Amber M. VanDerwarker
Gregory D. Wilson *Editors*

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Food Insecurity in Prehistory

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ISBN 978-3-319-18505-7 ISBN 978-3-319-18506-4 (eBook)
DOI 10.1007/978-3-319-18506-4

Library of Congress Control Number: 2015943036

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media
(www.springer.com)

For Duane Esarey and Lawrence Conrad without whose advice and support it would have been impossible for us to pursue our interests regarding the connection between warfare and foodways

Acknowledgments

We first conceived of the idea for *The Archaeology of Food and Warfare* following the first year of our joint field project (*Living with War*), funded by the National Science Foundation. As we began to make sense of our data, we realized there was no existing framework for evaluating the effects of chronic and violent warfare on the lives of families and communities through the lens of food data. Never ones to work in isolation, we decided that our research would greatly benefit from a broader perspective that could be drawn by forming a scholarly community invested in similar issues. We thus decided to organize a conference on the topic at our home institution (University of California, Santa Barbara). We could not have funded or organized the conference without the help of a number of individuals. Foremost, we acknowledge Dean Melvin Oliver and Dr. Barbara Voorhies for securing the funds that paid for the conference. Susan Cochran, Robin Roe, and Pamela Hudson were instrumental in navigating us through the financial logistics. Dr. Danielle Kurin dedicated a great deal of time helping us sort out the conference logistics, and we are grateful for her assistance. In addition, a number of graduate students helped us with a variety of tasks related to conference organization, including Dana Bardolph, Matthew Biwer, B. Geiger, Kristin Hoppa, Allison Jaqua, Craig Smith, and Heather Thakar. As always, our graduate students rose to the occasion and helped make the conference run smoothly.

The smooth transition from conference organization to preparation of the book manuscript was made possible by the timely submission of papers by our contributors, as well as the very competent editors at Springer, Ms. Teresa Krauss and Ms. Hana Nagdimov. Teresa and Hana provided support and timely assistance as needed. Finally, we are grateful for the stimulating conversations with and insightful feedback from Dr. Richard Chacon. In addition, several anonymous reviewers graciously reviewed and commented on all the chapters herein, providing oversight that has strengthened the final product.

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Gregory D. Wilson (Ph.D. 2005, University of North Carolina, Chapel Hill) is an associate professor at the University of California, Santa Barbara. His research is concerned with issues of social inequality, identity politics, and violence in pre-Columbian North and South America, which he investigates through a household and community-centered archaeology, emphasizing methodologically rigorous analyses of large and diverse datasets.

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Chapter 1
Toward an Archaeology of Food and Warfare

Gregory D. Wilson and Amber M. VanDerwarker

Independently, the archaeologies of food and warfare have developed significantly over the past several decades. This volume aims to provide concrete linkages between these research topics through the examination of case studies worldwide. Topics considered within the book include the impacts of warfare on the daily food quest, warfare and nutritional health, ritual foodways and violence, the provisioning of warriors and armies, status-based changes in diet during times of war, logistical constraints on military campaigns, and violent competition over subsistence resources. Some of the papers focus on *causal* aspects of warfare and others on its *effects*. It is interesting to be conducting archaeological research at a time when new and improved dating techniques allow us to test the causal dimensions of warfare in a more rigorous way. It is also fascinating to see an emerging focus on the effects of war on more mundane aspects of life. Indeed, it is a focus on the mundane that takes us beyond battlefields and defensive walls, and allows us to better capture the lives of men, women, and children, not just as captives or victims, but as families trying to make a living during difficult times. This topic is especially novel as most archaeological treatments of warfare either focus on the causes of war; take macro-level approaches that obscure the actual people involved in warfare; or, if people's actions and activities are considered, the lens is disproportionately focused on the acts of war, which are biased towards the acts of men (e.g., Carneiro 1970, 1981, 1990; Ferguson 1984, 2000; Gat 2000; but see Arkush 2005; Bamforth 2006; Dye 2008; Milner 1999).

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_1

The diversity of perspectives included in this volume may be a product of new ways of conceptualizing violence—not simply as an isolated component of a society, nor as an attribute of a particular societal type—but instead as a transformative process that is lived and irrevocably alters social, economic, and political organization and relationships (Pauketat 2009). The book highlights this transformative process by presenting a cross-cultural perspective on the connection between war and food through the inclusion of case studies from several continents. In addition to archaeological perspectives, we also include papers that provide ethnographic and ethnohistorical perspectives (Roscoe, this volume; Hassig, this volume); indeed, these perspectives are instrumental in grounding archaeological assumptions and interpretations about the dynamics that enable and constrain human action in times of war. Many of the papers engage with dietary data as the primary means of analysis (e.g., ancient plant fragments and residues, animal bones, human skeletons, and chemical analyses of these remains), thus highlighting how food remains can directly contribute to these broader social issues.

The connection to food is especially important because it links warfare to food production at the individual, household, community, and regional levels. At the individual level, diet is inscribed on the body, and we can detect evidence of nutritional deficiencies and growth interruptions from skeletal evidence; at this level, we can also determine how men, women, and children were differentially affected by the threat of chronic inter-group hostilities (Tung 2012; see also Tung, this volume; Kurin, this volume). At the household level, we can consider changes in the organization of food-related tasks; for example, whether food storage facilities move inside houses in order to restrict inter-household visibility (which becomes an issue with increased spatial packing of humans in denser, nucleated communities (DeBoer 1988)). Analysis of food remains (both plants and animals) allows us to assess how warfare may have impacted the food quest. Archaeological research in the Central Illinois River Valley, for example, has revealed significant decreases in the collection of wild foods that would have required individuals to travel farther from the safety of their village walls (VanDerwarker and Wilson, this volume); this narrowing of dietary diversity could have led to nutritional deficiencies that would be apparent on human skeletons, thus tying community-level changes back to households and individuals. Broad comparisons of communities within regions allow us to assess the extent to which different communities were structurally impacted by the escalation of warfare (see Kuckelman, this volume). Finally, comparisons between regions enable us to evaluate the generalizability of these outcomes at the different scales of analysis (see Keeley, this volume). Ultimately, the book addresses the costs of warfare on the lives of families and communities and evaluates different strategies for coping with the reduced mobility, subsistence stress, and increasing inequalities that often accompany prolonged exposure to chronic warfare (e.g., Bolin et al. 1998).

In this brief introduction to the *Archaeology of Food and Warfare*, we begin by contextualizing our approach through an abbreviated review of three broad theoretical perspectives by which scholars typically consider ancient war and conflict. What emerges from this review is a discussion of how archaeological scholarship on warfare could be improved through a more explicit articulation with a foodways perspective. Through a broad discussion of the case studies, the second section of this chapter presents what the archaeology of food and warfare has to offer in producing a deeper understanding of humans involved in ancient conflicts. Finally, we also consider the ethical dimensions of archaeological scholarship on ancient warfare. In evaluating this sensitive issue, we follow the lead of Chacon and Mendoza in arguing that by treating warfare as a condition of everyday life, instead of a series of violent incidents, it is possible to avoid sensationalizing ancient violence (see Chacon and Mendoza 2012). Such sensationalism can contribute to strained relations between anthropologists and indigenous communities, and thus, this chapter also outlines some ethical issues revolving around the collection and publication of warfare research (see also Chacon and Mendoza 2012).

1.1 Theoretical Approaches to Warfare

Anthropological research on warfare is strongly influenced by the theoretical perspectives of its scholars. Different theoretical approaches to the investigation of warfare and other forms of violence can be generally categorized as biological, material, or sociopolitical. We briefly summarize these approaches below; our goal in doing so is not to favor one over another but to assert that each would be improved by a more explicit articulation with a foodways perspective.

Biological approaches often assume that violence is driven by the innate desire to enhance reproductive fitness through the acquisition and/or defense of the material and biological resources within a particular territory (Wrangham 1999). Material approaches sometimes strongly overlap with biological approaches in regard to the assumption that violence is driven by the desire to defend or acquire basic economic resources necessary to thrive and survive such as food and land (Dickson 1981; Ember and Ember 1992; Ferguson 1984, 2001; Keeley 1996; Milner 1999). We argue that food is central to both of these approaches insofar as enhanced food security structures reproductive fitness. The problem has been, however, that access to food is usually an implicit assumption within many of these studies. Specifically, much of the archaeological research associated with these approaches has tended to use *indirect* food evidence in support of conclusions, as opposed to actual food data. Is warfare sometimes driven by the objective of enhancing food security, and is this a proximate goal that ultimately increases reproductive fitness? We argue that answers to these and related questions are best pursued through detailed studies of archaeological food remains coupled with observations about the nutritional health status of ancient populations.

Sociopolitical approaches to warfare are characterized by a diversity of theoretical approaches that share a common viewpoint that violence is contingent upon social factors. Such factors may relate to a society's administrative decision-making structure, relations of inequality, and/or linkages between warfare and gender and other forms of social identity. Numerous examinations of gender, power, ritual, and food production have clearly demonstrated the importance of investigating the relationship between these topics (see Dietler and Hayden 2001; Hastorf 1991; Spielmann 2002; VanDerwarker and Detwiler 2002). However, relatively few studies have explicitly considered the social linkages between warfare and foodways. For example, the fallout of warfare can create food shortages and other forms of resource scarcity that are often experienced most dramatically by those already occupying marginal social positions (see VanDerwarker and Wilson, this volume; Tung, this volume). Thus, warfare can intensify existing relations of social inequality, which in turn structures the unequal distribution of food and other resources.

Warfare, food production, and feasting are also causally interrelated. Indeed, ethnohistoric accounts indicate that war feasts were organized prior to (and sometimes following) battles among different Native American groups in the Early Historic period Southeastern USA (Hudson 1976, p. 244). During such events, the elevated social status of warriors, chiefs, and foreign dignitaries was defined through restricted access to certain public spaces and the ritual consumption of specific foods and beverages (Bartram 1928, p. 200; Joutel 1962/1714, p. 127).

There are other connections between fighting and feasting. For example, Junker (2001, p. 281) has argued that competitive feasting in the Colonial-era Philippines sometimes resulted in outright fighting due to its escalation of preexisting chiefly rivalries between elite hosts and guests. Competitive feasting can also de-escalate hostilities. Indeed, the potlatch feasts of the Early Historic period Pacific Northwest appear to have replaced the more bellicose dimensions of inter-group competition that occurred in the Prehistoric era (Drucker 1967).

1.2 An Archaeology of Food and Warfare

We argue that an archaeology of warfare that includes a consideration of food offers a richer, more nuanced understanding of inter-group violence. After all, warfare cannot be waged without food to feed warriors. Combatants often target food, either as spoils for plunder or for the purpose of destruction. The logistics of foraging, farming, and herding practices are affected by both the threat and the actuality of violence. As women are often closely tied to food collection and production, making an explicit connection between warfare and food brings women into the examination of a topic that is typically biased toward the roles of men. Related to the visibility of women is the visibility of everyday practices and activities—warfare does not begin or end on the battleground, but permeates the very fabric of daily life for those living in its shadow.

Most archaeological studies of warfare deal primarily with the actual events of violence or defensive measures against attack; when gender is explicitly addressed within the context of warfare, the focus is usually on the actions of men as warriors and defenders. One exception is the work of the late Walker (1998); Walker's analyses of skeletal trauma demonstrated that increases in warfare often were associated with increases in domestic violence against both women and children. When people reorganize into more compact living arrangements behind defensive walls, household activities are relocated indoors because outside space becomes more limited, and when daily activities shift from public to private space, there is a greater potential for domestic violence to occur when it is unobserved by community members. Although the papers in our volume do not deal explicitly with gender as a focal point, gender is nevertheless implicated in many of the papers included herein.

We organize the volume geographically with respect to the case studies (Chaps. 2–12). We begin in the Old World with a case study from New Guinea, authored by a cultural anthropologist (Chap. 2, Roscoe); Dr. Roscoe's perspective reminds us archaeologists that we are not living in a vacuum in which we must blindly make connections between human behavior and material remains. There is a wealth of ethnographic and ethnohistoric research that is instrumental in grounding our archaeological assumptions and interpretations about the dynamics that enable and constrain human action in times of war. Dr. Roscoe's research thus sets the stage for the archaeological case studies by permitting a rich visualization of humans caught in the nexus between food and war. Marshaling data from 96 communities in New Guinea, Roscoe considers how resource exploitation and military concerns affect people's settlement choices on the landscape. Roscoe's chapter is followed by two additional case studies from the Old World. To the southeast of Papua New Guinea, Mark Allen (Chap. 3) combines ethnographic and archaeological data to examine the relationship between foraged foods and fortifications among the prehistoric Maori. In contrast to Vayda (1960, 1976) who argued that Maori conflict stemmed from limited farming potential (e.g., inability to produce large surpluses), Allen suggests instead that it was the incentive to control certain types of wild food resources that accounts for Maori warfare and the building of fortifications in certain locales. Allen's findings indicate that the largest Maori politics were those with access to the most favorable resources; these resources were often stored in special facilities at a distance from the main habitation sites, and the storehouses were fortified similarly to the villages. To the north in Island Southeast Asia, Peter Lape (Chap. 4) explores the causes for early warfare through a consideration of climate, potential for food production, and the erection of fortifications around 1300 C.E. on the island of Timor Leste. Proposing a model that integrates multiple types of data (e.g., documentary, archaeological, ethnographic, paleoenvironmental), Lape considers the role of environmental change in fomenting inter-group conflict; the impacts of climate change on natural resources are argued to mediate choices related to food production, which, in turn, structured settlement patterns and decisions related to the erection of fortifications.

We enter the New World with the northernmost case study, set in the Central Illinois River Valley (CIRV) of west-central Illinois during the Mississippian period (1100–1425 C.E.). Using archaeobotanical and zooarchaeological data from sites that pre- and postdate the escalation of regional warfare, VanDerwarker and Wilson (Chap. 5) argue that villagers living with war made necessary subsistence trade-offs between foraged and farmed foods in order to minimize their exposure to danger beyond the walls of their communities. They demonstrate a decline in wild plant foods, fish, and overall diet breadth coincident with the outbreak of bellicose conditions in the region. Hunkering down behind their walls, however, came with a steep price as villagers were unable to increase their crop yields and likely suffered significant seasonal food shortages. In contrast to the CIRV case in which warfare led to subsistence stress, Kuckelman (Chap. 6) presents a case from the American Southwest in which drought-related subsistence stress was a prime causal factor leading to warfare. Set in the northern San Juan Basin of Colorado between 800 and 1300 C.E., Kuckelman's analysis combines detailed excavation data with the results of bioarchaeological, archaeobotanical, and zooarchaeological reconstructions from multiple sites. She is able to correlate incidences of rising regional violence (in the form of village massacres and anthropophagy) with increasing crop failure and subsistence stress following clear periods of drought demonstrated in the dendrochronology of the region.

South of the northern San Juan Basin in northern New Mexico, James Snead (Chap. 7) considers a specific instance of conflict at Burnt Corn Pueblo occurring in the late 1200s C.E. Named for the burned green corn that was left in the wake of the village's incineration, possibly at the hands of a rival group, the site provides an example of raiding in the context of subsistence scarcity. While Snead acknowledges the causal role of environmental marginality in structuring the relationship between subsistence stress and warfare in his case study, he also emphasizes the sacredness of corn within Ancestral Pueblo society. Snead proposed two scenarios which account for the burned village and its food stores: raiding by enemy aggressors or ritual decommissioning by local inhabitants prior to site abandonment. Both scenarios raise the question as to why all that corn was left behind. With the raiding scenario, Snead suggests that raiders likely looted the dried corn stores, which would have been considerably lighter and easier to transport. With the abandonment scenario, the implication is that local villagers were compelled to leave because of impending violence, taking the dried corn with them and burning the green corn in accordance with ritual practice or as a means to prevent co-option by their enemies.

Moving into Mesoamerica, Chap. 8, contributed by Ross Hassig, considers the logistics of feeding Aztec cities and armies during the fifteenth and sixteenth centuries C.E. Sustaining war campaigns for complex societies, especially empires, requires organizational structures that ensure the provisioning of armies. Hassig explores how the Aztec Empire was able to orchestrate long-distance and long-term military campaigns through tribute obligations and the seizure of consumables from conquered groups. Of particular interest is how the Aztec war machine benefited elites at the expense of commoners, particularly at the empire's capital city of Tenochtitlán. South of the Aztec Empire in the Maya world of independent city-states, Douglas Kennett and colleagues (Chap. 9) consider how the ancient inhabitants of the city of Mayapán weathered military sieges throughout the thirteenth and fourteenth centuries C.E. By cultivating and managing garden plots, tree orchards, and animal pens within the city walls, the city's urban dwellers were able to sustain protracted sieges without suffering shortfalls or subsistence insufficiency.

Three case studies from South America demonstrate how the fall of the Wari Empire led to an increase in warfare throughout the southern Andes during the Early Intermediate period. This rise in pan-regional violence was experienced differently in different locales. Tiffiny Tung and colleagues (Chap. 10) consider how drought conditions following Wari decline operated in concert with increasing regional violence, leading to significant negative impacts on childhood health. Using data from the Wari heartland in Ayacucho, Peru, Tung and colleagues combine trauma data from juvenile crania with stable isotope data to reconstruct and correlate childhood diet and exposure with violent trauma. After the fall of Wari (1250–1400 C.E.), violence against children rose significantly alongside a decrease in maize consumption. The implication of Tung's study is that the Wari Empire facilitated the equitable distribution of food and that the empire's fall had negative consequences for social and economic stability, consequences which were significant enough to be felt by the most vulnerable demographic of the population. Southeast of the Wari heartland in the Andahuaylas region of Peru, Danielle Kurin (Chap. 11) explores similar issues in a former Wari Province using osteological data on trauma, lesions indicative of nutritional deficiency, and cranial modification, in addition to stable isotope data to inform on dietary consumption. Dating slightly earlier than the Tung et al.'s study (circa 1000–1250 C.E.), the post-Wari Andahuaylas population suffered significant malnutrition in comparison with their earlier Wari-influenced ancestors. Interestingly, the post-Wari period saw the emergence of a distinct class of people who signaled their difference via cranial elongation; these individuals suffered more violence and more malnutrition than non-modified individuals. Collectively, these two bioarchaeological case studies demonstrate that imperial control acts as a significant stabilizing force among populations under the imperial thumb. While occupied populations may have chafed under Wari control, they experienced greater health and less violence because of it.

The third South American case study, undertaken by BrieAnna Langlie and Elizabeth Arkush (Chap. 12), takes a similar approach to VanDerwarker and Wilson in examining the potential risks of particular subsistence strategies during times of heightened conflict. Set in the Late Intermediate period (circa 1100–1450 C.E.) in the Lake Titicaca region of southern Peru near the Bolivian border, this case outlines a model of different risk-based strategies available to agropastoralists at the site of Machu Llaqta, one of the largest hillforts in the region. Langlie and Arkush test their risk-based model by examining the spatial organization of food processing and preparation areas alongside a presentation of archaeobotanical data. They conclude that local inhabitants made trade-offs between social and environmental risks in order to maintain personal safety while maximizing food production.

