced violence of tinku from *ch'ajwa*, a destructive, disordered type of violence that takes place beyond the tightly prescribed rules of tinku. However, Topic and Topic (2009) analyze the linguistic history of these seemingly opposing terms, arguing that they may reflect a false dichotomy between ritual and "actual" war left over from Spanish colonial misinterpretations. It is important to note that both forms of violence were often deadly, and both were probably bound by ritual prescriptions as to appropriate places, times of year, and performance by specialized combatants for specific audiences, and fulfilled specific cosmological and logistical goals. Both tinku and intergroup raiding or warfare fulfilled cosmological and social objectives simultaneously—indeed, modern tinku may be a vestige of pre-Hispanic warfare. Whether ritual or "real," and regardless of whether those categories would have been meaningful for ancient people, intergroup violence was clearly a powerful force ordering social power between and within Andean communities.

FOREIGN EXCHANGE AS HETERARCHY IN THE ANCIENT ANDES

The concept of heterarchy is useful in thinking about the multiple scales at which violence can structure social relationships and how those multiple scales are visible skeletally. The heterarchy framework is particularly well suited to examine how power imbalances are enabled by the circulation of relationships and objects through "nodes, links, and networks" (Crumley 1995; Crumley 2007, 30). Long-distance trade involves a limited network of travelers—priests, pilgrims, traders, wives, or warriors—that accumulate geographic, cultural, and magico-spiritual knowledge of other places through their travels (Helms 2014). In the pre-Hispanic Andes, the exchange of high-status objects over long distances through complex webs of camelid caravans is often attributed as a factor in emergent sociopolitical complexity (Nielsen 2013). Ritual interaction with distant or nonlocal landscapes, foreign traditions, and access to exotic objects may have connected these travelers in nonhierarchical webs of sociopolitical, economic, and ritual power, intricately and strategically woven throughout the region.

By referencing this kind of specialized knowledge over distant places unseen by most in a community, portable objects have the unique ability to reference and relate people and landscapes. As DeMarrais puts it, "objects situate people within social networks, materializing collective relationships across time and space" (2013, 349). The creation, exchange, and personalization of crafts are a way for individuals to participate in "social projects" that reinforce social relationships and identity within and between communities (DeMarrais 2013). In heterarchical systems, then, we expect to find highly individualized and expedient handicrafts as material expressions of diffuse forms of power and agency negotiated through expressive idiosyncratic production (DeMarrais 2013).

In the remainder of this essay, I consider the mobilization of combatants and the exchange of violently crafted, portable body parts like trophy heads as heterarchical forces. I briefly describe an example of a small-scale and possibly heterarchical society in the Lower Majes Valley of Arequipa, Peru. I argue that giving and receiving traumatic injuries and the taking, making, and circulation of trophy heads structured intergroup and intragroup status inequalities within communities and throughout the Majes and neighboring valleys.

STATUS AND THE CIRCULATION OF VIOLENCE AROUND THE MAJES VALLEY

The cemetery of Uraca represents a mortuary population that was organized around the performance of violence and violent ritual. The cemetery is located on a visually

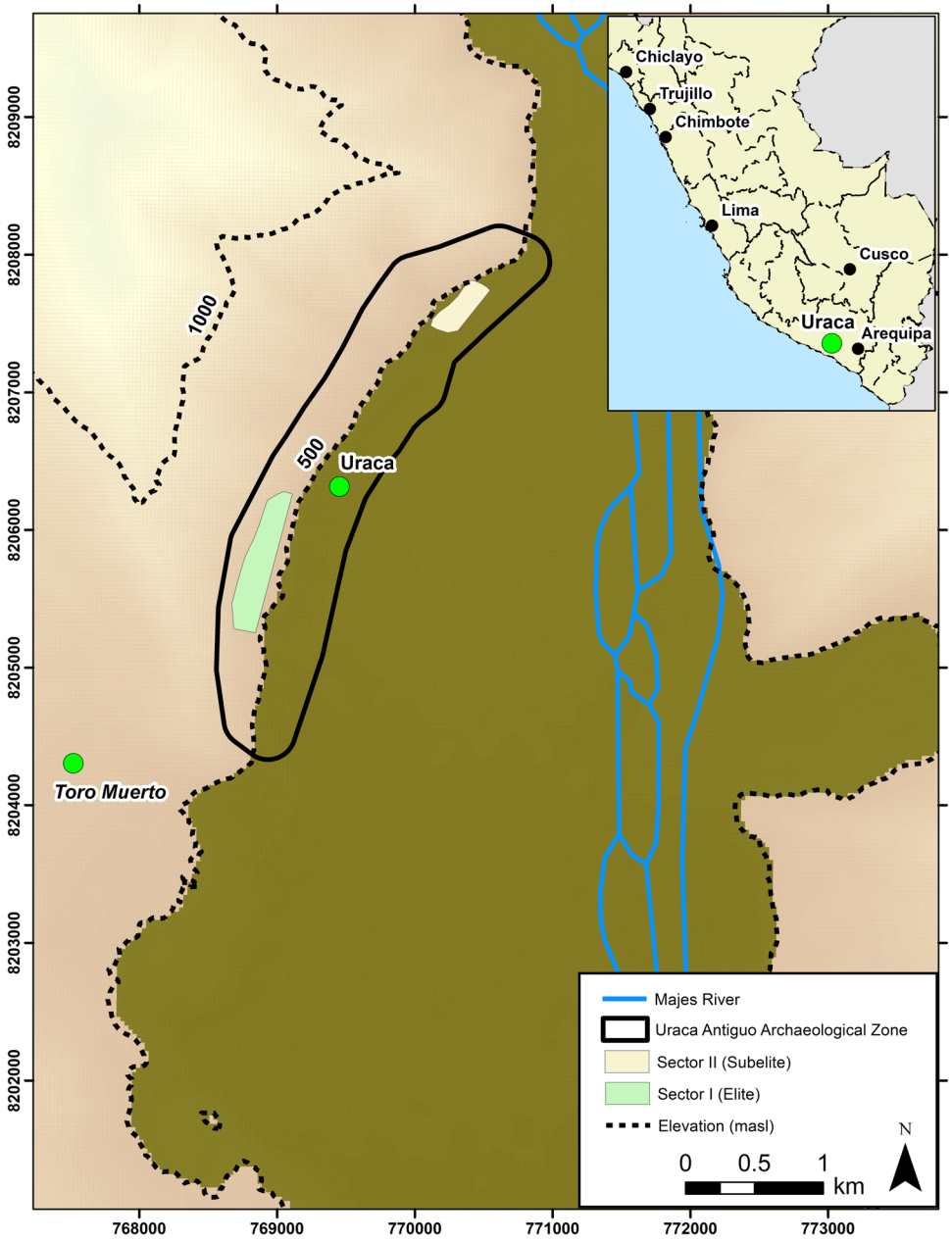


FIGURE 1. *Uraca and its two sectors relative to Toro Muerto in the Lower Majes Valley of Arequipa, Peru (inset map: site location relative to modern-day cities in Peru). [This figure appears in color in the online issue]*

prominent bluff beside a petroglyph shrine called Toro Muerto—a critical juncture in pre-Hispanic road networks (Scaffidi 2018)—that contains multiple carvings documenting violent warfare and death ritual involving decapitated human heads (Scaffidi, in press; Scaffidi and Tung 2020). Uraca dates to the Early Intermediate Period (ca. 200–650 CE) and the first half of the Middle Horizon (ca. 600–750 CE), situating the burial population to before and during the era of initial Wari imperial diffusion from its heartland in modern-day Ayacucho. There are no preserved domestic dwellings, communal plazas, or centralized administrative units, leading me to categorize the burial population as a small-scale society (Scaffidi 2018).