The concluding chapter to the volume, contributed by Lawrence Keeley (Chap. 13), takes a broad look at the connections between food and warfare. Keeley identifies three approaches to the study of food and warfare, all of which are addressed in some way by the case studies in this volume: (1) the production/collection of food to fund war campaigns; (2) raiding enemies to obtain foodstuffs as war spoils; and (3) destroying enemies' food stores as an offensive tactic. Using this lens to view ancient warfare, Keeley critically assesses the case studies in the volume while providing additional examples of the connection between food and war. Ultimately, the chapters in this volume offer multiple perspectives and frameworks, present multiple lines of evidence, and pose additional questions for anthropologists pursuing an archaeology of food and war.

1.3 Ethical Dimensions of Warfare Studies

In their recent volume on the anthropological ethics of reporting on Amerindian warfare and environmental degradation, editors Chacon and Mendoza (2012) discuss potential conflicts between researchers and native groups when it comes to the examination of these issues. Clearly, anthropological topics bear on sensitive issues, and decisions to publish findings related to Amerindian warfare can weigh heavily on researchers. The central problem has to do with the potential for researchers and the media to sensationalize native warfare, which can reinforce and perpetuate stereotypes of native groups as uncivilized and brutish, justifying past actions or current attempts to pacify, missionize, or Westernize native societies (Chacon and Mendoza 2012; see also Arkush 2012). These potential negative outcomes of reporting on native warfare in past or present contexts have led some scholars to minimize the scale of indigenous armed conflict or to outright argue for suppression of findings when those findings suggest that violence was perpetrated by native communities.

Yet other scholars argue that minimizing or denying the role of warfare among Amerindian groups can also have negative repercussions, especially for those groups who construct their identities in relation to an ethos of a strong warrior ideology. For example, Dye and Keel (2012) argue that presentations downplaying the role of indigenous warfare "dishonor the Amerindian warrior tradition" (Chacon and Mendoza 2012, p. 16). In her discussion of the Catawba Indian Nation of North and South Carolina, Bauer (2012) demonstrates how the Catawba utilized their combat abilities and strategies to make military and economic alliances to both support and oppose Euro-American groups; she highlights how canny the Catawba were in alliance formation, demonstrating their agency as warriors and politicians—not simply victims of European domination. Like Dye and Keel, Bauer argues that the responsible reporting of native combat honors native warrior traditions. Indeed, Ogburn (2012) contends that some native groups embrace an ancient past with a bellicose tradition, and he highlights how some contemporary Andean groups incorporate these warrior traditions into re-forming their modern identities. Thus, by pacifying the past (e.g., Keeley 1996), we also risk the erasure of the history of native resistance to Western conquest (e.g., Mendoza and Harder 2012). For example, the Aztec and Inca empires engaged Spanish forces with the use of complex military tactics and combat strategies in their attempts to defend their homelands against invading colonial forces (Mendoza and Harder 2012); these may be the most well-known examples of native resistance to conquest, but they are only two examples of numerous cases throughout the history and geography of the world (see also Demarest and Woodfill 2012).

In navigating this potential minefield, Chacon and Mendoza emphasize (2012) the ethical code outlined by the American Anthropological Association which requires that we publish our findings, while we also avoid harming the people that we study. Ultimately, we echo Chacon's and Mendoza's (2012, p. 6) statement that we should avoid creating a false dichotomy between respecting indigenous cultures and following "protocols essential to the practice of responsible social science." No matter the topic, there is always the potential for others to misuse or sensationalize research that is presented in an unsensationalized manner—this possibility does not mean that researchers should stop conducting research. As stated by Chacon and Mendoza (2012, p. 15): "despite the abuse of Darwin's theoretical frameworks, few would contend that this fact should deter contemporary scholars from publishing work informed by evolutionary theory and its proponents." As anthropologists that conduct warfare-related research and are sensitive to these issues, we are invested in reporting the past in a way that does not reduce native peoples to flat, two-dimensional stereotypes (see also Arkush 2012; Chacon and Mendoza 2012). Thus, instead of suppressing or failing to report findings that support indigenous groups engaged in combat, we reiterate Schmidt's and Lockhard Sharkey's (2012) suggestion that we consult with local descendent populations whenever possible in order to establish a dialogue and discuss findings prior to publication (Chavarria and Mendoza 2012; see also Allen, this volume).

The chapters in this volume present data on the connection between food and warfare in a mundane, matter-of-fact way—warfare is treated as a condition of everyday life that is intricately interwoven into the daily decisions that people must make regarding mobility, settlement, and food exploitation, to name a few. We argue that embedding the concept of warfare into the social fabric of routine experience avoids the problem of sensationalism because situations of chronic violence quickly become normalized as people adapt their daily and seasonal routines to adjust their security. Indeed, these adjustments to daily practice are what we seek to problematize and examine in this volume exploring the connections between inter-group violence and food security.

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Chapter 2
War and the Food Quest in Small-Scale Societies: Settlement-Pattern Formation in Contact-Era New Guinea

Paul Roscoe

Settlement patterns are one of the more robust archaeological signatures of prehistoric social life, and archaeologists have invested a lot of effort in understanding the processes and conditions that create them and generate variation from one society to another. Most of this research has focused on subsistence organization, the general idea being that individuals attempt to optimize returns on physical expenditures in exploiting material resources (e.g., Butzer 1982, pp. 211–229; Kelly 2013, pp. 77–114). Recent decades have seen increased attention to military concerns and their consequences for settlement patterns and social life (e.g., Arkush 2011; Arkush and Allen 2006; Chacon and Mendoza 2007, 2012; Keeley 1996; see other chapters, this volume), but what we lack as yet is a *theory* of how war—in particular settlement defense (Roscoe 2008; Rowlands 1972)—interacts with resource exploitation in different times and places to determine settlement patterns. We have well-developed theories of optimal foraging, even optimal farming, for instance, but none of optimal defense and of how these two logics interact to regulate how people locate themselves across a landscape.

Using data on about a hundred egalitarian and trans-egalitarian communities from contact-era New Guinea, this chapter investigates how these processes interact to determine polity size, territorial area, mobility, and levels of residential nucleation. My essential point is not complex: In a context of external military threat, researchers simply cannot explain a polity's settlement patterns in terms of ecology or economy alone. They result instead from a trade-off between the defensive value of military strength and the costs of the food quest required to support it. Just how this trade-off works in particular instances, however, is considerably more intricate, varying markedly with resource productivity, population density, and the military implications of the terrain.

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_2

In an effort to make a complicated argument less burdensome for the reader, I begin with a simple model of the forces that determine polity size, territorial area, and levels of residential nucleation. At first blush, the results appear to fare poorly against the New Guinea data. Closer investigation, however, allows us to unpack several further formative variables that appear to vindicate the model, sufficiently at least to warrant its testing against further ethnographic and archaeological data.

2.1 A Simple Model of War, the Food Quest, and Settlement-Pattern Formation

Numerous scholars have attempted to define war, the conventional view converging around a characterization that it is armed, "organized," lethal fighting between "communities" or "groups" (for a review, see van der Dennan 1995, pp. 70–78). Quite what kind of "community" or "group" these definitions envisage is rather unclear, but to the extent they are identified more precisely it is as *political* units, communities, or polities, or more precisely yet as politically *autonomous* or *independent* communities.

As venerable as it is, this definition leaves some important questions unaddressed. What *is* an (autonomous) political community? What defines it? Unfortunately, the definitional literature is all but mute about these questions, reflecting perhaps a tendency among Euro-American social scientists to consider the emergence and theoretical status of sociopolitical groups analytically unproblematic because they unreflectingly take them to be regulatory agencies (Harrison 1993, p. 22). An answer can be found, though, in an oddity about our conceptions of war. We tend to conceptualize war as an offensive rather than a defensive act—as an ambush, a raid, or an aggressor marching its army against a foe rather than as a settlement scrambling to fend off an attack or repel an enemy army at its gates. Yet, in many small-scale societies, it was defensive, not offensive, warfare that routinely engaged the maximal, autonomous units. Throughout lowland and much of highland New Guinea, for instance, it rarely happened that the entire complement of a village community (the largest autonomous political unit in these regions) combined to attack an enemy. Women, of course, seldom engaged in offensive combat in any case, but it was equally unusual to find all the able-bodied males of these communities combining to attack en masse. Rather, it was a subset of the village's males—a clan or, more commonly yet, a subclan—that launched offensive war if only because terrain and vegetation restricted the viable size of ambush parties and because the interests motivating attacks were seldom shared by every village member.

Things were very different in defensive warfare. Throughout New Guinea, an attack was *always* met with a coordinated, united response from every able-bodied member of an autonomous political unit, be it a village community or one of the large clan communities of the Central and Western Highlands. Every capable male in the community rushed to defend those in jeopardy, while every capable woman snatched up children and valuables and sought safety. Why should this be? Why was it that the autonomous political community always acted as a collectivity in defense, when it so often failed to do so in offense? As I have argued elsewhere, and as the ethnographic record of New Guinea makes clear, the answer is simple: In an environment of military threat, the political community was first and foremost a collectivity dedicated to mutual defense (Roscoe 1996, pp. 650–654, 2009, pp. 80–85).

If the reader is unconvinced by this argument from ethnography, the same conclusion can be derived by an entirely different train of reasoning. It is a commonplace observation in our disciplines that, in small-scale societies, communities nucleate their settlements for defensive purposes—to protect themselves against attack (e.g., Rowlands 1972; for New Guinea, see Roscoe 2009, pp. 82–83). What gets overlooked, however, is that nucleation can only succeed as a defensive measure if those who do the nucleating also act *as a defensive group*, as an organization dedicated to mutual security against external military threat. Settlement members must both commit to fighting off attacks and organize themselves to ensure they can do so. Whatever else it is, in other words, the political group inhabiting a settlement that has nucleated for defensive security must necessarily also be a group dedicated to *defensive* warfare.

2.1.1 Territorial Size

Let us define war, then, as lethal fighting between political communities (or polities) that are themselves cooperative organizations formed for the precise objective of defending against that violence. A simple model of the relationships between war, the food quest, and settlement-pattern formation then follows. Consider, first, the territorial area commanded by a small-scale political community. Because inferior fighting capacity can be existentially catastrophic, a unit formed for military defense is under constant pressure to increase its military strength. Military strength is a complex product of several factors (Roscoe 2009, pp. 90–94), but in small-scale societies, warrior numbers and their distribution in space are particularly critical. The more warriors a polity can deploy to repulse an attack, and the more women it can rely on to whisk children and valuables to safety in the process, the stronger its defensive capacity. A political unit dedicated to shared defense, therefore, has a chronic interest in maximizing the size of its membership.

Military strength also depends on the *rapidity* with which warriors and women can achieve their respective defensive tasks. This was the motive behind settlement nucleation, which increased a political community's defensive strength against an attack under cover of night, when its members are sleeping and arguably at their most vulnerable (Roscoe 1996, pp. 650–654, 2009, pp. 80–88). [During the day, when they disperse from their settlements out to their foraging or farming lands, their settlements provide little security, and they are obliged to make other defensive arrangements (Roscoe 2009, pp. 85–87).] By arranging to sleep in close proximity to one another—by nucleating their residences, in other words—a slumbering population can increase the speed and scale of its response once an attack has been detected.

There is a cost, though, to maximizing military strength. A large, tightly nucleated population increases military strength, but it also increases the travel costs of the food quest. To begin with, the tighter the polity's nucleation, the greater the fraction of its subsistence resources located in the countryside around it, which in turn increases the average travel costs associated with subsistence routines. Second, as the number of its members increases, the polity has to grow in territorial extent if it is to house and feed the additional numbers, which again increases subsistence travel costs. The greater the productivity of a polity's subsistence regime and the heavier the travel costs its members are willing to shoulder, the higher the polity's military strength can rise. At some point, however, the costs become so great that members are no longer able or willing to bear them; further increases in territorial area, settlement nucleation, and polity population then come to a halt.

We can construct a simple model of these processes. If we hypothesize that, across small-scale societies, people tolerate much the same travel costs and commute at much the same pace to their subsistence resources, then the territorial area (T) that they are prepared to defend and exploit will be given by:

$$T = k \times \left({}^{V_c}\!/_{t_c} \right)^2$$

where V_c is mean commuting speed, t_c is the average maximum commuting cost tolerated, measured in travel time, and k is a constant dependent on territory shape (e.g., circular, hexagonal, or polygonal).

Researchers within and beyond archaeology have devoted a lot of attention to figuring out t_c, the maximum travel time that people are willing to devote to commuting to and from their workplace.[1] These efforts yield widely differing

[1]Based on limited ethnographic data (Chisholm 1968, p. 131; Lee 1969, p. 61), some archaeologists and geographers have proposed that foragers will tolerate commutes of up to 2 h from a residential site but cultivators no more than 1 h (Roper 1979, pp. 123–124; Stone 1991, p. 343; Vita-Finzi and Higgs 1970). For their part, transportation researchers (e.g., Ausubel et al. 1998: Marchetti 1994; Roth and Zahavi 1981; Zahavi 1979) find that, across the developed and developing world, *mean* daily travel time budgets (averaged over the year and across a population) fall around 1 h (i.e., ½ an hour each way), with some evidence that this has been so for many centuries (Marchetti 1994, pp. 76–77). This research is not without its critics, but even they concede that commuting times do seem to have "some stability" across time and space (Mokhtarian and Chen 2004). The few precise measurements we have, moreover, indicate that the mean may be somewhat higher in small-scale cultivator communities. Hipsley and Kirk (1965), cited in Dufour (1984, p. 44), determined that New Guinea highlanders in the Pari area had a one-way mean of 0.83 h; Dufour (1984, p. 44) found Yapú women of the Amazon averaged 0.71 h. [Some previous work (Craig and Chagnon 2006, p. 55; Dufour 1984, p. 44) cites Norgan et al.'s (1974, p. 334) findings that, among the Kaul and Lufa of New Guinea, walking times totaled 1.70 and 2.48 h, respectively. Closer inspection of the data, though, reveals that these measurements refer not just to mean commute times to and from subsistence resources but also time spent walking around once there (Norgan et al. 1974, p. 337)]. Mean commuting times, however, are not the *maximum*

results, but they suggest that humans are willing to tolerate a maximum, one-way commute that is between about 0.75 and 1.2 h.[2]

To translate these maximum tolerated travel times into territorial areas, we need to know the average pace at which members of small-scale communities commute between home and worksite. This task is no easier to estimate than their commuting times, but what evidence we have indicates that a burdened member of the average small-scale community would probably average between 3 and 4 km/h.[3]

Footnote 1 (continued)

mean commuting times people will tolerate—i.e., the average commute time to the farthest flung subsistence resources. If subsistence resources are homogenously distributed and exploited, however, it can be shown that this maximum is 1.5 times the mean. (The mathematically inclined can verify for themselves that to a first approximation and given a circular territory:

$$t_\mu = \frac{\left(\int_0^{t_{\mathrm{mx}}} \frac{2\times\pi\times V_c^2\times t^2}{a_t}\cdot \mathrm{d}t\right)}{\left(\frac{\pi\times V_c^2\times t_{\mathrm{mx}}^2}{a_t}\right)} = 2t_{\mathrm{mx}}/3$$

with previous notation and where t_μ is mean travel time, t_{mx} is maximum travel time, and a_t is the average subsistence area worked/day). In practice, of course, subsistence resources are not homogenously distributed. People usually try to locate their settlements so that their most productive resources, or those they exploit most intensively, are closest to their residences, and vice versa, a practice that translates into a maximum commute greater than 1.5 times the mean. On the other hand, commuting time measurements all refer to peacetime conditions. Small-scale societies, though, were usually either at war or under military threat, a circumstance likely to reduce their tolerance for venturing far from the security of their settlements and, hence, decrease their maximum mean commutes.

[2]Anecdotal reports on New Guinea foragers and cultivators suggest a lower tolerance for maximum commutes. People are said to prefer to camp out overnight when they are more than about a ½–¾ of an hour from home (Oosterwal 1961, p. 57; Schieffelin 1976, p. 40; Townsend 1969, pp. 37, 78). Because these estimates are based on impression rather than measurement, I do not use them here.

[3]There is wide agreement that, on level terrain, unburdened humans can walk at about 4.4–5.5 km/h on a sustained basis, 5 km/h commonly being taken as the mean (e.g., Cole and King 1968, p. 253; Haggett 1972, p. 253; Jarman et al. 1982; Marchetti 1994; Tobler 1993). In small-scale societies, though, people are commonly burdened in commuting between home and worksite, and there is no guarantee that the terrain they traverse is flat or that their travel between home and worksite is in a straight line. Women in particular commonly bring infants and children along and carry heavy loads of food or firewood home. Many communities also live on complex terrain, ground that is hilly rather than flat, marshy rather than firm, or forested rather than open. We have only limited information on the degree to which loads and complex terrain slow walking speeds. Haggett (1972, p. 253) found in urban environments that a woman carrying a child traveled at 2.6 km/h. In small-scale communities, though, people may not be so slow. Dufour (1984, p. 40) found that, carrying a child, Yapú women (on relatively flat terrain) walked at about 3 km/h and bearing 15–20 kg loads at 4 km/h. !Kung women, carrying 10–15 kg on flat terrain, walked at about 4–5 km/h, though men carrying meat loads of 20–30 kg walked at just 3–4 km/h, with frequent rests (Lee 1979, p. 193). The optimal walking speed for Luo and Kikuyu women carrying loads up to 20 % of their weight was a little over 3 km/h (Maloiy et al. 1986). Haggett also reckoned that, in urban environments, a 10 % uphill slope slows normal walking speed by about 20 %, and a 20 % slope by 40 % (traveling downhill increases speed, though probably not in the same proportion). We have no information, however, on how slope (or for that matter soft or forested terrain) affects walking time in small-scale communities. Nor do we know the degree to which paths across complex terrain oblige people to deviate from straight-line travel between home and worksite.

Combining these estimates, the maximum average distance people in small-scale societies are willing to travel to procure subsistence resources falls somewhere between 2.25 and 4.8 km. [This range of figures compares to estimates by Chisholm (1968, p. 131) and others that agricultural activity is concentrated within a 1–2 km radius of a central settlement, falling off sharply at greater distances and terminating at 5 km (for summaries, see Roper 1979, p. 121; Stone 1991, p. 343).] Assuming a circular territory, these uncertainties translate into a territorial area of about 16–72 km^2, with a midpoint at about 40 km^2.

2.1.2 Polity Size

With territorial area (T) known, it is a straightforward matter to compute P, the numerical size to which people are content to let their polity grow. If we assume that people have much the same mean per capita consumption across small-scale cultures, then, to a first approximation:

$$P = S_\mathrm{p} \times T/m$$

where S_p is mean subsistence productivity/unit area and m is average per capita consumption.[4]

2.1.3 Residential Nucleation Versus Residential Dispersal

From a purely economic point of view, the optimal settlement pattern in small-scale, subsistence-based communities should be residential dispersal; in this pattern, each subsistence unit surrounds itself with its own subsistence resources, thereby minimizing its commuting costs. In a context of military threat, however, people are willing to bear a substantially greater economic cost by nucleating their residences in order to reduce the potentially catastrophic risks associated with military attack. Are there circumstances, though, that might shift the balance of this trade-off? Are there conditions that might prompt a polity to disperse its residences to minimize its commuting costs despite the presence of external military threat? The question seems perverse because it implies that, in some circumstances, nucleation has little or no defensive advantage. Yet, there are at least two circumstances in which this could be the case.

First, a polity might prefer residential dispersal over nucleation as a defensive strategy if it reduces the enemy's chances of locating its members. In the extreme, if foes are unable to locate their prey at all, the strategy is ideal because the enemy

[4]The model is approximate because: (a) In a nucleated settlement, some fraction of the travel to subsistence resources involves travel within the residential area of the settlement to resources distributed around it; and (b) the residential area itself is not available for subsistence exploitation.

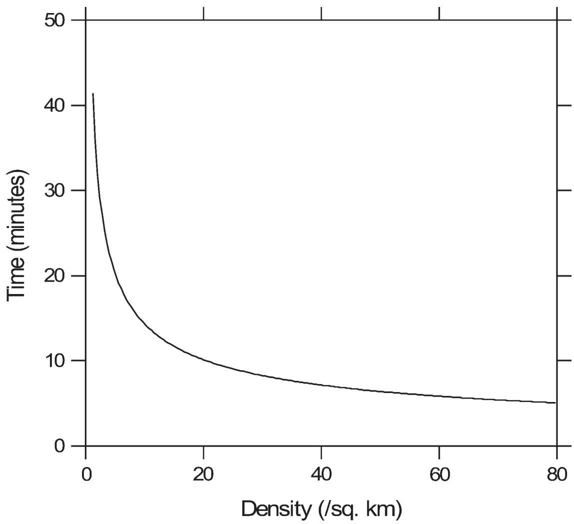

Fig. 2.1 Minimum time by density for 100 dispersed defenders on firm, flat, open terrain to rally to site of an attack. (Assumed speed 10 miles/h or 16.7 km/h; warriors comprise 20 % of population)

is then unlikely to try [e.g., see Steward and Faron (1959, pp. 429–430) on the Guayaki [Aché] of the Amazon]. In small-scale communities, three conditions favor dispersal as a military strategy: very low densities, heavily obstructed landscapes, and mobility. Low densities reduce a polity's military exposure because flows of information that might otherwise betray its whereabouts to an enemy are minimal. Heavily obstructed terrain—land that is highly dissected or blanketed in dense vegetation—is defensively advantageous because it reduces the chances that enemy surveillance will reveal the site's location. And these probabilities sink yet further if the prey population is highly mobile.

The second set of conditions under which a polity can afford to abandon nucleation in favor of residential dispersal is virtually the reverse of this first set. High-density, sedentary communities can adopt a dispersed settlement pattern because the marginal costs to their defense are outweighed by the gains in subsistence commuting. As population density rises, the average distance between individuals (and residences) necessarily decreases. This increased proximity, in turn, accelerates the scale and rapidity with which members of a polity can muster a defensive response against an attack. Figure 2.1 illustrates the point by plotting the time 100 warriors distributed homogenously across a firm, flat, open landscape would take to assemble at the site of an attack at different population densities.[5] At densities below 2 people/km^2, such a force would need more than half an hour to assemble,

[5]The *minimum* time, T_N, needed for N warriors to rally to the site of an attack is given by:

$$T_N = (1/V_a) \times \sqrt{N/(m \times D \times \pi)}$$

where V_a is mean running speed, m is the proportion of the population that can serve as warriors, and D is population density.

leaving antagonists time to wreak considerable damage before having to flee or be repulsed. At these densities, therefore, nucleation has considerable defensive value.

As population density rises, however, so too does the capacity of a dispersed population to muster a large and rapid military response. At densities above 60 people/km^2, for instance, 100 defenders spread homogenously across a landscape could be fully assembled within 6 min, leaving attackers hardly any time to inflict harm before they had to flee. At some point, in other words, density reaches a level at which the military advantages of nucleation over dispersal cease to outweigh the subsistence advantages of dispersal over nucleation. At this juncture, it is in agents' best interests to abandon residential nucleation in favor of dispersal into smaller residential units surrounded by their subsistence resources.

In an ideal world, we would be able to test the above hypotheses about polity size, territory, and nucleation using quantitative predictions and data. In practice, there are far too many theoretical and empirical unknowns to make any precise predictions. What we can do, however, is make comparative predictions:

1. Regardless of subsistence regime, territorial areas will be approximately constant—on the order of 40 km^2, but in any case between about 16 and 72 km^2.
2. Polity size will increase in direct proportion to subsistence productivity.
3. Very low-density, mobile communities on heavily obstructed terrain and high-density, sedentary communities will disperse their residences. Communities with intermediate densities, however, will nucleate their residences.

To test these kinds of comparative predictions, we require cross-cultural data, and in this paper, I evaluate the predictions against a database of about a hundred New Guinea communities. New Guinea is arguably the finest of all ethnographic theaters for examining social and cultural processes in small-scale society. Because it has attracted only limited archaeological attention (but see Hayden 1995), few archaeologists will be familiar with its ethnography or the quality of the data it provides. Before moving to test our hypotheses, therefore, it is well to begin with a brief overview of the island and its ethnographic record.

2.2 Contact-Era New Guinea

As "[t]he Last Unknown" (Errington and Gewertz 1995), New Guinea came under colonial control at a propitious anthropological moment, providing a sudden abundance of fresh field sites as the production of anthropologists boomed in the wake of World War II. The result is an ethnographic record of recently contacted, small-scale societies that is all but unparalleled in its breadth and documentary depth (Roscoe 2000). Even so, this evidence is not without its flaws, prime among them that no anthropologist ever made initial contact with the people he or she studied, and only a handful conducted research prior to their "pacification." By the time fieldworkers arrived to study them, in fact, most communities had already been reshaped, often dramatically, by the colonial presence.

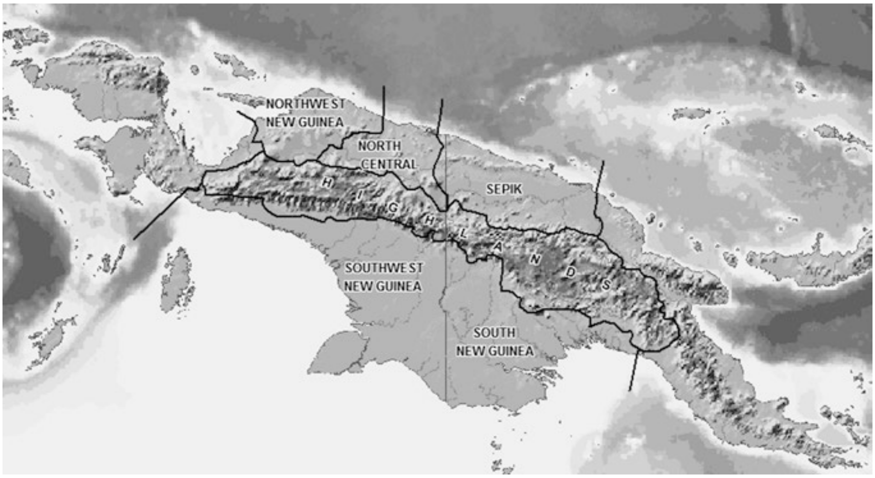

Fig. 2.2 The New Guinea study area and its subregions. The Bird's Head in the west and the southeast of New Guinea are not included in the study. Subregions of the study area are labeled

To reconstruct New Guinean lifeways in the contact-era,[6] therefore, the anthropological record has to be supplemented with historical documents produced by those who were present at the time. These sources—early explorers, gold prospectors, labor recruiters, missionaries, and patrol officers—commonly lacked anthropological training, but many were privileged to make first contact with New Guineans, and a number subsequently lived for months or even years with local populations, some even becoming fluent in their languages.

Accessing and presenting this expanded documentary record is challenging, and it is impossible to survey the whole island (Roscoe 2000, pp. 80–81). As a compromise, the dataset I use is limited to five key regions of mainland New Guinea: the Sepik Basin; the South and Southwest coast (collectively, the South Coast); the Northern (Northwest and North Central) sector of West Papua (Irian Jaya); and the Highlands that run down the center of the island (Fig. 2.2). Although it represents only a subset of New Guinea's societies, this dataset still embraces more than half of its cultures and covers the spectrum of its environmental, demographic, subsistence, and political diversity. The Sepik, in addition, is home to the Yangoru Boiken, a horticultural people among whom I have conducted over two years of fieldwork.

New Guinea is characterized by an extraordinary variety of ecological zones, from swamplands, rivers, and coasts, through grass plains and foothills, to high mountain valleys and peaklands (see Fig. 2.2). At contact, its inhabitants had developed an extraordinary diversity of subsistence regimes that can be divided into two major types—wetland and dryland—and seven major regimes.

[6]The contact-era is defined as the period between initial engagement with foreign agents and the point at which that contact began significantly to affect social and cultural life.

Wetland subsistence was confined almost exclusively to the lowlands, where seasonal freshwater flooding creates ideal conditions in many areas for the sago palm (*Metroxylon sagu*.), the staple of all wetland subsistence. Good quality sago starch, leached from the pith of the palm's trunk, is an abundant and reliable source of dietary calories, yielding this harvest for minimal inputs of labor. Commonly, an individual can produce an entire day's caloric requirements with less than 30-min work, and the product can be stored for weeks or even months (e.g., Flach 1997; Flach 1980, pp. 117–118, 120).

Rich though it is in calories, sago yields virtually no protein, fat, or other nutrients (Ruddle et al. 1978, pp. 57, 61–67). Populations reliant on sago as a staple, therefore, are critically dependent on other resources to meet their full dietary needs. In New Guinea, these resources principally came from either hunting or fishing, accounting for two of the island's seven major subsistence regimes. The first—sago and hunting—combined sago gathered from wild or planted palms with hunted game—wild pigs (*Sus scrofa*), the occasional cassowary (*Casuarius* spp.), and a vast array of other terrestrial, arboreal, and avian species. The second regime, restricted to the environs of major estuaries, rivers, and lakes, combined wild or planted sago with aquatic fauna—primarily fish and shellfish.

As Fig. 2.3 shows, population levels in these sago-dependent, wetland communities were among the lowest in New Guinea.[7] Sago-and-hunting populations had the lowest densities, most falling below 1 person/km^2 and only a few exceeding 3/km^2. With the possible exception of the Upper Tor groups (Oosterwal 1961, p. 57), though, it was hunting, not sago stocks, that limited densities (Townsend 1969, p. 78). Communities that combined sago with fishing appear to have had richer faunal reserves (e.g., Eyde 1967, pp. 10, 22–23). Even so densities were rarely more than two to three times those of sago-and-hunting regimes. It seems, in fact, that New Guinea's sago-dependent, wetland populations were stuck in a subsistence cul-de-sac, unable to intensify their production of food to support higher densities. They could not easily intensify hunting or fishing production, the subsistence activity limiting their population levels, while their water-logged environments prevented them from increasing subsistence production through cultivation or pig production.

Things were different in dryland environments, where cultivation and animal domestication were viable on more than a trivial scale, and intensification allowed population densities to rise beyond the wetland ceiling. Four of these dryland communities were sago-and-fishing villages that were located in wetlands but had

[7] **Sago+hunting** (n = 19): median = 0.8, mean = 1.3, s.d. = 1.4/km^2; **Sago+fishing** (n = 21): median = 2.9, mean = 4.4, s.d. = 5.3/km^2; **Sago+horticulture+hunting** (n = 9): median = 4.8, mean = 8.0, s.d. = 8.5/km^2; **Sago+horticulture+fishing** (n = 4): median = 5.7, mean = 7.3, s.d. = 4.8/km^2; **horticulture+hunting** (n = 9): median = 4.4, mean = 4.9, s.d. = 6.2/km^2; **horticulture+livestock** (n = 20): median = 18.5, mean = 25.2, s.d. = 17.6/km^2; and **agriculture+livestock** (n = 21): median = 49.1, mean 48.2, s.d. = 24.9/km^2.

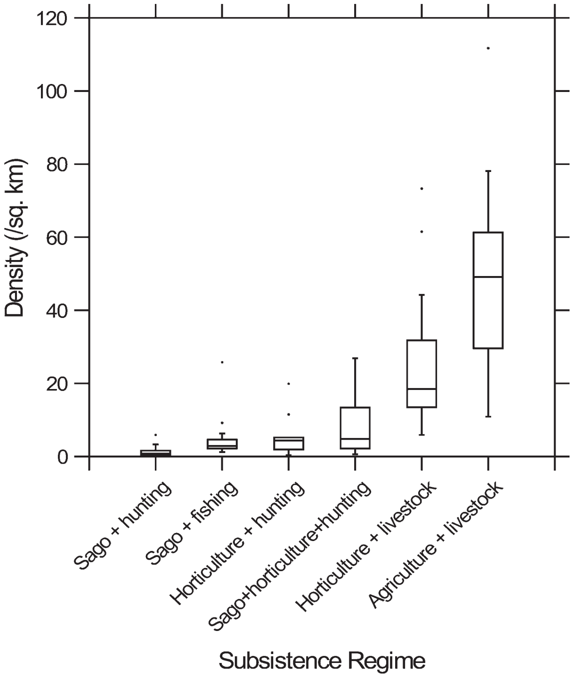

Fig. 2.3 Subsistence regime and population density in contact-era New Guinea ($n = 103$). *Note* Horticulture = main crop cultivated for one to two years on the same plot, followed by a minimum of 10 years' fallow; agriculture = main crop cultivated for more than two years on the same plot, or for one to two years on the same plot followed by less than 10 years' fallow

access to arable ground in the hinterlands. Because there were so few of these communities, however, they have been dropped from subsequent analysis. Of the remainder, communities that relied on horticulture and hunting, or combined sago with small-scale horticulture and hunting, had mean and median densities only slightly greater than those of fishing and sago populations. Most dryland populations, though—those that combined banana (*Musa* spp.) or tuber cultivation with pig-rearing—had considerably higher densities, ranging from 5.9 to as high as 111.1 people/km^2.

Taking population density as a proxy for subsistence productivity, therefore, we can order the productivity of the six New Guinea subsistence regimes on which we have sufficient data as follows: sago+hunting < sago+fishing < sago+hunting+horticulture < horticulture+hunting < horticulture+livestock < agriculture+livestock (see footnote 7).

Notwithstanding the dramatic differences in New Guinea's subsistence regimes and population densities, political structure and organization were everywhere much the same, differing principally in scale (Fig. 2.4). At the core was the political community or polity, an autonomous unit variously referred to in the literature by terms such as the "longhouse" (or "longhouse community"), the "residential hamlet" (or "hamlet group"), the "clan," and the "village" (or "village group"). Perhaps a thousand languages were spoken in contact-era New Guinea, but there were probably more than twenty thousand of these political communities.

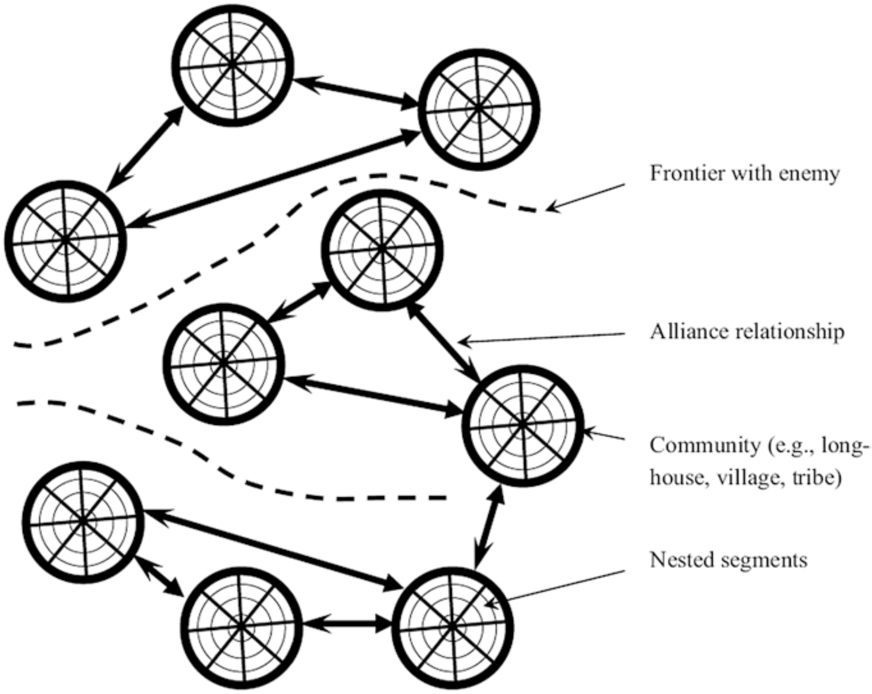

Fig. 2.4 Schematic diagram of New Guinea political structure and organization

Corroborating the argument made earlier, the ethnographic record makes quite clear that the polity was a mutual defense organization, its members depending on one another for military support in the event of a surprise attack, an enemy advance, or a challenge to battle (Roscoe 2009, pp. 82–85).

In most areas of New Guinea, polities enjoyed relations of peace (i.e., alliances) with a handful of neighboring polities, relations that were based on the mutual interest that closely proximate communities have in reducing an existential threat on their doorstep (Roscoe 2009, pp. 87–88). The diplomacy on which these relations depended, however, was by no means always successful, and a political community was invariably either permanently or at least episodically at war with one or more other polities within its vicinity (see Fig. 2.4).

As was the case for many other small-scale societies of the world (Keeley 1996, pp. 195–196), warfare exacted a heavy toll on New Guinea communities. Typically, between 12 and 35 % of New Guineans could expect to die in war, with figures in some areas perhaps reaching 50–60 % (Roscoe 2008, p. 508). Treachery apart, the most common form of lethal violence was ambush—a small-scale, surprise assault on a settlement by night or at dawn, or against people out and about their subsistence or social routines during the day. In low-density areas, large-scale raiding was also practiced, with fisher–forager populations commonly launching massive canoe-borne, headhunting raids that could wipe out entire hinterland settlements. In the open valleys of the Highlands, large scale battles rather than raiding complemented ambush. After several months to a year or so, these battles would usually culminate in peace negotiations, though occasionally they ended in slaughter, with the victors pressing deep into the territory of the vanquished, raping, massacring, burning houses, slaughtering pigs, destroying crops, and putting to flight whoever survived.