Key differences in the artifact assemblage between the two contemporaneous burial sectors at Uraca (Figure 1) imply the existence of combat-based social differentiation within the community. For example, the elite sector has the greatest viewshed (Fig. 2), the finest and most diverse grave goods, the only evidence for foreign-influenced artifacts, and the only evidence of musical instruments and camelid sacrifices used in mortuary ritual (Scaffidi 2018). The subelite sector contains a lower-quality viewshed (Figure 2), more utilitarian and local forms of ceramic vessels and textiles, and hundreds of stone *placas pintadas*, or painted stone slabs, characteristic of local burial traditions in Arequipa (Scaffidi 2018). Both sectors produced human trophy heads (defined



FIGURE 2. *View from Sector I (elite) to the southeast (left) compared to the view of valley-bottom thickets from Sector II (subelite) to the northeast (right). (Photographs by Beth Scaffidi) [This figure appears in color in the online issue]*

in the Uraca studies as decapitated enemy heads drilled with a hole for display, defleshed, and used in ritual), but the quantity (nine trophy heads and four isolated mandibles with cut marks) and diversity of styles was greatest in the elite sector (Scaffidi 2018, in press). The subelite sector produced three similarly styled human trophy heads, two isolated mandibles with cut marks, and the stuffed trophy head, and four paws of a pampas cat (Scaffid, in press). The number of trophy heads relative to the non-trophy heads recovered was relatively high: 11.5 percent, or 18 of the 157 crania recovered, were trophies. Assuming the heads were taken from enemy groups, this proportion represents a significant investment of labor in capturing enemy heads relative to the size of the burial community.

Differences in social status, as inferred from burial-ground and grave-good differentiation, did not lead to differences in physiological health between the sectors. Physiological health, as reflected by cribrotic lesions, was similar between the elite and subelite burial sectors—around 30 percent of individuals present cribra orbitalia at each sector, and overall (Scaffidi 2018). This is similar to other sites in the valley, and indeed, to neighboring valleys and to geographically and hydrologically similar valleys throughout the Andes (Scaffidi 2019). This suggests that whatever social differentiation was present in the community did not lead to markedly distinct health outcomes or nutritional disparities, at least among subadult members of the community.

Instead, burial differentiation was related to masculine identity and the propensity for enacting violence and being attacked rather than any inherited status. Violence-related injury was pervasive for adult males and females from both burial sectors. Overall, 70 percent of the non-trophy head adults ($n = 100$) buried at Uraca present either antemortem (sublethal) or perimortem (lethal) cranial trauma, proving that physically violent encounters were pervasive for the individuals buried there (Scaffidi 2018; Scaffidi and Tung 2020). This is the highest crania-trauma rate reported so far for contemporaneous or partially contemporaneous skeletal samples throughout the Andes (Scaffidi and Tung 2020). The locational distribution of cranial wounds is mostly on the anterior, but is also distributed about the lateral, superior, and posterior cranial vault bones. This, combined with the fact that 60 percent of the injured show multiple (possibly recidivistic) wounds, suggests Uracans were injured in a variety of repeated violent conflicts (Scaffidi and Tung 2020).

While the overall violence-related trauma rate is extraordinarily high, the intensity of injuries was more severe for males buried in the elite sector. For example, perimortem injuries and complex posttraumatic sequelae (e.g., infection, injuries penetrating the internal cranial vault, and nonunion of bones) were exclusively documented in male crania from the elite sector. This, coupled with the preferential burial of adult males there (Scaffidi 2018; Scaffidi and Tung 2020), suggests that social hierarchization at Uraca was bound by violent propensities—it divided individuals between those who were at risk for deadly violence and successfully collected trophy heads and those who had a lower risk for fatal encounters and collected fewer trophies. That said, it is informative that the even in the lower-status sector, trophy heads were interred with burials. Perhaps individuals buried in this sector collected heads as a means of social ascension. At the subelite sector, Uraca trophy hunters may have resorted to decapitating a wild pampas cat as a substitute when a human victim could not be obtained. Based on the intensity and lethality of injuries on elite-sector males, the locational distribution of cranial wounds, and rate of multiple injury, I argued that injured individuals gained social status incrementally throughout their lifetimes by participating in cycles of raiding and small-scale warfare against enemies (Scaffidi and Tung 2020)—individual male combatant status within their group and communal status within the region was constantly in flux depending on the sociopolitical and ritual outcomes of cyclical intergroup violence (Scaffidi 2018). Depending on the social and environmental circumstances, this violence could have played out at various ends of the spectrum between ritual tinku or more disorganized and less rule-bound intergroup warfare.

The paucity of foreign trade items in the artifact assemblage at Uraca paints a picture of an insular community during a time of endemic violence—Uracans seem to have limited their engagement with outside communities to raiding for heads and other prestige items. Despite the community's location along key transportation routes in Arequipa and its proximity to the petroglyph shrine at Toro Muerto, the limited evidence for distant Wari or Nasca prestige items comes a few of the elite-sector tomb, much like the Kayenta who lived in the backwater of Mesa Verde in the US southwest (Ralston and Martin, this forum). Uraca may have been successful due to their limited engagement with foreign power structures and reliance on their own flexible power structures and regional connectivity. Unlike the Kayenta, Uraca's regional connections were based on reciprocal acts of performing, enacting, and succumbing to violence. This circulation of violently affected bodies and violence-effecting bodies was likely the primary driver of individual and communal differentiation. Burying the most violently affected male combatants along the most visually prominent bluff in the valley, with visual linkages to the shrine at Toro Muerto, would have memorialized their collective violent power along a ritually charged landscape. Much like the communal *khirigsuur* complexes of Mongolia described by Lee (this forum), the Uraca elite-sector burial ground and its trophy head interments may have marked communal status along the landscape by celebrating the cumulative achievements of valorized ancestors rather than memorializing the exploits of certain individuals.