2.3 Territorial Areas and Polity Size in New Guinea

On first inspection, our predictions about subsistence regimes, territorial areas, and polity sizes seem to fare poorly against the New Guinea data. Figure 2.5 graphs territorial areas (computed as polity size over density) against subsistence regime, the latter arranged in order of rising productivity. *Contra* prediction, territorial areas differ markedly across subsistence regimes, varying inversely with subsistence productivity. Furthermore, only in three cases—sago+fishing, horticulture+hunting, and sago+horticulture+hunting—do either mean or median territorial sizes or both fall within the predicted bounds of 16–72 km^2.[8]

Figure 2.6 reveals that prediction fares only marginally better with respect to polity size.[9] According to the model, polity size should increase directly with subsistence productivity. This prediction holds, but the correlation is low ($r = 0.467$, $p < 0.001$, using density as a proxy for subsistence productivity). It is particularly striking that sago-and-fishing communities should rival the size of horticulture–livestock polities and even approach those of agriculture–livestock communities, when the productivity of the former regimes, as indexed by their densities (see Fig. 2.3), suggests they are markedly less productive than the latter.

Figures 2.5 and 2.6, in sum, provide rather disappointing support for the predictions of our warfare/food-quest model. The main challenge is the seemingly inverse relation between subsistence productivity and territorial area. Instead of remaining constant across subsistence regimes as the model predicts, the low-productivity, sago-based regimes have very large territories, while those of high-productivity regimes—horticulture or agriculture combined with livestock production—are very small. The implication, on first inspection, is that populations dependent on different subsistence regimes balanced the costs of the food quest

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[8]**Sago+hunting** ($n = 15$): median = 75, mean = 98, s.d. = 83 km^2; **sago+fishing** ($n = 18$): median = 65, mean = 83, s.d. = 59 km^2; **sago+horticulture+hunting** ($n = 9$): median = 20, mean = 24, s.d. = 15 km^2; **horticulture+hunting** ($n = 8$): median = 11, mean = 27, s.d. = 40 km^2; **horticulture+livestock** ($n = 17$): median = 11, mean = 12, s.d. = 6 km^2; and **agriculture+livestock** ($n = 18$): median = 6, mean = 7, s.d. = 4 km^2.

[9]**Sago+hunting** ($n = 17$): median = 45, mean = 55, s.d. = 33; **sago+fishing** ($n = 18$): median = 210, mean = 283, s.d. = 208; **sago+horticulture+hunting** ($n = 9$): median = 86, mean = 126, s.d. = 90; **horticulture+hunting** ($n = 9$): median = 48, mean = 69, s.d. = 66; **horticulture+livestock** ($n = 17$): median = 222, mean = 227, s.d. = 99; and **agriculture+livestock** ($n = 18$): median = 297; mean = 315, s.d. = 146.

Fig. 2.5 Subsistence regime and territory area ($n = 85$). *Horizontal lines* mark territories of 16, 40, and 72 km^2

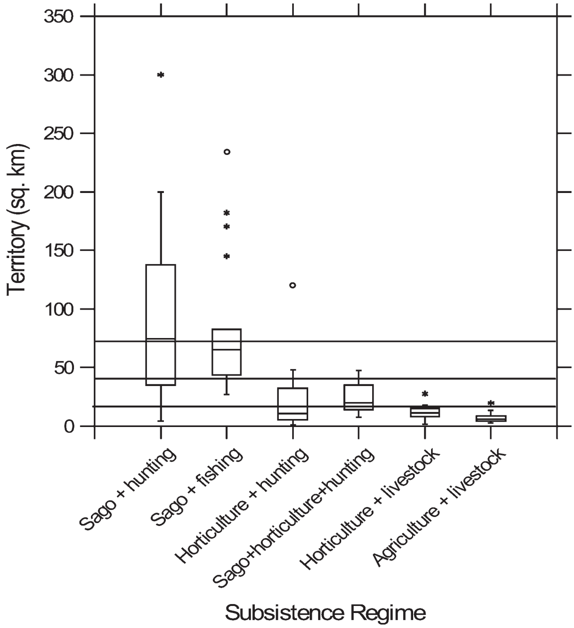
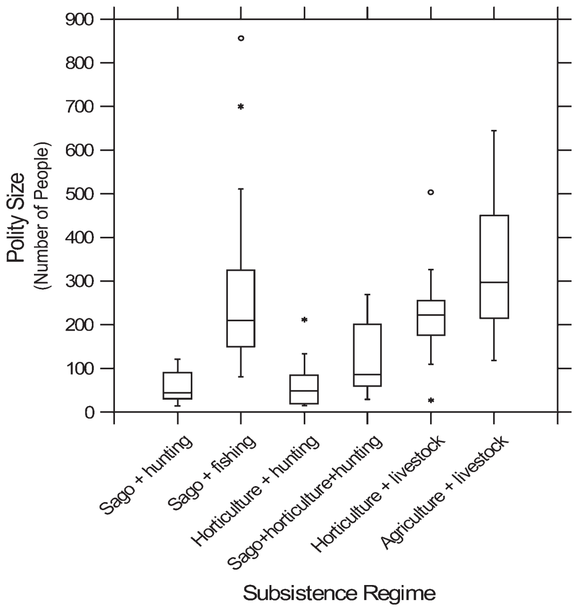


Fig. 2.6 Variation of polity size with subsistence regime ($n = 88$)



and the benefits of military security differently. Those dependent on low-productivity regimes were willing to bear unusually heavy commuting costs in order to bolster their military strength, while those dependent on high-productivity regimes were concerned markedly more with travel costs than with defensive strength.

A closer investigation, to which we now move, reveals that these appearances are probably deceptive. People across New Guinea's subsistence regimes did balance commuting costs and defensive benefits similarly. In the case of sago-and-hunting polities, though, it is simply that the data do not capture a critical complexity in their settlement pattern, one that masks the fact that they actually conform to the model. In the case of sago-and-fishing communities, the model fails to take into account that people mainly traveled by dugout canoe. As for dryland polities—those that depended on cultivation coupled with hunting or livestock—people appear to have balanced military security and travel costs like everyone else, but those whose densities were above about 40 people/km^2 passed a threshold that changed their settlement-pattern calculus entirely. In these communities, the ability to render mutual defensive aid superseded commuting times as the limiting factor on the size of polity territory and population size.

2.4 The Sago-and-Hunting Regime: Terrain, Defense, and Dispersal

Archaeologists interested in catchment analysis sometimes conclude that hunter–gatherers exploit larger territories than do cultivators. At first glance, the New Guinea data seem to confirm this generalization. Many of the communities that subsisted on sago and hunting were actually hunter–gatherer groups (Roscoe 2002, 2005), and as we have just seen, their mean territories were some three to twelve times larger than those of cultivator communities (see Fig. 2.5).

Whatever the case elsewhere in the world, however, the New Guinea data are misleading. Over the course of a year, most sago-and-hunting polities deployed two settlement patterns: one a short-lived nucleation, and the other a dispersed, default state. The data on polity population and territorial areas presented so far refer to the first pattern, but the second configuration was actually the more representative. When we take this complication into account, we find that the polity size and territorial areas of New Guinea's sago hunters fall into line with prediction.

The Bahinemo polity of Gahom illustrates this "pulsating" settlement pattern (Fig. 2.7). For a small portion of the year—perhaps a few weeks—members gathered in a single, central settlement, often sited defensively on a ridge or hilltop rising out of the surrounding wetlands, which provided its members' subsistence.[10] The first patrol officer to visit Gahom, for instance, found the village:

> situated on the crest of a hill several hundred feet high, and from this actual site a fine panoramic view of the surrounding countryside was gained. To gain access to the village it was necessary to climb up the face of this hill, and one could not enter without being observed from above. From the ground the village could not be sighted, being screened by vegetation. It's [sic] location must have been very carefully selected, and it forms what would be an ideal natural fortress against possible plunder or attack (AMB 6-1962/63, p. 13).

[10]**Bahinemo**—AMB (6-1962/63, p. 13), **Bisis**—Gewertz (1977, p. 189), **Mari**—Gewertz (1977, p. 189), **Sanio-Hiowe**—Townsend (1978, pp. 28, 66), **Yerekai**—Behrmann (1922, p. 121), Gewertz (1977).

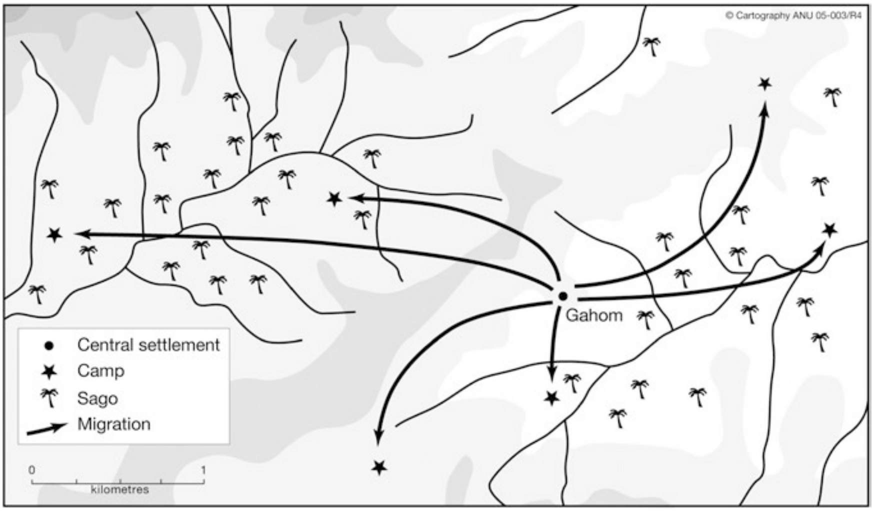


Fig. 2.7 The "pulsating" settlement pattern of the Bahinemo (Sepik New Guinea)

For the majority of the year, though, polity members lived not in this central settlement but in small, one or two family subsistence units that moved from one bush camp to another as game (or sago) in the environs became depleted (Roscoe 2005, p. 262).

Not every sago-and-hunting polity pursued this "pulsating" system. The Mander of the Upper Tor and the Sanio–Hiowe of the Sepik Hills pursued a logistical strategy, foraying out daily from the central settlement to their resources (though in the Sanio case, people moved every few weeks from one such settlement to another) (Oosterwal 1961, p. 57; Townsend 1978). The Waf of the Upper Tor Valley, by contrast, appear to have had no central settlement. Instead, they pursued a strategy of residential mobility, spending all—or nearly all—of their time in small, dispersed, subsistence units that moved every few weeks from one bush camp to another (Oosterwal 1961, p. 57).

The "pulsating" settlement pattern was the norm, however, and it appears to have mediated an intrinsic conflict between economic and military imperatives on the one hand and social and ceremonial demands on the other. Dispersal was the default setting and seems to have been economically advantageous. Both sago, the plant staple, and game, the faunal staple, were more or less homogenously distributed across these wetland landscapes, and by dispersing into small camps and shifting from one place to another as subsistence resources were exhausted, polity members could minimize mean commute times to their resources.

In other circumstances, these small bush-camp groups would have been exceptionally vulnerable to military attack. But for these groups, and these groups alone in New Guinea, dispersal was militarily as well as economically advantageous. With a median density of just 0.8 people/km^2 (mean of 1.3/km^2), these were the lowest density groups in New Guinea. Furthermore, their floodplain forest and sago swamp environments were also among the most obstructed. The German geographer, Walter Behrmann, who toured the Sepik's floodplain forests in the early 1910s, described an "entangled abundance of woven aerial roots," "the abundance of trunks and roots that block the way," and "an abundance of hindrances to advancing in these pathless forests" (Behrmann 1917, p. 74; my translation). In 1932, an Australian patrol, trying to hack its way through a sago swamp north of the Sepik River, had penetrated no more than about a mile by the end of the day and, after a sleepless night knee-deep in water, abandoned the project as hopeless (SD A3-1932/33, p. 9).

In this kind of environment, a small, mobile, low-density population is effectively invisible to its enemies. "The natives hide themselves, their houses and their plantations in the middle of the forest so that they are only found by accident," Behrmann (1922) observed of these remote regions. "This concealment protects them from their enemies" (Behrmann 1922, p. 201; my translation). The Nimo-Wasuai, hunters and sago planters of the Upper May River, observed one Australian Patrol Officer, were "a semi nomadic type and move from place to place in order to find food and escape from their enemies" (AMB 3-1958/59, p. 9; for the Abau, see also GR 6-1951/52, p. 7; for the Bisis, Mari, and Yerekai, see Gewertz 1977, p. 189). Many a Patrol Officer in these wetland forests abandoned his efforts to track down offenders against the Administration's pacification program because it was simply impossible to find them (e.g., AMB 3-1968/69).

If dispersal into small mobile units was both militarily and economically advantageous, then why would New Guinea's sago-and-hunter communities consider aggregating in a central settlement from time to time? The reasons, it seems, were social and ceremonial. These were the sites where communities aggregated temporarily to plan their raids and other cooperative ventures, conduct initiations and other life cycle rituals, and promote courting and other activities that depended on copresence (AMB 6-1962/63, p. 13; Oosterwal 1961, pp. 31–32). Many of these sites were defensively located, but people did not gather in them because they afforded protection. They gathered there for other, social reasons, but because they were temporarily exposed to an elevated military threat while in residence, they chose a defended location.

When we take the duality of this settlement-pattern structure into account, we can explain why sago-and-hunting polities had such large territorial areas. Our population figures refer to the total polity, the people whom the Australian Administration summoned to the community's central settlement to be accounted for in a census. In the normal course of events, however, these members were dispersed across the landscape in small camps. The effective polity, in other words, was not a community that averaged 57 people exploiting an area of 98 km^2 from a central site. Rather, it was a bush camp that comprised just one or two families—8 to 10 people at most—exploiting a territory of some 14–17 km^2. It was a territory, in other words, that brings these sago-hunting systems into line with the lower bound of our predictions.

2.5 The Sago-and-Fishing Regime: Canoes, Clumped Resources, and Defensive Nucleation

In contrast to sago-and-hunting communities, sago-and-fishing villages resorted to nucleation rather than dispersal for military security. The remarkable feature of these aquatically adapted, wetland communities, in fact, was the sheer *number* of people who clustered together. Although densities under sago-and-fishing regimes were only marginally greater than those of sago-and-hunting communities, these aquatically adapted villages had median and mean populations of 210 and 283, respectively, some of which were the largest conurbations anywhere in New Guinea. Nubuai, a Waropen settlement on the northwest coast, for instance, numbered at least 1700 people at contact, and the two contact-era village complexes that made up the Numai-speaking Koriki "tribe" had at least 3960 inhabitants between them (Roscoe 2006, p. 40). As we would expect, the territories that supported these populations were considerably larger than those of dryland, terrestrially adapted communities (Fig. 2.8).

Being large and nucleated, these communities were formidable targets; unless enemies managed to muster a massive numerical superiority, they were rarely attacked directly (Eyde 1967, p. 73; Harrison 1993, p. 39; Williams 1924, p. 107). But how could people who were dependent on such a low-productivity subsistence regime—many of these aquatically adapted communities were actually complex forager communities (Roscoe 2002, 2005)—support such large conurbations and exploit the resources of such extensive territories?

There appear to be two complementary answers to these questions. To begin with, the limiting subsistence resource in these sago-dependent villages was the faunal staple—fish, crustaceans, waterfowl, and the like, which are spatially clumped in or around rivers, lakes, estuaries, and oceans, and often further

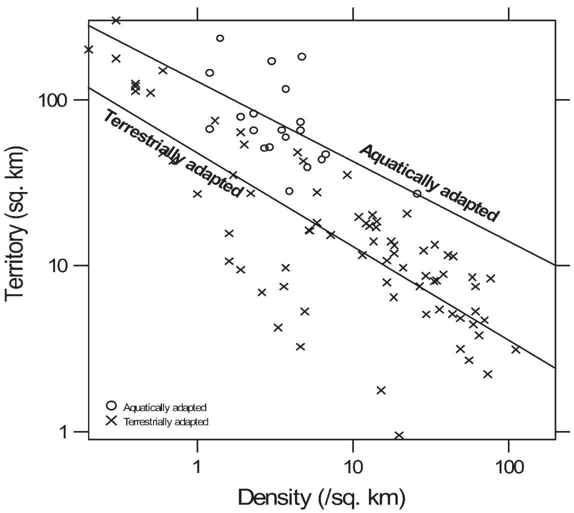


Fig. 2.8 Variation of territory size with population density, aquatically and terrestrially adapted groups. *Circles* represent aquatically adapted, wetland communities, crosses dryland, terrestrially adapted ones. Data plotted on logarithmic scales to reduce skewness toward large values. ($n = 95$)

concentrated in feeding and breeding grounds. In New Guinea, the vegetation bordering waterways—mangrove in tidal reaches, elephant grass (*Pennisetum purpureum*), and other reeds edging freshwater—is particularly rich in faunal resources, as are mudflats, spots at the mouths of tributaries, and estuary reaches subject to tidal mixing. By nucleating their settlements close to particularly rich patches of faunal resources, therefore, sago-and-fishing communities could optimize both the defensive advantages of nucleation and the economic efficiency with which they extracted their critical subsistence resource.

Resource clumping helps to explain why sago-and-fishing communities could nucleate, but what accounts for their size and their sprawling territories? The answer appears to be the dugout canoe. Without exception, these were waterborne people who paddled along watercourses rather than walking along paths. The effect of this mode of transportation on their subsistence commuting costs is hard to gauge. No useful data exist on the comparative energetics of walking and canoeing, either in New Guinea or elsewhere. No figures exist either on the average speeds of New Guinea canoes, and what little historical information is to be found elsewhere suggests that, at best, average canoe speeds are no more than 1–2 km/h faster than the 3–4 km/h calculated earlier for burdened, land-based travel.[11] These are small differences, but if the speed advantage of the canoe came at no greater energetic cost than walking per unit time or distance, then a waterborne people could exploit a territory that was as much as 225 % larger than a terrestrially adapted people for the same commuting costs.

Without further data on energy expenditures in travel, this conclusion must remain hypothetical. The further advantage of the canoe, however, lies in the energetics of load transportation, and here, we are on a sounder footing. Little (1987, p. 60) estimates that, in Mexico, four men in a 10-m dugout canoe could have paddled a 780-kg cargo five times more economically over water than they could have done transporting it on foot over land. If New Guinea canoes offered the same order of efficiencies for subsistence procurement, then sago-and-fishing communities could have exploited significantly larger territories than their land-based counterparts for the same commuting costs.

[11]Studies of historically known canoe voyages in North America indicate travel speeds of between 2 and 5.6 km/h traveling upstream and between 2.4 and 13.75 km/h downstream (Livingood 2012, p. 179; see also Little 1987). Long-distance river journeys in contemporary canoes, some of them record-setting attempts, average current-adjusted speeds between 4.7 and 6.4 km/h, with one clocking in at 12.3 km/h. Modern river trips that made no attempt on a record, though, averaged only 3.6 to 4.4 km/h (Livingood 2012, pp. 179–180). These estimates do not control for the number of paddlers in a canoe. This is important because, in contrast to travel over land, the energy put into canoe travel is scalable: All other things being equal, the more paddlers, the greater a canoe's speed. In the days of war, New Guineans commonly commuted between their homes and subsistence resources in large canoe-borne parties with at least two and commonly many more paddlers in each vessel (Eyde 1967, pp. 50–52, 68, 71–72, 348; Harrison 1993, p. 34). The commuting speeds of New Guinea's sago-and-fishing people, in other words, may have been toward the upper rather than the lower bounds of historical estimates, in which case they could have exploited a larger territory for the same commute time.

These are speculative conclusions, but the balance of the evidence does suggest that, for the same time and energy commuting costs, New Guinea's aquatically adapted communities were able to exploit larger subsistence areas by canoe than could land-based populations traveling on foot. If their average maximum commuting range was just 1.4 times that of terrestrially adapted communities, in fact, it would account for their greater mean territorial size (83 km^2) relative to expectation (40 km^2), increasing in direct proportion the nucleated polity population they could support (see Figs. 2.5 and 2.6).

2.6 Horticulture, Hunting, and Livestock Regimes: Nucleation, Dispersal, and Defense

In turning to the other set of New Guinea communities that deviated significantly from the predictions of the basic model—most of the horticulture–livestock communities and almost all of the agriculture–livestock ones—we found that these intensive subsistence regimes had territorial areas below even the most minimal expectations (see Fig. 2.5). This is puzzling because it suggests these groups were less concerned with defensive security than their counterparts who were exploiting less productive subsistence regimes. It is as though low-productivity groups were willing to commute substantial distances to procure the resources necessary to bolster their military strength, while these intensive cultivators sat around at home and let their security suffer. In an environment of constant military threat, of course, it is implausible that people would be so cavalier about their defensive security, and closer investigation casts yet further doubt on the idea. What distinguished these intensive cultivators from their lower intensity counterparts was not a disregard for security, but their high population densities, which transformed their settlement-pattern calculus.

As population density rises, recall that people become ever more closely packed together and are therefore increasingly capable of swiftly mustering a large defensive response in the event of an attack (see Fig. 2.1). At some point, in fact, they will find that they can radically reduce their commuting costs at no more than a marginal cost to their defensive readiness if they abandon nucleation altogether and disperse into small residential units, each surrounded by a patch of land sufficient to raise the crops and livestock on which they depend (Fig. 2.9).

With this switch from nucleation to dispersed homesteads, subsistence-commute costs are so radically reduced that they no longer limit the size to which a political community can grow. Does this mean, then, that polities suddenly explode in size? After all, if military security depends on numbers, and if commuting costs no longer constrain the number of people who can combine for defensive purposes, it would make sense for large swathes of these small residential units to unite into one gigantic community. As the ethnographic record tells us, of course, this did not happen; it did not happen because it would have been impossible. Although territorial boundaries (and polity populations) are no longer constrained

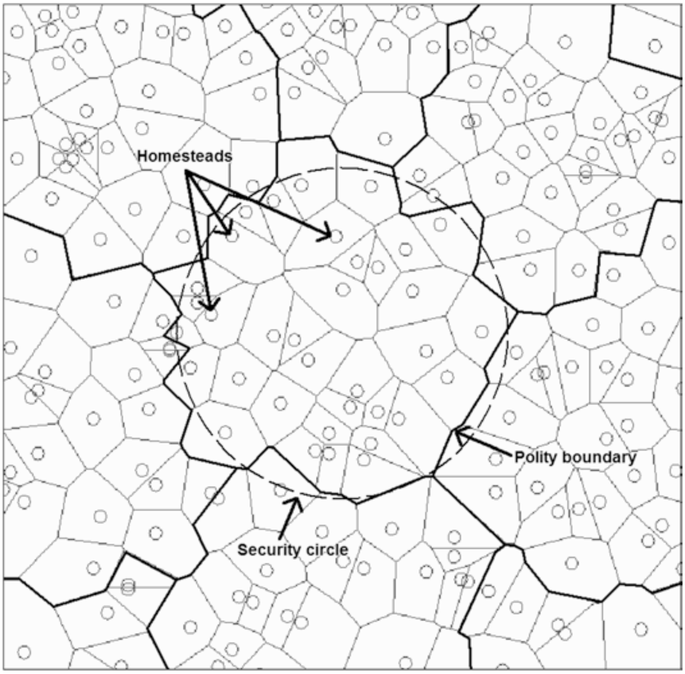


Fig. 2.9 Dispersed settlement pattern with security circle

at high densities by subsistence-commute costs, they nonetheless fall under the control of a second constraint: military response times.

If, as we have argued and as the evidence strongly confirms, polities are mutual defense units, then they necessarily comprise members who are not only willing to render one another mutual defensive aid in the event of an attack but also *able* to do so. For a polity to be a functional defensive unit, in other words, warriors must be located close enough together to be able to render one another effective defensive support. If they are unable to provide this aid—if, for instance, they are situated too far apart—then the mutual interest uniting the polity evaporates, leaving it vulnerable to fission (Roscoe 2013; see, by contrast Bandy 2004; Johnson 1978, 1982). Let us call this area within which community members are able to render one another effective military aid the *security circle* (see Fig. 2.9). Those who live within this security circle share a common defensive interest that unites them as a group; those who live beyond it share no such interest and will form a separate polity based on its own security circle.

Under this new calculus, a political community's territorial area is defined by a security circle, the diameter of which is the maximum distance that a warrior can be from the point of an attack and still arrive in time to render effective military aid. Beyond that distance, mutual military aid is impossible, no bonds of defensive mutuality exist to unite people, and the result is a political fault line. The area of a security circle, therefore, is approximately given by:

$$T_S = \pi \times (V_a \times t_a)^2$$

where T_s is security circle area, V_a is the velocity at which a warrior can run to the site of an attack, and t_a is the time between an attack being detected and when it ends.

So much for theory. In practice, it is difficult to estimate T_s to anything more precise than an order of magnitude. For one thing, it is all but impossible to establish on the evidence available what constitutes *effective* military aid—that is, assistance sufficient to provide a unifying motive for collective defensive action. If warriors are spaced so far apart that they are unable to reach the site of an attack until the action is *nearly* over, will the limited aid they can provide be sufficient to ensure defensive reciprocity or not? For another thing, response times are affected by terrain. Polities that dwell on an open landscape such as a prairie can detect a daylight advance by their enemy and begin to respond much earlier than if they inhabit a terrain blanketed in heavy forest. On firm and flat terrain, moreover, warriors can rally more quickly than across soft or heavily dissected land such as swamplands or mountains. In rugged terrain, even the configuration of ridge top complexes affects response times; other things being equal, more warriors can respond more rapidly to the site of an attack if a ridge complex has a star shape than if it is a single, long ridge (Roscoe 1996; Tuzin 1976, p. 87). Finally, there is the dialectic of military practice. The time between an attack being detected and when it ends, t_a, depends on the speed with which the community under attack can muster an equal and opposite response. If the speed of the response is slow, attackers can prolong their assault. In our high-density intensive cultivation communities, however, the defensive response can be swift; attackers are therefore obliged to hit and then run (e.g., Bergmann 1971, vol. 1, p. 195; Meggitt 1977, pp. 74–76, 93; Roscoe 1996, pp. 651–652; Strathern and Stewart 2000, p. 45).

Assuming a firm, flat, open terrain and that warriors can run at an average speed of about 10 miles/h (17 km/h), the area of a security sphere (T_S) will be smaller than a territory defined by subsistence commuting so long as attacks average no longer than 15–30 min (with previous data and equations, and assuming circular territories). If we assume that such an attack lasted 10 min on average, then warriors could viably render one another mutual defensive aid over a straight-line distance of up to 2.8 km, or within a territory of about 6.2 km^2, which is surprisingly close to 7 km^2, the average territorial area of New Guinea's *agriculture and livestock* communities. If attacks lasted 15 min, the straight-line distance would be 4.3 km and the territorial area 14.2 km^2, close to the 12 km^2 average for the territorial area of the country's *horticulture and livestock* communities. These calculations provide encouraging evidence, in sum, that, at high densities, New Guinea settlement patterns switched from nucleation to dispersed homesteads because their determining calculus changed from a system that traded military strength off against subsistence commuting costs to one governed by the physical exigencies of rendering mutual military aid.

Although they had no idea of its causes, early European travelers in highland New Guinea were struck by the results of this density-induced shift from a nucleated to a dispersed residential organization. Traveling from the moderately populated Eastern Highlands into the densely populated valleys of the Central and Western Highlands, they noticed an abrupt settlement-pattern change from nucleated (and usually palisaded) villages to a dispersed hamlet system. "The most interesting feature of these people," Taylor (1933, p. 53) wrote as he trekked into Chimbu territory, "are [sic] that they make the chessboard type of garden, and that they do not build villages but live in small farm houses instead. When one crosses the Chimbu River the change is immediate, and from then on to Mt. Hagen this type of garden and manner of living persist" (see also Hide 1981, p. 210). "About 10 km east of the Chimbu river," the missionary, William Bergmann (1971, vol. 2, p. 1; see also 1971, vol. 1, pp. 13, 28), observed, "is the borderline for villages and from there on toward Mt. Hagen one finds only the hamlet system." Puzzled by the transition, Bergmann (1971, vol. 2, p. 2) wondered whether Central Highlanders were "somewhat more 'individualists'" than those to their east.

The transition, I propose, had nothing to with individualism and everything to do with a rational evaluation of defensive costs and energetic benefits at high densities. Just how high population density has to be for the transition to occur is difficult to determine, partly because there are so many variables at work but more so because, as Fig. 2.1 demonstrates, rising density erodes the value of nucleation continuously rather than discontinuously. That said, inspection of the Highlands data suggest that the dispersed, hamlet system began to emerge when densities reached about 40 people/km^2.[12]

2.7 Conclusions

To summarize a winding tale, I have sought to demonstrate that, in a context of military threat, settlement patterns in most small-scale societies are determined by a trade-off between the defensive value of military strength and the commuting costs of the food quest. The particular way in which this trade-off manifests itself, however, is sensitive to a range of conditions, including the intensity of subsistence production, population density, transportation technologies, and the military implications of the terrain.

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[12]Readers with more than passing familiarity with New Guinea ethnography may object that a number of lowland, horticulture-and-livestock communities, notably those in the Maprik District—including the Central, Eastern, and Wosera Abelam, and the Yangoru Boiken—had densities rivaling those of the "dispersed" communities in the Highlands, yet their settlements were commonly referred to as "villages," implying that they were nucleated. As I have pointed out elsewhere (Roscoe 1994, pp. 205–207), closer inspection undermines this claim. While it is true that these polities can be classified as "villages" in a *social* sense (as in "village group"), their residents were not markedly more *physically* aggregated than those of the Central and Western Highlands [compare, e.g., settlement maps in Lea (1964) and Roscoe (1996, p. 652) to those in Brown and Brookfield (1967), Bulmer (1960, Map III), and Waddell (1972, p. 29)].

Several specific findings may prove of sufficient interest to archaeologists to warrant further testing and investigation. In low-density, low-productivity subsistence regimes, where commuting between home and subsistence resources is on foot, mean territorial areas tend toward the lower end of expectation—on the order of 15–30 km^2 (see above for the sago+hunting, sago+horticulture+hunting, and horticulture+hunting subsistence regimes). This pattern differs in societies that use canoes in the food quest, which have markedly larger territorial areas—on the order of 83 km^2 (reflecting a commuting radius some 160–240 % larger than in foot-borne communities).

At high densities, in more intensive subsistence regimes, however, a further factor emerges to affect the settlement-pattern calculus: military response times. In these communities, settlement patterns shift from residential nucleation to residential dispersal, subsistence commuting costs cease to determine territorial areas, and territory and polity size are dependent instead on the time it takes a community to muster a military response to an attack. Under most if not all military conditions, these response times result in territorial areas that are smaller than those in low-intensity subsistence regimes—less than 12 km^2.

Finally, this transition in small-scale societies carries an interesting corollary for more politically centralized ones. Politically complex systems generally have more intensive subsistence regimes and denser populations than egalitarian and trans-egalitarian societies. We should therefore expect their territories (and populations) to be determined by the extent of their security spheres rather than by the costs of subsistence commuting. With their greater technological and organizational capacity to organize sentinels, faster modes of transport and communication, and so on, we would expect the scale of these spheres to expand dramatically, thereby explaining perhaps why subsistence production, population density, polity territories, and political complexity appear to have increased in tandem in the course of human prehistory (Feinman 2013; Roscoe 2013).

Acknowledgments Thanks to Terry Hays, Lawrence Keeley, Ross Hassig, and the anonymous reviewers for advice or comments on previous versions and to Amber VanDerwarker and Greg Wilson for their encouragement. Special thanks to VanDerwarker for assistance with the graphics. Figure 2.7 courtesy of The Australian National University, CAP CartoGIS.

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Chapter 3
Food, Fighting, and Fortifications in Pre-European New Zealand: Beyond the Ecological Model of Maori Warfare

Mark W. Allen

He toa taua he toa pahekeheke, he toa mahi kai he toa paumau

Maori proverb: *To be famous in war is soon forgotten, but fame in producing food will always remain*

Few places have been more important to the anthropology of warfare than New Zealand. Detailed accounts of pre-European and protohistoric Maori war are abundant given the late "discovery" of its islands and the long period of contact prior to its annexation into the British Empire, and these accounts provide information that is not usually available. Second, the reputation of Maori warriors and the prevalence of cannibalism have long aroused interest, both sanguinarily and scholarly. Maori warriors and soldiers continued to impress long after first European contact, perhaps most notably drawing the attention of Erwin Rommel and other members of the Afrika Korps in the North African campaign of World War II (Allen 2006; McGibbon 2000). The research of anthropologist Vayda (1960, 1976) produced a widely cited ecological explanation of traditional Maori warfare that can be thought of as a cornerstone in the anthropology of warfare. Subsequent archaeological research on Maori warfare has focused on abundant prehistoric and early historic fortified settlements in New Zealand. These have emphasized the role of economy (Allen 1994, 1996, 2006, 2008; Irwin 1985), ideology (Barber 1996; Sutton 1990), and social power (Allen 1994, 1996, 2006, 2008). This chapter seeks to further examine the economic aspects of Maori warfare and fortifications through an emic analysis of Maori food. The relationship of food and war in

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_3

New Zealand cannot be completely understood through such lenses as behavioral ecology or formal economic theory. As will be seen, some foods have prestige, while others do not, and the roles and statuses of food differed significantly in times of peace and war, as well as throughout the yearly cycle.

3.1 The Ecological Model of Maori Warfare

New Zealand is an ideal location to examine the roles of warfare and economic power in the formation of complex pre-state societies. Definitions of warfare used by anthropologists can vary tremendously. It is common for those who argue for a short chronology of war in human history to "rely on tenuous definitions that are often tautological, inconsistent, or idiosyncratic" and that often blur distinctions among war, feud, and homicide (Allen 2014, p. 20). The definition of warfare followed here is potentially lethal conflict between different communities. Some of the advantages for studying warfare in prehistoric New Zealand include one of the shortest prehistoric cultural sequences on the planet, rich ethnohistorical and oral traditions to complement the archaeological record, and a prehistoric landscape of warfare and power literally carved into hills and ridges above slopes that could marginally support sweet potato (*Ipomoea batatas*) horticulture. Its islands were settled by Polynesians around 800–1000 C.E. Faced with cool temperatures, frost, and rugged terrain, the settlers and their descendants were content for several centuries to more or less set aside a traditional Polynesian horticultural economy and turn to hunting, fishing, and gathering indigenous flora and fauna, including the giant flightless *moa* (consisting of four genera and a dozen or so species of Dinornithiformes). After a few centuries, around 1300–1500 C.E., the development of elaborate storage pit technology and the intensification of sweet potato horticulture led to considerable changes in Maori settlement patterns, economy, and sociopolitical organization (Allen 1996, 2006, 2008; Best 1975, 1976; Davidson 1984, 1987; Kirch 2000, pp. 275–283).

The most obvious change was the proliferation of earthwork and palisaded fortifications called *pa* (the Polynesian word for fence or palisade). The oldest appear to date to about 600 years ago, but most were constructed after 1500 C.E. (Schmidt 1996). They are heavily concentrated in areas suitable for horticulture (close to the ocean to avoid freezing temperatures, near gentle north-facing slopes to capture sunshine, friable soils, and with milder winter temperatures). The vast majority are located along the northern and central coasts of the North Island. Of over 6000 recorded *pa*, only around 100 are located in the colder South Island (Best 1975, 1976; Davidson 1984, 1987; Fox 1976).

The close timing of horticulture, pits, and *pa* has led to the development of a dominant ecological model proposing that limitations to horticulture in New Zealand, the difficulty of clearing temperate rain forest, and population growth resulted in fierce competition for favorable areas (Allen 1996; Davidson 1984, pp. 181–194, 1987; Kirch 2000, pp. 275–283). Warfare, so important in the rest of Polynesia, became central to Maori society. *Pa* were key in this process as they allowed groups to defend their gardens and other coveted resources. This ecological model was primarily constructed by Vayda (1960) based on his classic analysis of Maori warfare through oral history, ethnography, and ethnohistory. In particular, he emphasized that endemic warfare made sense in New Zealand due to the relative scarcity of appropriate gardening areas and the difficulty of clearing the temperate rain forest that covered much of both major islands.