Finally, when examined through the lens of a heterarchically structured social crafting project (DeMarrais 2013), the idiosyncratic variation in the Uraca trophy heads (Scaffidi, in press) suggests a highly personalized and urgent engagement with decapitated heads. This highlights how every individual battle, every blow, each of the cervical vertebrae cleaved from occipital bone, and every careful pick of the flesh away from bone would have been a performative, deeply culturally charged, and conscious choice—simultaneously restoring cosmological balance while dividing the Uraca group between those who could carry out this violent prescription and those who could only view it. The extraordinary cranial trauma rate, the pervasiveness of repeat injuries, and the practice of trophy taking suggest violence was instrumental in establishing and negotiating the social order among Uracans and between Uraca and its neighbors. The exchange of heads and blows between Uraca and neighboring communities was the basis for an imminently unstable, precarious power structure, expressed through the bodies of those who participated in this fearsome tangle of violence. Uraca's propensity for violence may have contributed to anarchical aspects of organization as they resisted domination by outside groups, even as Wari imperial influence spread throughout Arequipa.

CONCLUSION

In sum, I considered how the bioarchaeology of violence might engage with the bioarchaeology of cooperation vis-à-vis the concept of heterarchy. Drawing on skeletal evidence for violence-related trauma and trophy taking, I suggested that physical violence and the circulation of human trophy heads were heterarchical structures that ordered relationships between elites and subelites and distant communities in this stateless society living at the dawn of the Wari Empire.

As Crumley and others in this forum conclude, considering how diffuse forms of social power might impact (and be impacted by) skeletal bodies are essential if we are to give voice to the dead and understand how violence impacted their lives. Given rapidly increasing access to specialized analytical techniques, we can explore agency and constraint throughout lifetimes in ways never possible before. Life course approaches and the use of multiple lines of empirical evidence are necessary for developing narratives of life circumstances as they changed along with violent events. Collaborative bioarchaeology is more important than ever. Contextualized, holistic studies of skeletal samples at the site level are infinitely enhanced by regional comparisons and meta-analytical approaches.

Within the landscape of these rapidly accelerating technical advances in bioarchaeology, heterarchical approaches to violence can help us appreciate the ephemeral impacts of violence in some cases, as well as the durable health and social status outcomes that arise out of violence in other cases. Ultimately, I hope this will help us deconstruct the trope of violence as a natural and necessary tool of state systems; perhaps states need not make war, and viceversa (Cohen 1984). In this time of pervasive social inequality and the socioeconomic stress of the 2020 pandemic, the bioarchaeology of cooperation can highlight how communities can cooperate within hierarchical, heterarchical, and anarchical systems to improve health outcomes and security for all.

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Working, Living, and Dying Together: Rethinking Marginality, Sex, and Heterarchy in Kayenta Communities (AD 900–1150)

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> What is most powerful about the concept of heterarchy is its indeterminacy, its potential, its sense of movement carried to all dimensions.
>
> —Crumley (1987, 161)

Remote and environmentally marginal, the Kayenta region in northeastern Arizona was often described as a "provincial backwater" when compared to the more architecturally impressive ceremonial and political centers surrounding it (circa AD 900–1200) (Gumerman, Westfall, and Reed 1972, 198; Martin 2019). These include Mesa Verde and its complex of ancient cliff dwellings to the northeast, and Chaco Canyon, with its multistoried great houses, to the southeast. Both exhibit evidence for hierarchical systems of trade, governance, and decision-making that generated inequalities between localities and social groups by sex, age, and status (e.g., Harrod 2017; Martin, Harrod, and Fields 2010).

Archaeologists have described the Kayenta people as both culturally and geographically isolated from their contemporaries at Chaco Canyon and Mesa Verde due to the paucity of exotic trade items and the absence of large and dense political centers in the Kayenta region. The Kayenta region also lacks evidence of raiding and small-scale warfare, both of which characterize settlements at both Mesa Verde and Chaco Canyon (Gumerman, Westfall, and Reed

1972; LeBlanc 1999). For instance, there is no defensive architecture, no strategically placed towers, no palisades, and no communities placed in inaccessible areas at Kayenta, all of which are noted at in the other regions (Gumerman 1988; LeBlanc 1999). However, while the archeological evidence for interactions with people outside their homelands is limited, there is compelling evidence that the Kayenta people were interconnected and integrated through locally focused exchange networks and communal rituals (Hegmon 1986).

The archaeological and bioarchaeological evidence described here supports the hypothesis that communities occupying this remote region are best described as heterarchical. Heterarchy, as it is variously defined by Crumley (1987, 1995) and others, is a useful concept for thinking about the organizational diversity of social groups like those at Kayenta. Here, there is a model of social organization that is not based on enforced codes of conduct that leave little room for innovation or flexibility. We argue that the archaeological and bioarchaeological data suggest the Kayenta relied on a different, more flexible, and egalitarian social model of interaction than their neighbors and that they succeeded in a harsh desert environment as agriculturalists precisely because they remained flexible, inventive, and unified across the region.

The concept of heterarchy, as it is understood in this forum (see Juengst), allows for the possibility that hierarchical and egalitarian relationships can coexist simultaneously in a single social arrangement and fluctuate in relation to one another depending on the needs of the social group at any given time. Furthermore, the potentiality for elements of a social structure to be ranked in different ways indicates that heterarchical structures allow for flexibility in the decision-making systems of a group to respond to shifting circumstances, such as resource shortages or conflict. The combined bioarchaeological and archaeological data reveal multiple lines of evidence supporting heterarchy at Kayenta. By intentionally crafting adaptable networks and flexible cooperatives, Kayenta communities thrived when they could have been suffering and fighting over resources.

This study reevaluates two general indicators of well-being that include an assessment of overall health and robusticity. Drawing on the relatively large skeletal population from Black Mesa, in the heartland of the Kayenta region, the skeletal data evaluated here reflect analyses completed by Martin and colleagues (1991) and additional studies conducted prior to repatriation of the remains in 2018. The skeletal data is derived from 169 individuals represented by 90 adults (38 males, 51 females, 1 undetermined adult) and 79 nonadults. Attention was paid to nutritional indicators of inadequate diet, including porotic hyperostosis (PH) and cribra orbitalia (CO), and their synergy with poor health (e.g., Walker et al. 2009) and metric observations of relative muscularity and robusticity (Martin et al. 1991; St. Hoyme and İşcan 1989). The presence and/or absence of these skeletal markers were evaluated to identify the percentage of individuals at risk for poor nutritional health and greater workload (Martin 2000). The analyses presented here are confined to the adult portion of the population to evaluate the nature of physiological stress among individuals habitually involved in subsistence and other life-sustaining activities.

Not all individuals evaluated in this study could be scored for the presence of PH or CO due to issues of preservation and/or missing skeletal elements. Of the adults that could be scored, the sample frequency for PH was 95 percent (58/61) (Table 1), and the sample frequency for CO was 42 percent (20/48) (Table 2). However, nearly all of the cases of PH (89 percent) and a large number of the cases of CO (35 percent) were mild in expression, indicating that *low-level* but persistent dietary inadequacies and disease stress were part of daily life among the Black Mesa Kayenta (Table 1 and Table 2). The data also indicate that dietary and disease stress were experienced in nearly equal measure by both males and females, with 96 percent of males and 94 percent of females exhibiting PH lesions and 41 percent of males and 44 percent of females exhibiting CO lesions, respectively (Table 1 and Table 2). The ubiquity of porotic hyperostosis across the Southwest was noted by Walker (1985, 153), who observed that "the remarkable prevalence of osseous lesions … resulted from the interaction of a complex set of biological and cultural variables relating to nutrition and infectious disease." Therefore, it is not surprising that PH was observed in nearly every adult, but it is notable that in almost every case its expression was scored as mild. This suggests that the etiological processes producing the lesions were not pervasive or debilitating, even though they were prevalent.