3.2 Economic Power and Warfare: The Role of Maori Fortifications

In the early 1990s, I conducted a regional analysis of a roughly 55 × 50 km study area in the mid-Hawke's Bay on the east coast of the North Island (Allen 1991, 1994, 1996). My goal was to expand the ecological model of Maori warfare by analyzing the distribution of *pa* throughout the region to understand their economic and political contexts. I visited and mapped or remapped some 130 *pa*, each one sited to take advantage of natural defenses, but augmented with palisades, ditches, banks, and terraces (Fig. 3.1). Some of these earthworks were quite elaborate and extended over several kilometers of hills and ridges. Each site is unique, a product of a group of people intent on enhancing their security from attack from enemies near or far. One of the main contributions of my research was the perspective that Maori fortifications were part of a political process and not just a static means of defense. I refer to them as the nexus of polity formation and

Fig. 3.1 Aerial view of site V22/13, a *pa* of modest size located within the Te Hika a Papauma polity of mid-Hawke's Bay. The steep slopes of the ridge are supplemented by three transverse ditches and a few additional transverse scarps, as well as several lateral scarps and terraces. The defenses would have been further protected with palisades. Enclosed within the defenses are eleven storage pits and five likely house platforms, and several more pits are located just outside of the ditches at either end of the site. North-facing slopes around the site were likely used for gardening. View to the west, photograph by the author, February 1990

the means by which *ariki* (chiefs) built and consolidated regional power, a view endorsed by Kirch (2000, p. 283) in his masterful synthesis of the archaeological history of Polynesia.

I used central place theory, rank size, and catchment analysis in combination with ethnohistory and Maori tradition to reconstruct six polities and other smaller groups that dated from around 1500 C.E. to the early nineteenth century. The two largest of these meshed well with Maori history as two different factions of the *iwi* (tribe) Ngati Kahungunu: Te Hika a Ruarahanga to the north in the area of a famed brackish lagoon called Te Whanganui o Orotu and the Tutaekuri River and dominated by the inordinately large Otatara Pa with an impressive large chiefly house site at the summit; and Te Hika a Papauma associated with a series of inland valleys and lakes to the south. These chiefdoms were separated by a buffer zone along the Ngaruroro River (see Allen 1996, p. 179, Fig. 4).

I employed data on soil types, rainfall, frosts, and vegetation to reconstruct the economic resources of these groups; I also calculated labor investments, storage volumes, and residential data to document how each polity sought to protect itself and its resources with *pa*. This work revealed that fortifications in mid-Hawke's Bay were situated tactically and strategically to control access to resources and movement corridors.

In sum, my research in Hawke's Bay documented the association of *pa* with favorable economic resources, but discounted Vayda's emphasis on the costs of clearing forest for gardens given the relatively warm and dry summers of Hawke's Bay. Analysis of site catchments and ethnohistory revealed that marine, riverine, lacustrine, and forest resources were also protected by fortifications. Horticulture only provided a portion of the pre-European economy, and in many inland areas, it was negligible. I argued that Maori leaders organized and financed the construction of *pa* through attracting followers with security and surer access to resources. While fortified communities were the nexus of polity formation, they nevertheless also served to *limit* the power of chiefs (Allen 2006, 2008). The Maori *pa* was a sophisticated and highly effective fortification that could (more often than not) resist direct attacks. Utilizing the perspective of military science, I have pointed to the inherent advantages of defense, particularly with fortifications, in pre-state-level societies, and argued that archaeologists often do not appreciate the role of fortifications wherever they are to be found. Fortifications make regional consolidation extremely difficult in pre-state societies, as should be recognized by any model of warfare and political organization (Allen 2006, 2008; Arkush 2011; Liu and Allen 1999).

As others (Marshall 2004, p. 70; Phillips and Campbell 2004, pp. 98–99) have noted, my interpretations stand rather apart from those of most New Zealand archaeologists. This is because my colleagues there have not attempted to replicate my approach over a large region where polities and boundaries can be identified through spatial analyses. While my study region in Hawke's Bay was about 2000 km^2, other studies of site distribution in New Zealand have been limited to regions ranging from only 9 to 165 km^2 (Marshall 2004, p. 79, Table 3.5). Nevertheless, Marshall (2004, p. 70) proclaims "Allen's assumption that settlements could be equated with discrete social groups occupying fixed territories was highly problematic in the New Zealand context." If I follow her argument, since no other (small) regional study has detected polity boundaries in New Zealand through the distribution of *pa*, they did not exist, and therefore, either Hawke's Bay is unique, or I created polities out of statistics. I might suggest that a larger study area would yield similar results in other areas of New Zealand. Nor do my critics engage with the other half of my evidence: that of the Maori history of Hawke's Bay. Unfortunately, New Zealand archaeologists have a long history of their own that has all too often failed to use or even acknowledge the perspective and knowledge of Maori people in the areas where they work. Instead, my project embraced this information, and I have maintained an active research partnership that has been continuously vetted through the tribal government as well as local *kaumatua* (elders) of the various regions in Hawke's Bay since 1990 (Allen 1991). In short, the polities delineated in my research were not created by me on a computer; they existed in the past and are still there today in the form of *wharenui* (meeting houses) standing on *marae* (communal areas belonging to local groups called *hapu*).

3.3 Maori Views of Maori Foods

A productive new direction for research on the roles of economy and warfare in prehistoric New Zealand is to build on earlier studies through Maori perspectives on food. While my earlier work was heavily influenced by cultural ecology, Marxism, and social power theory, here I take a broader look at food resources and their meanings to the people of the past and present. I take advantage of rich ethnographic sources on Maori agriculture, hunting, and gathering as well as perspectives of the present-day Maori people. This is a landscape approach that looks beyond soil types and frost patterns to see the resources from the Maori point of view. My questions include the following: (1) How the Maori perspective on food can add to the ecological arguments of past studies; (2) how the status of different foods affected the political and military decisions of leaders and followers; and (3) how different types of food resources relate to the nature of fortified sites. The first step is to consider the full range of foods available to the pre-European Maori.

3.3.1 Horticultural Products

When the first canoes touched the shores of New Zealand, they were likely stocked with a wide variety of Polynesian cultigens that were well suited to coral atolls, high volcanic islands, and other types of islands in the tropics. Most of these, however, failed to be widely adapted to the wet and frosty winters of New Zealand. Likely, the mild northern third or so of the North Island served as a sort of nursery where some plants survived the first few centuries of human colonization, though it is also possible that plants that initially failed were reintroduced later (Best 1976; Colenso 1881; Davidson 1984; Firth 1972; Fox 1974; Leach 1979, 1984; Vayda 1960; Yen 1961, 1974). As noted earlier, it was the development of new storage technology that enabled tropical cultigens such as the sweet potato and taro to become fairly common staples in favorable horticultural areas.

The most important cultigen in New Zealand was the sweet potato or *kumara* (Best 1976, pp. 99–227). Best (1976, pp. 111–116) lists well over 80 different names for varieties of *kumara,* though there is likely considerable overlap among these. In general, the tubers of the sweet potato were grown along gentle slopes in well-drained, friable soils near the coast. Soils were often improved for cultivation through the addition of sand and gravel. The tubers were usually planted in shallow mounds (*puke*), often protected by windscreens (usually wooden fences or stone walls), and covered with a layer of gravel to protect them from cold or wind and to retain sufficient moisture. Planting of tubers was restricted to men and conducted in early spring during the month of October. The work was highly ritualized and coordinated by a *tohunga* (priest, specialist). Garden plots were communal, but were subdivided by family groups. The garden was under the domain of the agricultural deity Rongo, often depicted or evoked with carved stone figurines or preserved human heads. The garden was highly *tapu* (Firth 1972, pp. 245–281). *Tapu* means simultaneously unclean and sacred, and something *tapu* is to be both avoided and respected. However, people of different statuses approach *tapu* objects or actions in very different ways. Penalties for disturbing the crop were severe, including death. Smaller groups planted their *kumara* in many small scattered patches sometimes considerable distances from habitation areas to avoid destruction by marauding war parties or *taua muru* (plundering parties comprised of local people to avenge an insult or broken *tapu*). In contrast, larger groups could maintain gardens in the open and close to their *pa* (Best 1976, pp. 132, 140).

Kumara, while fairly hardy in the ground, were extremely vulnerable after being harvested. The intensification of this plant depended on the development of intensified storage technology to protect tubers from cold and wet conditions during the winter months. Storage facilities (*rua*) were roofed pits with drains, shelves, and sufficient insulation to protect the tubers. They were stored in baskets, with next year's seed crop (compact tubers with many *whata*, or eyes, as they produce more shoots), and kept separate from the stores meant for winter consumption. Storage pits are highly visible in the archaeological record of the North Island (Fig. 3.2). The *rua*, often with raised rims along the east coast of the North Island, are quite numerous in landscapes where gardening was commonly practiced (Davidson 1984; Fox 1974).

The next most important cultigen was taro (*Colocasia antiquorum*). There were several varieties present in New Zealand, but it could only be grown in the warmest parts of the North Island. Taro requires moister soil than *kumara*, though there is no evidence that irrigation was present in New Zealand. This crop was not considered *tapu* and lacked the prestige of *kumara* as a food. Both men and women were involved in planting and harvesting taro. It was planted in small isolated

Fig. 3.2 Aerial view of raised rim *kumara* storage pits within a portion of Tiramoana Pa (W21/1), a site within a small coastal polity at Te Awanga in mid-Hawke's Bay. View to the north, *photograph* by the author, February 1990

patches and required no special storage facilities. These tubers were often simply left in the ground until eaten or were placed in piles covered with rushes (Best 1976, pp. 233–243).

Uwhi, yams (*Dioscorea* spp.), were the final Polynesian food crop, grown only in the far north and along the warmer stretches of the east coast of the North Island. This plant was not associated with *tapu*, and like taro did not depend on special storage facilities. Little is known about the use of yams in New Zealand, but it is clear that they were present prior to European contact (Best 1976, pp. 228–232).

Three other plants were transported to New Zealand by Polynesian colonists. The most important was a variety of the *ti* tree (*Cordyline terminalis*), the bottle gourd (*Lagenaria siceraria*), and the paper mulberry (*Broussonetia papyrifera*). The first was a food source and discussed below, but the other two were used for storage containers and clothing or mats, respectively.

3.3.2 Semi-Cultivated Foods

The introduced variety of *ti* produced an important food for times of war, but like taro and *uwhi* was limited to the northern part of the North Island where temperatures were warmer. It was called *ti pore* in New Zealand, and it was planted but not tended. The edible part of the tree is a large root which was beaten and steamed in an earth oven (*hangi*), forming a sugary mass that was "highly esteemed, not only for its agreeable taste, but for its nutritive and keeping qualities, especially in times of war, when it was a question of provisioning the *pa*, or carrying food on the war path… it is probable, however, that owing to the slow growth of the plant, it was most generally used as a sweetmeat" (Best 1976, pp. 257–258).

Several other varieties of the *ti* plant were indigenous to New Zealand, and the leaves and taproots of many of these were similarly used as a food which could be stored a long time, or for periods when other foods were unavailable. The most common is *Cordyline australis*, generally known in New Zealand as the cabbage tree. It had many names, but a widely used one was *ti kouka.* Its uses and importance varied considerably across New Zealand (Roskruge 2012, pp. 55–57). In the Hawke's Bay region, it provided an important food during the winter months when other crops were unavailable, and *ti kouka* "is sweetest when the first frosts have arrived" (Robert MacDonald, personal communication, 2013). Perhaps the highest status indigenous variety of *Cordyline* was called *ti para*, and in some areas, it was planted and harvested with considerable ritual (Best 1976, pp. 258–272). In sum, the *ti* plant was sometimes an important food, particularly during times of scarcity, and it is common to see a number of them in the vicinity of archaeological sites.

3.3.3 Gathered Plants

In most of New Zealand, cultigens were not viable. This includes nearly all of the South Island and much of the inland regions of the North Island. Short frost-free periods were anathema to tubers. Consequently, the most prevalent staples for the Maori were gathered native plant resources. The most important was *aruhe*, the rhizome of bracken fern (*Pteridium esculentum*) (Shawcross 1967). The root was dried, roasted, pounded, and formed into cakes or rolls 15–25 cm long and called *komeke*. The bracken fern was found throughout Polynesia and was nearly always a food source. However, for all islands but New Zealand, it was a famine food, eaten only when all else had failed. While relatively nutritious, the root required substantial preparation and produced a tough, fibrous meal that wore teeth extremely quickly (Houghton 1980). An apt Maori proverb states that *ko ora karikari arhue, ka mate takiri kaka* (a fern root digger has plenty of food, but a parrot-snarer will go hungry). Perhaps the need to resort to fern root as a staple best illustrates the marginal nature of the New Zealand climate and biogeography for the cultivation of Polynesian tubers. It further heightens the value of the areas which were cultivable.

Yet in war, *aruhe* was the preferred food of warriors on the march, even for the elite. One could count the number of *ariki* (chiefs) in a *taua* (war expedition) by the numbers of chewed and discarded remnants of specially prepared *komeke* (Best 2001, pp. 63–64). If at all possible, slaves were brought along on *taua* to carry *komeke*, as it would pollute the *mana* (spiritual power and prestige) of warriors, both commoners and chiefs. However, if this was not possible and the party had to carry its own supplies, *komeke* were carried in the left hand as that side of the body is *noa* (profane, ordinary), while the right side has *mana* (Best 2001, p. 64).

Other gathered plants were numerous. These included a variety of berries such as those from the *karaka* (*Corynocarpus laevigatus*), *tawa* (*Beilschmiedia tawa*), and *kahikatea* (*Dacrycarpus dacrydioides*) trees. These trees are fairly common in the vicinity of archaeological sites. Other gathered plants are described in Roskruge (2012).

3.3.4 Terrestrial Animals

New Zealand was animal poor, with the exception of birds that underwent adaptive radiation to fill a number of niches normally reserved for mammals or marsupials. The most obvious source of food among them was the variety of giant flightless *moas*, but they were extinct within a few centuries of human colonization (Anderson 1989; Davidson 1984). Dozens of other birds were similarly extinct or extirpated due to losses from hunting, raiding nests for eggs, and especially habitat destruction.

By late prehistory and the early contact period, many species of birds were understandably considered a prestigious and/or highly desirable food. Preferred species included the muttonbird (*Puffinus griseus*), pigeon (*Hemiphaga novaeseelandiae*), and the *tui* (*Prosthemadera novaeseelandiae*), but there are dozens of others (see Davidson 1984, pp. 134–137). Birds were usually caught with snares, and they were mainly hunted by specialists armed with both effective traps and considerable magical assistance (Firth 1972, pp. 145–169). Firth (1972), in his classic work *Economics of the New Zealand Maori*, completed a thorough analysis of fowling. He noted:

> [t]he bulk of the birds from the snaring are set aside for preserving. .. the pigeons or *kaka* parrots, or whatever they may be, are then roasted before a fire, and packed in calabashes, boiling fat being poured in over them to fill up the gourds and so seal them up in airtight fashion. Birds so preserved are termed *huahua manu* and are esteemed a great delicacy at a feast. Very often they will form the center piece of the occasion. The calabash is provided with carved wooden legs, a carved mouthpiece, *tuki*, is lashed to the top, a small mat wrapped around, for decorative purposes, and the whole adorned with feathers of hawk or pigeon which are hung in bunches from legs and sides. Such a *taha huahua* – a calabash of preserved food – is very much admired, and as forming the principle item of the feast was placed before important guests or presented to the chief persons of rank present (Firth 1972, pp. 164–165).

Their status as a prestige food is further illustrated by their manner of storing. The calabashes were kept in highly decorated elevated storage structures called *pataka*. These structures consisted of wooden structures decorated with carvings placed on top of pillars to protect stored birds and dried fish from *kiore* (rats) (Phillipps 1952, p. 95). *Kiore* (*Rattus exulans*) arrived in New Zealand as stowaways on the colonizers' oceangoing canoes. They, too, were eaten, but as a low prestige food. The Polynesian dog (*Canis familiaris*), or *kuri*, was the sole purposefully transported mammal to survive Polynesian voyaging to New Zealand. Neither pigs (*Sus scrofa*) nor chickens (*Gallus gallus*) evidently made it through the beachhead bottleneck (Keegan and Diamond 1987), though they are fairly common throughout Polynesia (Kirch 2000). To be sure, the appearance of a two-meter-high *moa* at the first landings might have led to a serious devaluation of any chickens that managed to survive an ocean crossing. Dogs were useful for hunting, security, refuse control, and as a source of fur cloaks, but nevertheless were also eaten.

A final source of animal protein that was obtained on land came in the form of sea mammals, mostly seals (Davidson 1984, pp. 131–133). This was most common along the coast of the South Island where habitats were favorable.

3.3.5 Freshwater Foods

Several freshwater resources served as important foods, particularly for inland regions far from the ocean. These included species of fish, but more importantly eels (*Anguilla* spp.) called *tuna.* Freshwater mussels, *kakahi* (*Hydrilla menziesii*), were edible, but not regarded as a high-quality food compared to ocean shellfish (Davidson 1984, pp. 141–145; Firth 1972, pp. 68, 72, 171–172, 181).

3.3.6 Kaimoana (Seafood)

Most protein was derived from the ocean in the form of fish and shellfish. Dried and smoked fish could be kept in the elevated *pataka* along with dried fern roots and birds for periods up to months. A wide variety of fish were taken with nets, lures, and hooks, both from the shore and from canoes. Fishing territories were well known and demarcated, using coastal headlands and other landmarks (Barber 2003). The brackish Inner Harbour of Hawke's Bay (Te Whanganui o Orotu) was famed for flounder (*Rhombosolea plebeia*), one of the major reasons it was invaded by elements of the Ngati Kahungunu *iwi* (or tribe) around 500 years ago (Allen 1996; Liu and Allen 1999). Upon hearing about the harbor and its abundant food, the chief Tawhao declared, "the harbour shall be my garden" and the chief Taraia, hearing about the abundant *kahawai* (a fish, *Arripis trutta*) in the Ngaruroro River claimed it "shall be my drinking cup" (Prentice 1976, p. 40). Nearly all archaeological habitation sites within a few kilometers of the coast have shell middens. But it is also clear that there was tremendous variation in the abundance and diversity of shellfish along the coast. Such spots are still well known and well used today.

Sharks (*mango*) were pursued from canoes, usually during expeditions organized by chiefs, attendant with considerable *tapu* (Firth 1972, pp. 227–230). Shark fishing was a metaphor of war against sea monsters called *taniwha.* Chiefs dutifully pursued these real *taniwha* just as the mythical *raison d'être* of European knights was to slay dragons.

Less elusive and far less dangerous, *karengo*/*parengo* or seaweed [(*Porphyra columbina*) (Roskruge 2012, p. 45)] was collected off rocks at low tide (though I took a nasty fall in pursuit of some in July 2010). There is an important site for this at the southern end of Ocean Beach in Hawke's Bay, where it is gathered by Maori people in late August or September, for it appears only during the coldest part of the winter after substantial rainfall. It was thus an important food during the time of greatest food scarcity.

3.4 Maori Food, Maori War

With the menu set but for one important course, the next step is to more fully consider how foods fit into Maori warfare, as a motive for attack, a need to protect or control resources, and in the practice or conduct of war.

3.4.1 Kaitangata (Cannibalism)

The last source of food prior to European contact provides the starkest link between food and war in prehistoric and early historic New Zealand. *Kaitangata* (people as food or eating people) was a major source of nourishment for *taua* when in neutral or enemy territory (Best 2001; Vayda 1960). It was also the reward for a successful rout or sack of a community. War parties travelled light and fast, and other than fern root bundles to last a few days, they had little or no commissariat. The ideal outcome was to sack a community and then to devour captured stored foods and then to cook and eat the slain. If this was not achieved, a secondary goal was to at least kill one or a few people outside of their defenses for sustenance. War parties quite literally lived on their enemy. Successful warriors might gorge on human flesh for days at the scene of their victory, enjoying "*Te Ika a Tu*" (the fish of Tu, the war deity), the victims in battle or sacking of a *pa*.

A key function of *kaitangata* was to insult the enemy and to destroy their *mana*. For example, the ultimate insult was to convert men to cooked food and then to use their bones to construct utilitarian tools used for gathering yet more food. Their heads might be smoked and preserved and then displayed next to the victors' ovens to continue to humiliate them by associating them with the female realm of food preparation. Any human flesh taken back to home communities was carried by a few prisoners (likely related to the flesh they were forced to tote) kept alive long enough to accomplish that *tapu* task.

As noted by Best (2001, p. 65), "it [*kaitangata*] was a source of pure unadulterated joy to the old-time Maori; to be able to say to an enemy, 'I ate your father' or 'your ancestor,' although the occurrence may have occurred ten generations before his time." I saw this very thing in 1990 when I accompanied a member of the *iwi* (tribe), Ngati Kahungunu, to visit another community two hours south. When he met one of the local fellows, one of the two pointed out that his ancestor had eaten one of the other's ancestors. They laughed about it, but there was most certainly an uncomfortable atmosphere.

Kai oraora were chants composed by those eager to kill and eat their enemies in the future. An excellent example is an excerpt from one composed by the Tuhoe (an *iwi* on the East Cape of the North Island) *ariki* (chiefs) Taru and Te Nau against their enemies, the Ngati Ruapani (Best 2001, pp. 91–92):

Whakataha koe, E Te Ariki! ki tahaki
Kia haere iho aku niho i runga i tō tipuaki
Ka pakeke tō kutu, te riha, i aku niho

I te apunga i ngā roro o Whakapiko
Taku kai – e
Kai kutu au, kai roro au
Kai takatakanga hou ōu e Horu
Te titohia iho ki te tukituki
U rere ana te wharawhara
Aside with thee, O Te Ariki!
That my teeth may gnaw thy skull,
That the parasites may be crushed,
When glutting on the brains of Whakapiko
O! My food!
A parasite, a brain eater am I!
An eater of thee, O Horu!
When stricken and smashed
Then fly the fragments!

Kaitangata was most certainly not a staple. It was relatively rare, with incidents remembered for centuries (and as my anecdote from 1990 illustrates, still counting). But without question, human flesh was the highest status food of all and usually reserved for elites and warriors after a successful raid or attack.

3.4.2 Kai Tapu (Food Prohibitions) and War

It has already been noted that a primary concern for chiefs and others of status was maintenance of their *mana* by avoiding *tapu* prohibitions. Firth (1972, p. 181) states that "cooked food and all things connected therewith were the very antithesis of *tapu*." Men did not cook food in underground ovens, collect firewood, nor carry cooked foods on their backs, as demonstrated by the manner in which roots were carried by war parties.

Tapu could also be used as a political and economic tool. Chiefs could place resources under *tapu* through planting carved wooden posts (*rahui*) in their vicinity to declare them off-limits to their followers or members of other groups (Firth 1972, p. 258). As the survey of food items undertaken earlier revealed, many important economic resources were at *all* times considered highly *tapu* and thus were approached only by authorized specialists or with chiefly or priestly (*tohunga*) oversight. These included *kumara* gardens, fishing grounds, eeling weirs, fowling, and shark fishing. Violation of *tapu* restrictions was a frequent cause of war as it was not just theft. Such resources could be damaged or contaminated irreparably by encroachment or trespass. Even an insult to a *tapu* resource was just as bad as actually taking it through force or theft. Food was not easy to come by in New Zealand, and the most desirable of foods were the most difficult to secure. As a consequence, threats of any kind to food functioned as a hair trigger to violent response, required by an ideology of *utu*, or revenge. As I have noted elsewhere:

> [W]hile all Polynesian societies have similar cultural concepts to maintain *mana* against insult, affront, or attack, the Maori ideology of *utu* is unique. This deeply embedded value system evolved in New Zealand under conditions of endemic warfare. It served as an incentive to maintain a strong deterrent that tolerated no transgression whatsoever. A failure to retaliate to any kind of threat or attack was an invitation to more attacks, perhaps even direct assaults aimed at destroying or removing a group. Fierce and assured counterstrikes were the best means to maintain land and to protect a polity. This was in effect a policy of mutually assured revenge (Allen 2006, p. 208).

Recently, Barber (2012) has examined the role of *kumara tapu* in the first documented encounter between Europeans and Maori. He points to archaeological data which reveal a few *pa* sites, concentrations of *kumara* pits, and improved garden soils in the immediate vicinity of the shoreline when Abel Tasman and his two Dutch ships entered Golden Bay in the northwest corner of the South Island in December 1642 (Fig. 3.3). This would have been in the middle of the *tapu* period for gardens. This encounter ended violently as a number of war canoes cut off a small boat going back and forth between the two ships as Tasman was trying to establish friendly relations. Three Dutch crewmen were killed, with one body being hauled back to shore for (with little doubt) *kaitangata*. Barber argues that

Fig. 3.3 View of Anatakapau Bay, Mutton Cove, and Separation Point in Abel Tasman National Park. Separation Point was one of the *pa* sites that defended the gardens, fishing areas, and shellfish resources of Golden Bay. Likely, its inhabitants were involved in the response to Abel Tasman's ships. The violent encounter between the local Maori people and the Dutch took place in Golden Bay a few kilometers northwest of Separation Point. View to the north, *photograph* by the author, August 2014

this violent response was likely because of the threat to the *tapu* of the gardens. He notes that harvesting ceremonies were required to lift *kumara tapu* and that these often invoked the mythological struggle between the deities Rongo (agriculture) and Tu (war) and thus argues, “the harvest officiator acting as Tū digs up selected crops, effectively killing and devouring Rongo” (Barber 2012, p. 804).

Barber further argues that the Tasman encounter escalated from defiant challenge to violence because of this perceived threat to the *tapu* of the gardens. He points to the next recorded encounter in the north of the South Island, that of James Cook in Queen Charlotte Sound in January 1770, which “resolved into social interaction following a standard show of defiance” (Barber 2012, p. 806), with the critical difference being that this latter encounter occurred in a region without horticulture. Barber’s interpretation is that the Maori response to the Tasman visit was unusually violent because of special circumstances:

> [It was] an outcome of Māori identifying a Dutch threat to highly regulated production. Māori warnings and hostility may also have channeled expressions of concern and fear around the intrusion into, and potential ritual violation of, the *tapu* and gardens in the care of Rongo. The Dutch had come in effect, as Tū rather than as Rongo, where in the middle to later part of the myth cycle, the *kūmara* was threatened and eventually taken by force in the depredations of the war god and his allies (and representatives) (Barber 2012, p. 807).

I would agree that this was likely perceived by the *tangata whenua* (people of the land) of Golden Bay as a direct threat to their gardens and the *tapu* on them. However, we have nearly exactly the same scenario in Hawke’s Bay in October 1769 when Cook arrived in *Endeavour* (for details see Allen 1994, pp. 160–168). *Endeavour* was also challenged by a large number of well-coordinated war canoes. Unlike the Dutch, who may have misread the situation through not understanding the dire nature of the threats (while it is not obvious how this could happen, it is possible), Cook had aboard the Tahitian chief Tupaia, and he provided rough translation which left no illusions as to the intentions of the defensive force. They were in effect saying: Come down out of that large canoe and fight like men, we will smash your skulls with our war clubs and then eat you! Cook wisely deferred to drop down a smaller boat. In one encounter off the coast of Mid-Hawke’s Bay, he fired warning shots with cannon to stifle an imminent attack by a number of coordinated canoes. After this remarkable display of smoke and sound, a more peaceful group was persuaded to approach, and trade was conducted. However, the following day, Tupaia’s young servant or son was seized by another group engaged in trade and forced into one of their canoes. Cook, obviously ready for this sort of event, ordered his men to open fire on the fleeing canoe and killed or wounded several of the Maori, and in the traditional historical view at least, the young Tahitian was able to jump out and was rescued. The perspective (passed on orally since the incident) of the local *tangata whenua* is that rather than abduction, the men in the canoe were the ones trying to rescue the boy from the clutches of such strange-looking people. Many local Maori people are not pleased that the prominent headland where the incident occurred is known as Cape Kidnappers, rather than by its important Maori name of Te Matau au Maui (the Fish Hook of Maui), where the deity himself hooked and pulled up the North Island from the sea.

Similar tense and sometimes violent encounters took place along the coasts of New Zealand at different times of the year (not just at harvest time) during the early contact period. The difference that matters is not whether there was or was not harvest *tapu* underway at the moment. It is that Cook was more experienced and judicious in Polynesian encounters than Tasman or others, such as the French officer Marion du Fresne slain in the Bay of Islands in 1772. He knew better than to lower small boats into the kill zone of far swifter and more numerous war canoes paddled by obviously hostile and coordinated forces. Of course, a few years later, he seems to have lost his situational awareness and was himself killed in Hawai'i.

Barber (1996) has also argued that *pa* fortifications are best seen as monuments that symbolized group identity rather than as pragmatic forms of defense. The argument that the Tasman encounter in Golden Bay encounter was unusually hostile and not the normal response of Maori to unexpected visitors is in this same vein—it downplays the seriousness and ferocity of Maori warfare. Defiance toward enemies was not scaled down when garden *tapu* were not in effect. Vigilance and *utu* were constant and ever-present. It did not matter which season the Dutch showed up in Golden Bay, they likely would have received the same response (even if opposed by a smaller force) and the same outcome if Tasman had dropped down small boats in harm's way. As the character Chef learned during a curtailed mango expedition in the film *Apocalypse Now*, never get out of the boat.

3.4.3 The Seasonal Cycle of Food and War

Firth's analysis of Maori economics outlines the annual cycle of work (Firth 1972, pp. 70–89). This had a tremendous bearing on the conduct of war. The planting of the *kumara* crop in October signaled the start of the war season. The cultivation season started with the first appearance of the star called Rehua (Sirius) in the night sky, also called Rehua Kai Tangata, or Rehua the Eater of Men (Best 2001, p. 151). It was thus both the sign of planting and upcoming war. When the tubers were securely planted under proper direction, men were freed up from gardening labor and tending the crop then fell to women and children for the spring and summer. The onset of harvest in April often meant the end of the war season as men returned to economic activity.

Another reason this was the time of war was the relative abundance of food in the spring and summer (November through March). It was the time of greatest surplus and variety of available resources, making it easier for war parties to find food while on the move and at the same time enabling communities to sustain themselves during the absence of young men.

3.5 Food and Fortifications in Prehistoric New Zealand

The association of fortifications and economic resources has long been obvious, from the first observations of European visitors. *Pa*, in addition to their role in protecting people from attack, housed food stores and functioned to secure gardens and other resources (Allen 1996, 2006, 2008; Best 1975, 1976; Davidson 1984, 1987; Fox 1976; Vayda 1960).

The analysis of polities and their *pa* and resources completed in Hawke's Bay offers a clear illustration that the most favorable resources produced the largest and most integrated political formations in the region (Allen 1994, 1996). The largest polity was Te Hika a Ruarahanga, associated with prime garden lands with long growing seasons, the unique brackish lagoon Te Whanganui o Orotu, excellent access to rivers, and proximity to the ocean. This polity illustrates the ability of a fairly complex chiefdom to rely on population size as a major deterrent to attack. It had a concentration of large fortified communities able to ostentatiously display stored foods. *Kumara* pits are common, both within and outside of *pa*, and highly decorated raised storage buildings such as *pataka* for storing dried fish and fern roots were also likely constructed on the numerous terraces within the polity. Particularly noteworthy, this polity had a number of fortified food stores for *kumara* along the Tutaekuri River located some distance from the fortified habitation sites. They were capable of defending these with small garrisons and the threat of immediate reinforcement. These were the property of the chiefs of Te Hika a Ruarahanga, making them part of the political economy of this chiefdom. The chiefdom clearly had inordinate access to the highest status foods in the region and was also able to display these resources with little fear of losing them.

The next largest polity, located across a "no-man's land" of about 15 km, was Te Hika a Papauma. Though it was of similar population size to the Ruarahanga polity, it was not as integrated. Rather than having central places, it was comprised of confederations of closely allied clusters of similarly sized *pa*. While nearly all of the constituent fortifications have a number of internal storage pits visible, there are only three or four relatively small dedicated fortified food storage sites in Papauma. Furthermore, these are located in the middle of the polity rather than on the margins as are those along the Tutaekuri River. They are well behind the border of the polity, modest in scale, and clearly not ostentatiously displayed.

The next scale of communities in the region includes a number of small coastal polities characterized by a dozen or so fortifications each. These small polities lack evidence of marked integration. Their *pa* include storage pits, but there are no specialized fortified food stores as seen in the two larger polities. The primary resource base of these polities and *pa* is clearly *kaimoana* or seafood. The beaches of these polities have high densities of shell middens, and all of the fortified sites have clear shell middens as well.

Lastly, the hinterland region of Hawke's Bay has a number of small scattered *pa* that correlate with a much less integrated group of people called the Ngati Upokoiri. These sites represent much smaller concentrations of people and nearly all lack storage pits. The defensive strategy of the hinterland was thus extremely different than that of the larger polities in the region.

The most prestigious foods were clearly claimed and controlled by the largest polities. Only the largest could afford the luxury of essentially bragging about their abundance by displaying stored resources and gardens, even far from their population centers, as described by Best (1976, p. 140). These resources included both the high-status *kumara* (ocean resources) and the unique brackish lagoon with its famed flounder and shellfish. The next largest polity enjoyed productive garden lands, but lacked coastal access. Their stores were not displayed and clearly were not monopolized by chiefly leaders to the same extent. The coastal polities secured for themselves access to desirable marine resources, but were vulnerable to incursion from larger and more integrated groups. Finally, as noted by Best (1976, p. 132), the people of the hinterland avoided demonstration of food surplus and relied on scattered and isolated gardens or other resources. Their main access to prestigious foods would have been birds from the extant forest areas inland and away from the cultivable areas of Hawke's Bay.

3.6 Conclusion

In pre-European New Zealand, food and war were inseparable. Cannibalism was the ultimate linkage of war and food, but nearly every type of food had a major role in either the aims or conduct of war, if not both. Wars were fought over economic resources, but dictated by the availability of food and the time of year. Different types of food were not equal, and those with a high degree of *tapu* necessitated a posture of defense so extreme that even a spoken insult to a garden or shellfish bed demanded punishment by force if at all possible. Large polities, such as Te Hika a Ruarahanga in Hawke's Bay, could dangle and boast of highly prestigious resources such as Te Whanganui o Orotu or prominent food storage facilities in front of other groups with little fear, but in most cases, it was important for a community to conceal vulnerable food resources to discourage insult, trespass, or attack. In all ways then, the realms of Maori food, such as that of Rongo the agricultural deity, meshed with and were interwoven with those of Tu the god of war or Rehua the Eater of Men. It is hoped that this exercise in combining ecological and economic perspectives with emic views of Maori foods provides a more nuanced understanding of Maori warfare than can ecology or economics, alone or combined.

Acknowledgments The greatest privilege of my professional career has been the close relationship that I have enjoyed with the *tangata whenua* (the people of the land) of Heretaunga and the surrounding regions since early in 1990. My dissertation research there was possible only through the permission, support, and *aroha* of Te Runanganui o te Ngati Kahungunu (now Ngāti Kahungunu Iwi Incorporated) and the many *kaumatua* and other knowledgeable persons who have taught me over the decades. For this particular paper, I am particularly indebted to Robert MacDonald and Rose Mohi for sharing with me their knowledge of Maori food and showing me so much of Ocean Beach and Waimarama. I am also very grateful to the tribal chair of Ngāti Kahungunu Iwi Incorporated, Ngahiwi Tomoana, for supporting my research since the 1990s and for hosting my Cal Poly Pomona contingent for a memorable *hangi* at his home in July 2011. *Kia ora* to my Heretaunga *whanau*!

I thank Amber VanDerwarker and Greg Wilson for inviting me to be a participant in both the Archaeology of Food and Warfare Conference in Santa Barbara in February 2013 and in this published volume. I would also like to express my appreciation for the presentations by the other participants in the meeting. Learning about their research and conversations with them were truly inspirational. The paper was improved by the comments of the anonymous reviewers, though I was unable to accommodate several good suggestions due to limitations of space. All errors and omissions are solely the fault of the author.

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Chapter 4
The Role of Food Production in Incipient Warfare in Protohistoric Timor Leste

Peter Lape

Does climate change cause warfare? Several recent publications have noted significant correlation between climatic instability and warfare in the modern period (e.g., Hsiang et al. 2011; Scheffran et al. 2012; Zhang et al. 2011). However, the underlying causal links between the complexities of human group conflict and climate change (with its equally complex impact on human life) remain murky in these studies, which rarely cite archaeological data. Archaeologists, who have access to long records of warfare and climate, can provide useful data and explanatory models of potential causal links (e.g., Arkush and Allen 2006; Keeley 1996; Kennett and Kennett 2000; Lambert 2002). This chapter reviews the history of warfare in Timor Leste, located in the eastern half of Timor Island in Island Southeast Asia. A causal model, which links changes in rainfall and food production to chronological and spatial patterns of fortifications, was first proposed by Lape and Chao (2008). The model allowed for independent testing of the relationship between archaeological and climate proxy evidence. A recent critique of that model proposed alternate explanations for the archaeological patterns (O'Connor et al. 2012). This chapter analyzes that critique and suggests other ways to build our understanding of past causal relationships that may have relevance for understanding the causes of war in other regions and at other times.

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_4

4.1 The Fortifications of Timor Leste

Scattered across the rugged landscapes of the north coast of Timor Leste (Fig. 4.1), fortifications have recently drawn the attention of archaeologists (Lape 2006; Lape and Chao 2008; Lape et al. 2015; O'Connor et al. 2012). In the Lautem district, they are built of dry stacked rocks with walls as tall as 5–6 m and as thick as 2–3 m at the base. They are often perched on the edge of limestone cliffs overlooking the Banda Sea. Structures located in low, flat parts of the landscape that lack natural cliffs usually have larger walls. On the higher elevation sites, the walls can be low enough for an adult human to easily climb over. There is also a concentration of similar structures on the hilltops overlooking the floodplains of the Laclo River near the town of Manatuto (Chao 2008; Lape and Chao 2008). These are typically walled terraces that modify the natural steep gravel hills. In both regions, local people identify these places as old villages, and they continue to play important and active roles in local memory and politics. Local narratives often describe the abandonment of these places as a result of inter-clan battles, which either extinguished all members of the clan living there or forced the survivors to relocate (McWilliam 2006, 2007, 2011; Pannell 2006, 2011).