Comparing the total sample frequencies of PH prevalence with those of Mesa Verde (45 percent) and Chaco Canyon (65 percent) (see Martin et al. 1991, 162), Kayenta groups demonstrate evidence of high levels of dietary inadequacies and disease stress consistent with a subsistence economy based on marginal desert agriculture and semisedentary lifestyles. However, the expression of PH at Black Mesa as noted is predominantly mild across the adult age categories, whereas the cases at Mesa Verde and Chaco Canyon were more severe in expression (see Harrod 2017, 107–8; Martin et al. 1991, 162). This indicates that although mild dietary and disease stress was a part of daily life at Black Mesa, it was not a major source of suffering as it likely was in neighboring regions.

Robusticity indices previously published by Martin et al. (1991) indicate that there are no statistically significant differences between adult males and females in terms of muscularity and robustness of the long bones of the legs and arms (Figure 1). Martin and colleagues also examined other aspects of muscularity and consistently found that "males and females were indistinguishable in all measures of robusticity, strength, and muscularity" (Martin 2000, 282). This suggests that females were participating in equally strenuous tasks as males in their daily work activities.

TABLE 1. *Frequencies of Porotic Hyperostosis (PH) for Males and Females*

Porotic Hyperostosis (Adults)	Males (n = 28)	Females (n = 32)	Indeterminate (n = 1)	Total (n = 61)
Not Present	4%	6%	0%	5%
Mild	89%	88%	100%	89%
Moderate–Severe	7%	6%	0%	6%
Total % PH Present by Sex	96%	94%		
Total Adult Sample Frequency: 95%				

TABLE 2. *Frequencies of Cribra Orbitalia (CO) for Males and Females*

Cribra Orbitalia (Adults)	Males (n = 22)	Females (n = 25)	Indeterminate (n = 1)	Total (n = 48)
Not Present	59%	56%	100%	58%
Mild	32%	40%	0%	35%
Moderate–Severe	9%	4%	0%	6%
Total % CO Present by Sex	41%	44%		
Total Adult Sample Frequency: 42%				

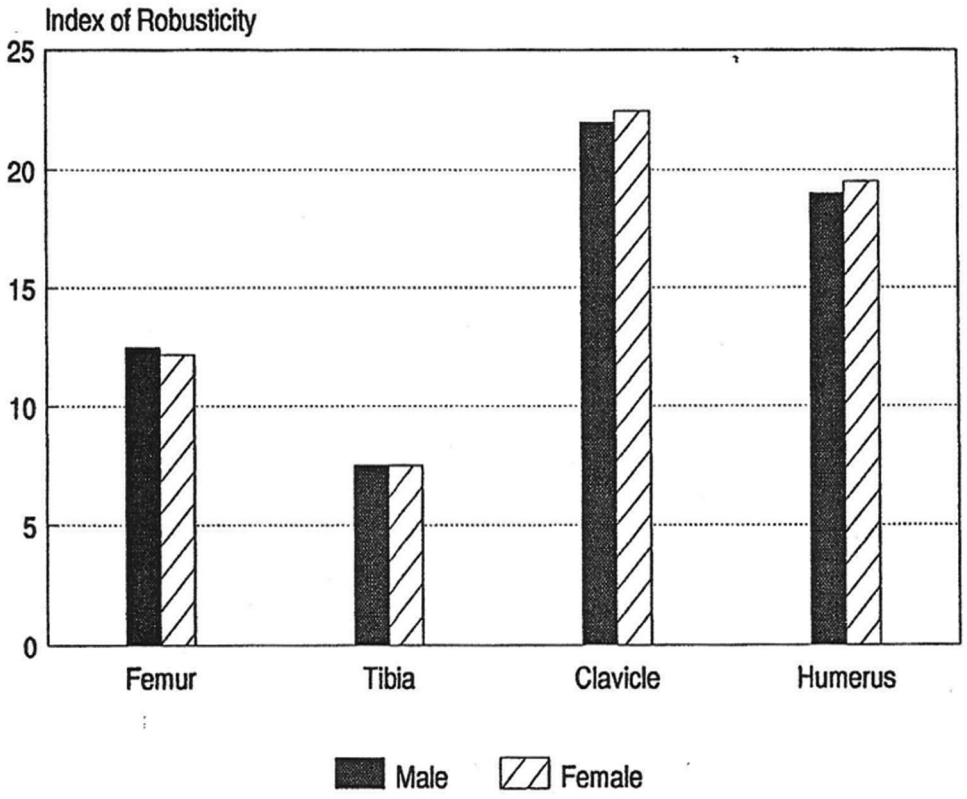


FIGURE 1. *Indices of robusticity by sex. (Source: Table 9–3, Martin et al. [1991, 94])*

When contextualized, these selected skeletal markers provide information on the daily stresses that people were exposed to. Black Mesa is located in the mountainous upland areas of northeastern Arizona, where being an agriculturalist would have been difficult. Unpredictable and variable rainfall, short growing seasons, early and late frosts, and patchy distributions of wild plants and animals meant that food resources were challenging to coordinate and there was a high risk for crop failure and shortages (Gumerman 1988). These factors may explain the ubiquity of nutritional indicators of

stress. However, demographic data shows that despite these challenges, population size continued to increase within the Kayenta region between AD 900 and 1150. However, this growth was not due to immigration from other regions but largely to increases in fertility over time (Euler 1988, 195–97).

Population growth and viability were robust because Kayenta groups practiced a mixed subsistence economy that combined farming with gathering and hunting in order to maximize the use of scarce resources and minimize risk (Geib 2011, 394–85; Hegmon 1986). Diverse social strategies are supported by evidence of an emphasis on storage facilities in some communities and exchange networks in others (Gumerman 1988). People lived in dispersed, semipermanent settlements composed of nuclear and extended households that were interconnected through trading, networking, and shared ceremonial spaces (Hegmon 1986). Although agricultural, these groups were also seasonally mobile, living in small hamlets part of the year and aggregating into larger communities situated around ceremonial structures other parts of the year (Hegmon 1986). During these periods of aggregation, there was likely an exchange of information, a redistribution of resources, trade, and engagement in ceremonial rituals. The stylistic consistencies in distinctive Kayenta ceramic vessels and design elements across the Kayenta region throughout its occupation suggest a well-integrated social network within and between settlements that may have emphasized and supported a strong local identity among the dispersed Kayenta communities that was reaffirmed with ceremonial rituals and feasting events (Haas 2001; Lyons 2013; Spielmann 2004).

This flexible social strategy would have reduced the risks for food shortages while maintaining strong social networks that could be called upon to redistribute food to kin groups in need. In addition, Kayenta-made pottery is found in neighboring regions, such as Mesa Verde and Chaco Canyon, indicating some interaction with these regions occurred (Dean 2002, 129). However, there is very little evidence of extralocal pottery or exotic trade items from Chaco Canyon, Mesa Verde, or any other region at Kayenta (Dean 2002). It is likely, therefore, that the Kayenta internally exchanged their locally made ceramics, while preferentially trading these same ceramics for information, food, and possibly for mates with external regions, rather than for extralocal pottery or exotic trade items.

These archaeological data are supported by biodistance and mtDNA analyses demonstrating the genetic relatedness of Kayenta with other neighboring Ancestral Puebloan groups, including those living at Mesa Verde and Chaco Canyon (Barbian 1991; Carlyle et al. 2000; Corruccini, 1972). Martin (2019) posits that these data collectively suggest that the Kayenta were not endogamous or insular but rather that they were intentionally selective about the nature and extent of their interaction with social groups outside their region (i.e., with Mesa Verde and Chaco Canyon). In other words, the Kayenta remained geographically and socially marginalized by choice, opting not to buy in to the rigid hierarchical social activities of their neighbors in favor of the flexibility afforded to them by more horizontal (i.e., heterarchical) arrangements of decision-making strategies and distributions of labor, resources, and social power. Therefore, heterarchical social arrangements can be seen as an alternative strategy by which groups, like the Kayenta, were able to be successful in marginal environments and resist the centralization of authority and social coercion observed in contemporaneous neighboring groups (see Angelbeck, Borck, and Sanger 2018).

While it is easy to assume that groups organized according to heterarchical principles are automatically egalitarian and predicated on social systems emphasizing cooperation and consensus because of the decentralized nature of social relations, it should be noted that the concept of heterarchy does not automatically imply universal equality or cooperation in a social arrangement. Rather, the decentralized nature of social relations characterizing heterarchical systems *permits* cooperative strategies to be selected and implemented according to the systemic requirements of a social group as they respond to external and internal stressors (e.g., Crumley 1987, 1995). However, in this case multiple lines of evidence suggest Kayenta communities consciously crafted a largely egalitarian and cooperative lifeway composed of interconnected communities, which drew upon themselves and their local resources in innovative ways (Dean 2002; Geib 2011, 394–85). Without the constraint of rigid and hierarchical social structures, the Kayenta benefitted from a flexible social system that enabled them to organize, dissolve, and reconfigure communities in different ways in response to changing circumstances (Dean and Clark 2013, 22–23).

The settlement arrangement of dispersed hamlets around a centrally located communal pit structure and the internal exchange of locally made ceramics is consistent with the archaeological evidence of consensus-based social systems and coalitions discussed by DeMarrais (2016). This arrangement would have facilitated the exchange of information and resources as well as participation in consensus-based decision-making processes. Additionally, this strategy afforded the Kayenta a remarkable amount of flexibility to respond to a diverse range of environmental, social, and political opportunities and challenges (Dean and Clark 2013, 22–23).

The comparable distribution of skeletal indicators of stress between adult age and sex groups among Black Mesa individuals also suggests a unique form of heterarchy foundational to the Kayenta people. Porotic hyperostosis and cribra orbitalia were ubiquitous and endemic to the adult population, but they were predominantly mild in expression and affected both adult males and females equally. This likely included low to moderate nutritional stress and constant exposure to low-level parasitic and communicable disease. The robusticity data show that both males and females equally engaged in regular strenuous activities. Collectively, these data indicate food resources, disease load, and labor responsibil-

ities were equally distributed between adult males and females, suggesting communities organized in equitable social structures.

Conclusion

The combined archaeological and bioarchaeological data indicate that Kayenta social practices were based on egalitarian structures and cooperative networks. However, what best explains this island of heterarchy in a sea of hierarchies? Giddens's (1984) notion of ontological security describes the collective sense of security stemming from an impression of order and continuity created by familiar and predictable experiences in one's daily life. Giddens (1984) argues that this sense of security arises from strategies emphasizing consensus and collaboration to mitigate unpredictable effects, especially in marginal and challenging environments. Based on this notion, we argue that by focusing inward and developing a heterarchical social structure based on equity, the Kayenta communities put their faith in innovation, flexible social processes, and collaboration to mitigate the unpredictability of the marginal environment they occupied.

These strategies likely reduced the risks of living in a marginal environment by offering these groups the flexibility to innovate and adapt as needed to fluctuations in resource availability and distribution. Thus, while Kayenta settlements were originally thought to be the poor struggling cousins to their more resource-rich, powerful, and stratified neighbors to the north and east (Gumerman 1988), it is apparent that Kayenta communities were better equipped to respond to and survive periodic droughts, climate changes, and resource unpredictability when compared to the higher morbidity burdens evident at the larger centralized communities outside of Kayenta (Martin 2019). By intentionally embracing their marginalized existence and engaging in a flexible and nonrigid heterarchical social structure predicated on cooperation and collaboration, Kayenta communities experienced better overall health outcomes.

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Why Heterarchy? A View from the Tiwanaku State's (AD 500–1100) Labor Force

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Throughout the past and present world, people have congregated to form complex societies. Descriptions often skew toward a centralized hierarchical model with assumptions of an overarching ruling class. This linearly oriented system translated into early assumptions that civilizations form out of smaller foraging bands, then into semi-sedentary tribes, further into chiefdoms with a ruler chief, and finally into complex states as a *fait accompli* (e.g., Carneiro 1970; Service 1975). However, Crumley noted (1995, 3) that researchers looked for alternatives to the "traditional" or "classic" centralized hierarchical model of the state as a result of dissatisfaction with this systems-theory modeling.

Recent studies of ancient societies note that human organization may be predicated on a number of organizational techniques, like anarchy or heterarchy, that promote and reify complexity in nontraditional ways (for a longer review, see Juengst, this forum). For example, anarchical societal organization encourages egalitarian cooperation and collaboration, resisting authoritarian power as against community interest (Angelbeck, Borck, and Sanger 2018). Similarly, the term heterarchy comes out of early neural-networks studies that show the human brain functions in netlike, orderly associations, with occasional logical contradictions (McCulloch 1945).[1] Understanding these concepts from an archaeological perspective, heterarchical societies can be suited as a corrective to systems theory in that various elements (e.g., values, behaviors, and organization of people) over time and space can be unranked, ranked in a number of ways, and/or not permanently ranked (Crumley 1987, 1995, 2003, 2012)

Under what circumstances would heterarchical be emphasized over top-down, hierarchical configurations in state-level polities? My bioarchaeological research addresses this question by investigating the emergence of the precontact South American expansive state of Tiwanaku (AD 500–1100) (Figure 1). Tiwanaku was one of the earliest complex societies to develop in the Andes, with agricultural and pastoral settlements spanning both high- (3800 m a.s.l.) and lower-elevation regions (900–1500 m a.s.l.). My approach focuses on activity and labor and how labor organization influences and is influenced by social organization. My prior research shows that during the Tiwanaku state, labor inclined toward a shared, reciprocal, and heterarchical labor force over wide geographic areas (Becker 2017, 2019b). Adding to these data, I compare labor changes in the core over time using two skeletal indicators associated with human activity: osteoarthritis and entheseal changes. My results demonstrate that heterarchical reciprocal labor organization may have benefited Tiwanaku peoples by reducing overall labor load with the advent of this high-altitude state. Ancient Andean peoples founded this high-altitude complex society emphasizing labor reciprocity, and this type of shared workforce continues in modern Indigenous Andean populations. Thus, by evaluating activity and labor differences on the bodies of Tiwanaku individuals from a diachronic population perspective, I am able to provide explanations for why this culture may have heterarchically organized labor.

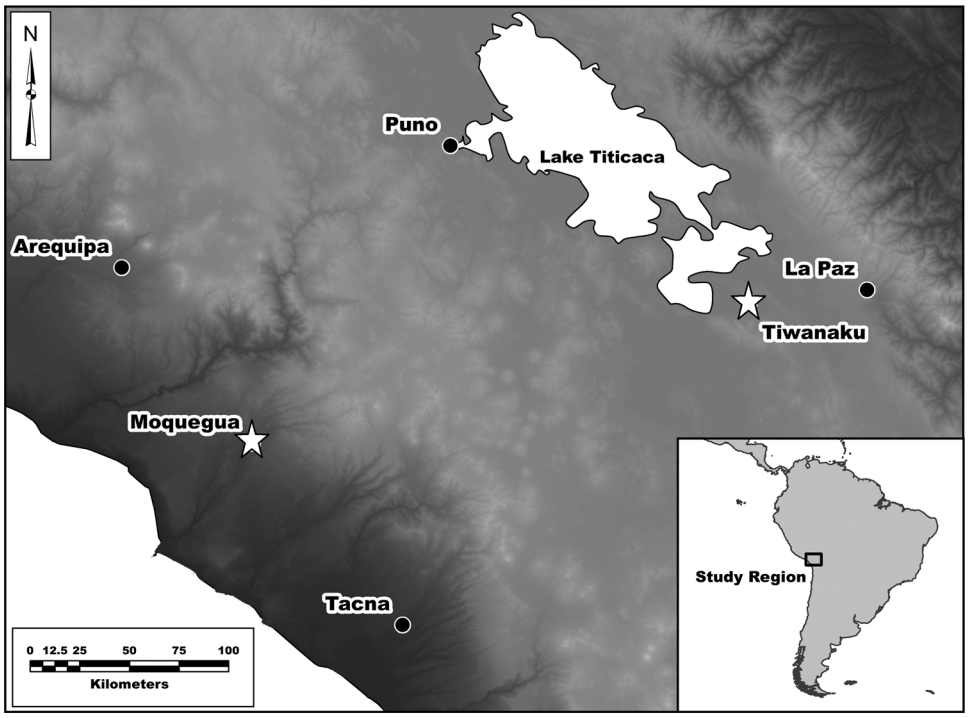


FIGURE 1. *Map of the study area.*

ANDEAN LABOR

Archaeology and bioarchaeology often look to the historic and ethnohistoric record to understand past societies. In the Andes, the expansive but short-lived Inca civilization (AD 1438–1533) is the prime example for all earlier Andean state-level societies. Inca state development followed a hierarchical example, with elites living in the core city of Cusco, Peru, and lower-status individuals farther away from this core, and labor was organized under a mandatory corvée labor tax called the *mit'a*. Men and women between the ages of fifteen and fifty were required to perform yearly service to the Inca state, averaging around three hundred days a year. This system of labor, defined as "he who works when his time comes" (Murra 1980, 192–93), was reported during colonial times as nonlocal groups of people were moved by the state to work lowland crops for the Inca elite. In return, the mit'a groups may have received rewards, such as land or goods, as well as the right to sell some of their lowland product in the highland markets (Murra 1995). Besides agricultural production, under a mit'a system people may have served in Inca military functions or trained as specialists in the production of certain goods. In a few cases, these specialists were removed from society, elevated in status, and employed in special production locations. For example, *acllas* were groups of women who were weavers, *chicha* (i.e., corn beer) producers, and ritual specialists (Silverblatt 1987). Under this mit'a system, those who worked had state support, and those who did not were put to death (Cieza de Léon [1553] 1998).

This hierarchical model of an elite centralized society is also found in many other Andean state-level societies prior to the expansive Inca state and contemporaneous with the Tiwanaku, such as the Moche (AD 100–700) and Wari (AD 500–1000) (Quilter 2013). Each of these civilizations had their own capital city (near present-day Trujillo, Peru, and Ayacucho, Peru, respectively) and were similarly militaristically expansive, with high levels of interpersonal violence (e.g., Sutter and Verano 2007; Tung 2012, 2014; Verano 2014). Archaeological data also show lower-status people farther from the core city centers, with higher workloads among lower classes, performed services and moved goods back to the elites at the heartland core. However, there does not seem to be a labor system as formally organized as the Inca mit'a.

Among the Tiwanaku culture, there was a heartland core and expansive influence through colonization. However, contrary to the nature of these other Andean polities, the Tiwanaku show no evidence of militaristic conquest of other areas. Violence is rare, especially when compared to these other civilizations (Becker and Alconini 2015). Instead, Tiwanaku may have been composed of multiethnic people from various places in the Andes, and this was reflected in the varied neighborhoods (*barrios*) in the Tiwanaku heartland (e.g., Becker 2017; Blom 2005; Janusek 2005). These multiethnic groups may have been organized around an *ayllu*[2] system. These ayllus, which in the modern Andean community combine a kin-based (real and fictive) household group, consider themselves linked to the land and function using fluctuating nested hierarchies. Impermanent control of these groups was organized and maintained by elected or appointed leaders who share a common ideology, structuring labor within a reciprocal network. Thus, it is likely that the

Tiwanaku state emerged at an ayllu level and functioned similarly. While the term heterarchy was not originally used by archaeologists, who rejected the idea that a forming and expanding Tiwanaku state required a centralizing and hierarchical core of elite managers (e.g., Albarracín-Jordán 1996; Erickson 2006), the description of it as "nested hierarchies"[3] does fit well with heterarchical organization.

Ayllus also have the potential for local negotiation into larger labor groups to tackle monumental projects as part of major reciprocal exchange. The payment for such tasks would be feasting in the form of corn beer (i.e., chicha) and/or future promises of aid, as is noted among both modern Aymara people and archaeological evidence from Tiwanaku. Further support for ayllu-level control was also noted in experimental reconstructions of Tiwanaku-style raised-field agriculture, suggesting that smaller groups could have controlled large-scale agriculture under a local leader who also worked the land in the ayllu system (Erickson 1985, 1993, Erickson 2006; Erickson and Candler 1989). In addition, prior Tiwanaku labor research shows lower colonial labor rates than in the core heartland of the Tiwanaku state during the Tiwanaku phase and embedded independent craftspeople within the core (Becker 2017; Becker and Goldstein 2017). Hence, these data indicate that Tiwanaku colonists were no lower in status than those in the core, that agricultural and pastoral production were under local control, and that there was no mit'a-style system during this state.

MATERIALS AND METHODS

I examined 612 adult individual burials from two different time periods: 226 people from the Late Formative (250 BC–AD 500) and 386 from the Tiwanaku period (AD 500–1100). I evaluated all individuals for two skeletal measures of physical activity: entheseal changes and osteoarthritis. For entheses, prior medical and bioarchaeological research has shown that certain tasks, like farming, show an increase in muscle mass over an individual's lifetime. Since muscles work like bony levers for the underlying skeleton and attach to bone, as a person increases muscle mass, so too can the connection points on bone grow and strengthen. The attachment points, or entheses, can help identify directional movement in the kinds of activities people did and levels of physical labor, such as workload. Overall, I looked at thirty-seven muscle-attachment points and sorted them into five groups according to location on the body: upper arm (i.e., shoulder movement), lower arm (i.e., forearm movement), mid-body (i.e., hip movement), lower body (i.e., knee movement), and feet (i.e., ankle and foot movement).

Osteoarthritis (OA) was the second activity indicator I used. OA shows injuries related to repetitive movement; thus, OA can help identify the same motion used over and over again, such as grinding grain or weaving textiles. I looked at twenty-four joint surfaces within seven joints: shoulder, elbow, wrist, sacroiliac, hip, knee, and ankle. For each individual, the multiple surfaces within each of the seven joints were examined for the evidence of osteoarthritis.

Data were analyzed across time periods using generalized estimating equations (GEE) (Agresti 2007). This method is useful in bioarchaeological studies, as GEE can also evaluate any number of nominal or quantitative predictor variables that cannot be assessed using bivariate analysis, such as controlling for age at death and sex, as has been previously performed for these data sets (Becker 2019a). All data were evaluated for significance at 0.05 level using the chi-square statistic in SAS 9.4.

RESULTS

Within the highland core area, entheses were compared over time from the Late Formative to the Tiwanaku phase (Table 1). Statistically significant differences were found in various entheses of the upper arm and mid-body, with higher rates in all muscle groups during the Late Formative. Thus, entheseal changes show that people who lived and died in the core area had heavier labor demands prior to the Tiwanaku state. Table 2 presents the diachronic OA core comparison. During the transition to Tiwanaku statehood, rates were higher during the Late Formative in the arms (shoulder, elbow, and wrist) and in the knee and angle joints of the leg, with one significant difference in the shoulder joint. However, in the sacroiliac joint, rates were 20 percent higher during the Tiwanaku period, while the hip joint was only slightly higher (2 percent higher during the Tiwanaku state).

DISCUSSION AND CONCLUSIONS

In contrast to other contemporaneous Andean groups and many state-level societies worldwide, the Tiwanaku were not a centralized hierarchical model of conquest and control. Instead, they showed very little evidence of violence or militaristic conquest and inclusion of multiethnic groups with retention of group identity. During the Tiwanaku state, they also demonstrated the promotion and reification of complexity in nontraditional ways through heterarchical nested-hierarchy organization per local control of things like labor (Becker 2017; Blom 2005; Janusek 2005).

As to why this type of organization would be favored over centralized hierarchical organization, seen elsewhere around the same time in the Andes and frequently described in archaeological literature, the skeletal evidence of labor presented here demonstrates a reduction in workload through all entheseal changes and repetitive movement in almost all joints with the advent of the Tiwanaku state. This could indicate why heterarchy would be emphasized over top-down hierarchical configurations. Reduction of workload, along with local peace and the ability to retain ethnic identity, were likely persuasive reasons for people to join and participate in the emerging and expanding Tiwanaku state. In addition, while we do not know the origin of the Andean ayllu, it is possible that this style of familial and land-linked organization played a role in Tiwanaku management. Thus,

TABLE 1. *Entheses Results from Late Formative to the Tiwanaku Phase*

MSM Use Area	n =	LF Modeled % frequency	TW Modeled % frequency	χ^2 value (df = 1)	*p*-value
UPPER ARM	**1074**	**82%**	**63%**	**7.74**	**0.01**
FOREARM	697	66%	56%	2.29	0.13
MID-BODY	**310**	**90%**	**77%**	**4.11**	**0.04**
LOWER BODY	269	70%	62%	0.98	0.32
FOOT	227	70%	62%	0.61	0.44

TABLE 2. . *OA Results from Late Formative Phase to the Tiwanaku Phase*

JOINT AREA	n =	LF Modeled % frequency	TW Modeled % frequency	χ^2 value (df = 1)	*p*-value
SHOULDER	**109**	**61%**	**25%**	**7.30**	**0.007**
ELBOW	443	46%	36%	1.49	0.22
WRIST	177	44%	30%	1.28	0.26
SACROILIAC	100	44%	64%	1.55	0.21
HIP	109	20%	22%	0.02	0.89
KNEE	321	26%	17%	1.57	0.21
ANKLE	168	26%	22%	0.15	0.70

no centralized elite group needed to be in charge prior to and during the Tiwanaku state because elected or appointed leaders who shared a common purpose and ideology could locally handle things (e.g., monumental building projects, agriculture and craft production, chicha brewing, trade between the core and colony).

Converse to the overall pattern of reduced labor, OA data did show greater repetitive movement in the hip and sacroiliac joints during the Tiwanaku state. However, this increase in hip and sacroiliac joint OA may be related to a newer or more-widespread technological innovation: people transporting goods using an *aguayo* (i.e., Andean cloth backpack). Modern clinical studies (Chosa, Totoribe, and Tajima 2004; Whiting and Zernicke 2008, 281) have shown that children who carry heavy loads on their backs often have problems with these joints, especially the sacroiliac. Thus, these higher rates represent the movement of heavier goods on the back while mobility (i.e., knee and ankle joints) stayed the same or decreased with the advent of the Tiwanaku state.

Overall, these data show that heterarchical reciprocal labor organization benefited Tiwanaku peoples and helped found this state in the heartland core. Workload (as demonstrated by entheseal changes) and repetitive labor (as demonstrated by OA) were reduced during the state when compared to the prior period in this high-elevation community. Thus, by evaluating activity and labor differences on the bodies of Tiwanaku individuals from a diachronic population perspective, I have been able to provide explanations as to why this culture favored heterarchically organized labor.

NOTES

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1. One example of this is that humans in the decision-making process can be both pro-life and pro–death penalty. This contradiction in value of life is one of the issues that computer programmers of artificial intelligence (AI) have dealt with in order to program human-like thought that is linearly inconsistent.
2. The world *ayllu* has multiple meanings and varying levels of complexity. Albarracín-Jordán (1996, 185–86) note some of various ways this word is used. Abercrombie (1986, 97–100) also discusses the varying scale (i.e., macro-, micro-*ayllu*) to which Aymara people apply the word and in what context.
3. Albarracín-Jordán used Netherly's (1984) north coast Peru research on the Chimú as the basis for his concepts, hence why they were not initially labeled "heterarchical."

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Openings and Implications

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Since the nineteenth century, osteologists and skeletal biologists have studied human skeletal material recovered from archaeological contexts. Now termed bioarchaeology or biocultural bioarchaeology (see Blakey 2001), this rapidly growing field of study integrates paleodemography, paleogenetics, history, archaeology, and mortuary studies into an anthropological framework. Focusing on the intimate histories of individuals and groups, bioarchaeology ethically explores the intertwined biological and cultural plasticity of the human body over time and space.

Bioarchaeologists employ recent technical and theoretical advances to examine this rich intersection of biology and culture, using the history of the body to reveal characteristics of the social, political, economic, and physical world that molded them. These new techniques are combined with standard bioarchaeological methods to ascertain sex and gender, social status, occupation, and damage from disease and violence. The study of human remains now reveals the physical movements of individuals and groups; changes in diet and health throughout the lifespans of individuals and within groups; patterns of nutrition and disease; and the expanding ability to deduce sociopolitical organization. Much of this information is invisible to standard archaeological techniques and historical sources.

Biocultural bioarchaeology has become a leader in the new study of paleopolitics. Stable isotope analysis of carbon and nitrogen in human bone collagen allows bioarchaeologists to determine diet, nutrition, and long-term dietary patterns. The DNA of past populations can determine the sex of individuals and explore genetic affiliations, marriage patterns, and population movement. As Juengst (this forum) asserts, public policies, systems of exchange, subsistence strategies, and social roles structure how people obtain resources and how they experience the result of toil and violence. Many forms of governance increase the population's risk of disease, trauma, and physical as well as social stress. Thus, these new tools can produce reliable determinations of risk and vulnerability from the individual to large populations; together, they can form a picture of life as lived, marking stressful and tranquil periods that the person or the group survived.

As the biocultural investigation of social formations increases, it is particularly important to link the new work to a framework for tracking changes over time. The ability to trace past societies' sociopolitical forms is fundamental to understanding what factors kept the society viable and which led to its demise. The concept of heterarchy, now seen as a fundamental principle of human social organization (Crumley 2007, 2015), is particularly useful to identify cooperation in the archaeological record. The heterarchy/hierarchy framework introduces a means by which systemic change can be studied at different scales.

This is important information for the human future: the old paradigm that asserted competition and conflict as the primary motors of civilization can now be refuted with solid evidence. In the course of human history, societies engaged in cooperative activities that advanced their well-being, as well as periodically falling into conflict. If we begin with the premise that the tension between competition and cooperation exists in all human societies, it then behooves us to explore the ways rules and norms permit or deny each and how both interact with history and changing conditions to forge institutions (Chapman 2003).

One of the most enlightening themes to emerge from bioarchaeological analysis is the impressive range in size of cooperative political bodies. While community-wide governance in smaller-sized groups with economies based on hunting, gathering, pastoralism, or small-scale farming would surprise no archaeologists, there are cooperative states, regions, and urban agglomerations (Callejón de Huaylas/Requay, central Thailand, Mimbres, Tiwanaku, Marroquíes) and even empires (Xianbei, Genghis Kahn's Mongols) that were collaboratively organized. Minimally, this understanding will require a rethinking of how states are defined and in what circumstances large collaborative formations appear.

One attraction seems to be a more equitable reassignment of the collective workload. Following Scott (2009), it would be very interesting to examine the tension among states and other polities when workers die in large numbers or flee. Ancient states' continual need for replacement of urban populations and the need to "keep track" of those who work were, perhaps, countered by secret refuges or early "sanctuary cities." The relative peace of more-heterarchical communities would also attract newcomers, contributing to White's (1995) list of conditions for collectively governed communities. Paired with the "regional turn" in archaeology, the opportunity to take greater areas and contiguous polities into account can begin to recover the dynamism of paleopolitics. However that discussion advances, these much larger populations have many commonalities with the collective governance of smaller groups. All are characterized by strong group and/or regional cultural diversity; sex, gender, and age equality; flexible social status; diverse means of supporting the population in precarious times (e.g., kinship, enduring reciprocity, trade relations); the welcoming of individual newcomers and of groups with different identities; and various effective means for reducing conflict.

Several other intriguing aspects of heterarchical governance deserve broader scrutiny. One is the role of marginality. The geography of collaborative groups deserves its own focus, whether they are found at the borderlands of powerful states, in areas with marginally adequate or widely dispersed resources, or in regions otherwise characterized as conflictual. Regions/areas with long histories of collaboration (e.g., central Thailand, the Eurasian steppes) would be particularly interesting. Heterarchical elements (e.g., individual or household cooperation) embedded in more-rigid structures draw attention to the many cross-scale appearances of hierarchy and heterarchy in all societies. New investigations of violence seem to reveal that competition among lineages (e.g., Chan, Kayenta, Marroquíes, and Mimbres) can exist in otherwise communitarian groups. In particular, ritual violence as a means of reducing wider conflict may have considerable explanatory potential, not just in collaborating groups but also in many societies.

Long-held assumptions are challenged by new research on individual and community diet and health. Dietary variation, heretofore more often attributed to differences of class/status and seen as sumptuary, may have other causes. It is reasonable to broaden the causes for dietary difference beyond sumptuary laws to include sacred dietary restrictions on the consumption of particular animals. Such restrictions may indicate clans and individuals who take the responsibility to honor the spirit of the prey that feeds the group. Similarly, the contemporary study of infectious, deficiency, and hereditary diseases will benefit from new bioarchaeological tools. The ability to track disease vectors and their genetic evolution across time and space extends available data well beyond documentary evidence.

How much and how far did people in the past travel? Of considerable importance in the past as well as the present, population movements, migrations, individual relocations, and long-distance trade can help form a picture of the environmental, political, or other motivations for leaving home. For a broader audience, bioarchaeology can explain why popular genetic testing consistently points to the long and complex intertwining of human populations as our species explored the planet.

Taken together, these new avenues of research by bioarchaeologists are both exciting and potentially perilous. While safeguarding the rights and sensibilities of groups that could be affected by their research is already a part of the practice of bioarchaeology (e.g., the Native American Graves Protection and Repatriation Act [NAGPRA]), it is imperative that the bioarchaeology community increase awareness of conflicts that entangle politics and history. Even carefully reported findings can disrupt deeply held personal, group, and institutional identity, as aDNA researchers have already learned. Heritage—and history—are a contemporary battleground, as nationalist and white identity political movements battle with proponents of diversity and social justice.

While this conflict is not new (viz. the Nazi use of archaeologist Gustaf Kossinna's interpretations to assert national and "race" supremacy), the current tumultuous world situation renders it increasingly dangerous. Because their research has important, new information to be shared with the general public, bioarchaeologists must be prepared to range beyond their scholarly comfort zone. The enduring popularity of archaeology ensures an audience for these new understandings, but the message must be careful, clear, and positive. Bioarchaeology can contribute to the search for new ways to envision an equitable human future; insights from our past could lead the way.

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