Archaeologists interpret these places as *fortified* villages because of their placement and form, such as location on cliff edges or hilltops, with restricted entryways and views of the surrounding landscape (Lape 2006; Lape and Chao 2008; Lape et al. 2015; O'Connor et al. 2012). The presence of a broad assemblage of habitation remains, including faunal remains, pottery, and sometimes lithics, suggests use as permanent living spaces rather than occasional use for refuge or ritual practice. They are similar to other structures interpreted as fortifications throughout the Pacific, including other parts of Island Southeast Asia, although there is significantly less documentation of the Island SE Asian fortifications compared with those in Oceania (Field and Lape 2010).

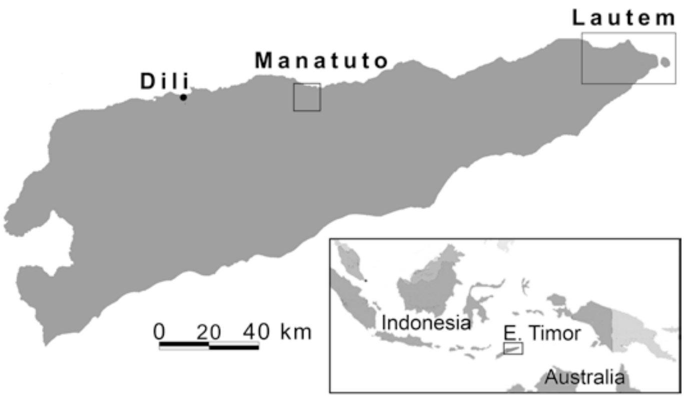

Fig. 4.1 Map of Timor Leste

The dating of the initial construction and subsequent use of these structures is difficult (Lape 2006). In the Lautem area, very thin soils overlying limestone bedrock provide little chance for the development of stratified cultural deposits. There is more sediment at the sites in Manatuto, but in both areas, continued anthropogenic burning up to the present means that charcoal not necessarily linked to archaeological target events is prevalent in the minimal sediments available. The location of the fortifications on hilltops and other high points in the landscape means that sediments are generally transported away from the structures downslope, often leaving completely deflated sites consisting of artifacts with larger rocks and almost no finer-grained sediments.

The resulting uncertainty in dating makes it difficult to establish chronological links between the fortification-building episodes and other environmental or historical events, as will be discussed below. Nevertheless, because of the relatively short occupation periods of the fortified settlements, it is possible to create a relatively coarse-grained chronology of fortification building and use in the context of Timor's culture history.

Humans have been present in Timor since at least 42 kya (O'Connor et al. 2002; O'Connor 2007). Between 3 and 4 kya, domesticated animals and possibly some domesticated plants were adopted locally or brought by new populations (Glover 1986; Oliveira 2006, 2008). Fortifications all appear to date to after 1100 C.E. This shift to fortification building stands out in contrast to otherwise relatively stable traditions of technology, foodways and landscape use, though this apparent cultural stability may be partly an artifact of the paucity of archaeological research in the region. This relatively late and quite prominent shift to fortification building invites hypothesizing about causes, and furthermore, suggests an important role for novel external forces. The ongoing use of these structures as important centers for sacred practice, social memory, and political symbolism provide intriguing hypotheses regarding their origin.

4.2 Food and Fortification: A Climate-Sensitive Model

Lape and Chao (2008) first provided a model for initial fortification building in Timor Leste, hypothesizing that people would initially choose to build fortifications under two conditions: (1) during times of unprecedented drought, when agricultural food production systems would be stressed and risk mitigation strategies (food storage, trade) would be underdeveloped; and (2) in the boundary areas between drought-sensitive and drought-tolerant agricultural landscapes, where conflict (raiding, land capture) would be most likely to erupt.

Testing the model required: (a) investigating whether there was a chronological correlation between initial fortification building and times of unprecedented drought; and (b) comparing fortification densities in boundary zones with those in non-boundary zones. Following Ferguson (1994, 2006), we assumed that fortification-building choice would be most dependent on external climate forcing at an incipient stage. Once fortifications existed on a landscape and social systems reorganized to incorporate group conflict and defense of land tenure, subsequent causal mechanisms become much more complex and environmental factors become relatively less emphasized.

We used data from a series of surveys and excavations of fortifications in both Lautem and Manatuto conducted from 2003 to 2006 to locate and date fortified sites. To date drought episodes, we relied on El Niño Southern Oscillation (ENSO) records. In the twentieth-century C.E., historical records indicate that El Niño years reliably bring drought to Timor Leste (and most of SE Asia) and also delay the onset of seasonal rains (Fig. 4.2). Unfortunately, we still lack local paleoclimate proxy data for the Timor area that has the resolution relevant to our timescale. Therefore, we used paleoclimate data from eastern and central Pacific proxy ENSO records to infer drought in Timor. This approach assumes that ENSO teleconnections existed in the past. Verification of this assumed teleconnection into the pre-twentieth-century past awaits better local paleoclimate proxy data for past rainfall, which may be available from lacustrine or marine sediment cores, or from speleothem samples from local caves.

We analyzed the landscapes of Lautem and Manatuto to identify boundary areas between drought-tolerant and drought-sensitive zones. This analysis considered rainfall or irrigation by surface channels only, not other factors like soil moisture capacity. The Lautem district has highly variable elevation-dependent orographic rainfall, bringing drought-tolerant and resistant areas into close proximity (Fig. 4.3). In Manatuto, the perennial Laclo River allows for drought tolerance via irrigated agriculture at the river's edge, while lands further from the river (where irrigation is impossible) are extremely drought sensitive. In the boundary between these two zones, the model predicts that conflict would be a likely choice for residents, though cooperation strategies were also likely employed

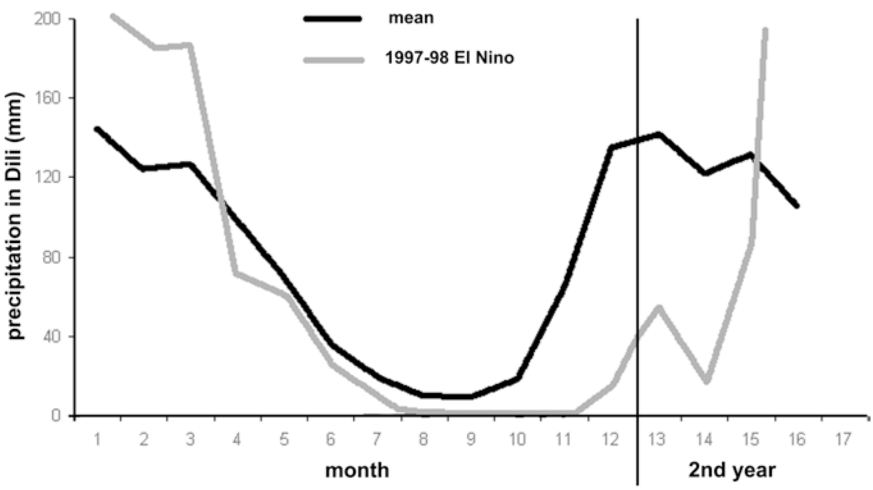

Fig. 4.2 Rainfall amount and seasonality in Dili, East Timor

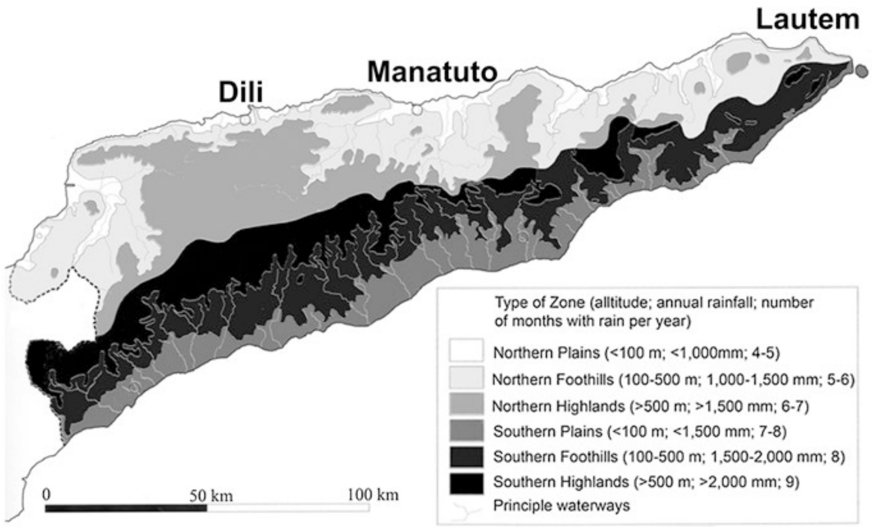

Fig. 4.3 Spatial distribution of rainfall in Timor Leste. Adapted from Durand (2002)

(and of course group conflict requires cooperation within and sometimes between groups). In this situation, fortification building would be a beneficial strategy. Fortifications would create a safe haven from raids on both people and stored food caches. Locating them at high points would allow for defense of claims on productive agricultural lands within their viewshed (Field 2008; Smith and Cochrane 2011). Building of them would be a cooperative group effort that would reinforce group identity, reify leadership roles, and channel excess labor, particularly potentially volatile young male labor, toward activities that promoted group cohesion (Goldstein 2001).

The results of our tests of chronological correlation between unprecedented drought and initial fortification building were mixed (Lape and Chao 2008). We concluded that there was a close correlation between a rapid increase in El Niños beginning at 1300 C.E. and patterns of initial fortification building in Manatuto, but that the fortifications in Lautem first appear 100–200 years after the El Niño peak. Spatial correlations were stronger. We found the highest concentration of fortifications in boundary areas between drought-tolerant and drought-sensitive zones in both Lautem and Manatuto.

4.3 Critiques of the Model

O'Connor et al. (2012) provide a critique of these conclusions. Their critique cites specific challenges to the data used to justify the conclusions in Lape and Chao (2008), but also raises larger issues of environmental determinism, causality, and model building. The response to that critique detailed below addresses both the specific questions about the data, but also the wider concerns, which should be relevant to larger debates about the causes of war (and how to use archaeological data investigate them).

O'Connor et al. (2012) provided dates for two additional fortified structures in the Lautem District excavated by their team, claiming initial construction dates during the eighteenth-century C.E. They conducted a Bayesian analysis of a combined set of AMS dates from our work and theirs (N = 31, from seven sites) in order to evaluate the chronology of fortification building in the Lautem and Manatuto Districts. This analysis, they argue, suggests that while fortification building and use likely began prior to 1300 C.E., it only became *widespread* later, around 1550–1750 C.E. The authors then suggest that this later period for widespread fortification building postdates the period of increased El Niño frequency (1300–1600 C.E.), thereby negating a causal role for ENSO droughts. They did not evaluate the spatial hypotheses of our paper.

The authors then propose several alternative hypotheses for the causes of fortification building, which in their view have a better chronological fit with their 1550–1750 C.E. chronology for widespread fortification building and use. These potential causes are not directly related to environmental forces or local food production. Instead, they propose causes related to the effects of post-sixteenth-century European colonial intrusions into social systems. One suggested cause is the intensification of slave trade to provide labor for European colonial plantations in SE Asia. In this case, fortifications may have been a defensive reaction to slave raids. Another possible factor they propose is the intensification of trade of local products such as sandalwood (*Santalum album*) and beeswax. In this case, fortifications may have been built to signify and protect ownership of these trade items, or been a response to local conflicts caused by social instability from intensified trade. They also propose population growth and autochthonous forces as other potential causes, albeit untestable ones.

Unfortunately, this critique misunderstands the Lape and Chao (2008) model with regard to chronology. The date of interest in our model is the initial or oldest dated fortification in a given geographic area. The fact that there are fortifications in Lautem dating to the eighteenth century is interesting and asks for explanation, but it is not relevant to our model. As mentioned above, once the first fortification was built, subsequent fortification building (even "widespread" building) is in part a response to that first one, much in the same way an arms race takes on a life of its own, delinked from other causes of group conflict. For example, social hierarchy and the power and activity of social group leaders may be enhanced during periods of initial conflict. These leaders subsequently use warfare (including the building of additional defensive sites) to maintain and reify their power. As another example, there are caves, redoubts, and other military buildings that were used by soldiers and refugees during WWII, and during the East Timor–Indonesia conflict from the early 1970s through 2000, but we do not count those as relevant to the initiation of fortification building in the region. Additionally, the total number of samples (31) used for the Bayesian statistical analysis of AMS dates is small and some would argue below the minimum to obtain statistically robust results. More importantly, however, is that the target event discussed by Lape and Chao (the oldest fortification in a given single region) is not the same as the target event in O'Connor et al. (2012) [the period of "widespread" building *and* use of fortifications in *all* regions]. The period identified from the latter may indeed be of historical interest and invite explanation, but it is quite different from the period of interest for the sensitivity model we proposed (Lape and Chao 2008).

Aside from the dating issues, the various social forces identified by O'Conner et al. (2012) are valid alternative hypotheses for fortification building. However, their paper fails to provide any kind of model or means of testing them. It is, however, a good reminder of the critique of deterministic (often environmentally deterministic) "explanations"—that chronological convergence does not necessarily equal causation.

4.4 Issues for Further Consideration

Advancing this important area of research will require more sophisticated models for fortification building than either Lape and Chao (2008) or O'Connor et al. (2012) have proposed. In the remainder of this paper, I explore some areas that may bring greater insight into the complex factors involved in decisions behind fortification building. In particular, I discuss trade and wild foods in the context of Timor's agricultural systems likely in place by 1100 C.E.

4.4.1 Sandalwood Trade

O'Connor et al. (2012) identify sandalwood trade as the most likely cause of fortification building, primarily on chronological grounds. Sandalwood trade in Timor was documented by Chinese accounts as early as 1227 C.E. and continued into the European colonial period. In other parts of the world, trade is indeed often a factor in increased group conflict (Ferguson 2006). It can reify leadership roles in parallel ways with those related to war and can bring new forms of wealth and warfare technology that can serve to escalate previously existing low-level conflict into more extensive and violent forms. While O'Connor et al. (2012) dismiss the possibility of archaeological testing of the sandalwood trade hypothesis, there are several ways we could further investigate this possibility. Sandalwood trees were not uniformly distributed throughout Timor. By using historical records and environmental reconstructions, one could map densities of historic sandalwood groves and compare those to densities of fortifications. Lautem, in fact, appears to have been less endowed with stands of sandalwood than Manatuto and other areas of the island (Chao 2008). Thus, the high density of fortifications in Lautem would appear to suggest that sandalwood trade was not a factor in fortification building, but this requires mapping of fortifications on other parts of Timor, which has yet to be done.

That said, the larger issue of trade in Timor is not a simple one. Although never politically or linguistically unified, the various communities in pre-colonial Timor were likely integrated through interconnected social networks mediated through trade and other forms of social interaction (including conflict). Sandalwood trade, even if focused on areas other than Lautem, may have had indirect consequences that might have resulted in fortification building there. For example, sandalwood trade might have stimulated an increase in the trade of other items, such as slaves, pottery, or food. Conflicts might have spilled over into adjoining regions with alliance relationships.

Sandalwood harvest and trade also likely had direct impacts on food production (Crespí et al. 2013). Sandalwood harvesting had significant environmental impacts in Timor. The highest quality sandalwood oil comes from the roots of the tree, so harvesters often dig up these roots in addition to cutting down the tree. In Timor's steep slopes, this can seriously destabilize soils leading to high rates of erosion on upland slopes and sedimentation in downslope valleys and nearshore coral reefs. Loss of tree cover in this case can be permanent, as supporting soils are quickly stripped away, and high evapotranspiration makes exposed soils too dry for new trees to become established. These effects are coupled with anthropogenic burning and grazing of goats (*Capra hircus*) and sheep (*Ovis aries*) that prevent new forests from establishing. Much of the current savannah landscape of northern Timor Leste probably has its origins in these anthropogenic processes. Ultimately, the combined effects of intensive sandalwood harvesting would have probably reduced the fertility of forest areas for swidden farming and changed the population dynamics of wild plant and animal ecosystems. Evidence for rapid, large-scale transport of sediments into the Laclo River floodplain abounds (Chao 2008). This may have had some beneficial results for farming in the floodplain (enlargement of areas suitable for irrigation, input of new fertile sediments), but would have negatively impacted the uplands and the coral reef ecosystems near the river mouth (e.g., Spriggs 1997). Increases in climate uncertainty related to ENSO may have further amplified these effects, through intensification of drought–flood cycles.

Trade booms and busts can also have social impacts that result in group conflict. When sandalwood was completely extinguished from the Manatuto area, people living there would have been left with a greatly changed local ecosystem that might have been unable to support a newly grown population base, a population which may have grown reliant on food obtained though trade.

4.4.2 Agriculture Versus Wild Terrestrial and Marine Food Resources

While domesticated plants (taro [*Colocasia esculenta*], yams [*Dioscorea* spp.], bananas [*Musa* spp.], tree crops) and animals (pigs [*Sus scrofa*], goats, cattle [*Bos taurus*]) were most likely available to people in Lautem and Manatuto by 1100 C.E., it remains unclear how much of the total food consumption was supplied by these various means (Oliveira 2006, 2008). During fieldwork in the early–mid-2000s, people in Lautem, particularly those living in the smaller villages far from the district capital, supplemented food from swidden fields with wild terrestrial plants (tubers and leafy greens) and animals (cuscus [*Ailurops* spp., *Strigocuscus* spp.], bats [Chiroptera], deer [Cervidae], civet cat [Viverridae], various birds), fish, shellfish, and seaweeds from beaches, reefs, and the open sea, freshwater fish from lakes, as well as food bought or traded from other areas (e.g., see Pannell and O'Connor 2010). Low population densities (at least partly the result of violent conflict in the region since the 1970s) and diverse habitats make these wild food supplies available to many. In comparison, the Manatuto region is characterized by relatively more intensive agriculture (irrigated rice [*Oryza sativa*] and corn [*Zea mays*] in place of swidden crops), but fewer wild resources due to drier and less productive and ecosystems and higher human populations densities.

For Lautem, at least, one question raised by O'Connor et al. (2012) that requires better archaeological evidence to answer is whether drought impacts on agriculture would have been easily mitigated by the availability of wild food resources. This question in turn raises a series of related questions. Would drought have had a similar negative impact on terrestrial wild plant and animal resources versus marine resources? Presumably marine resources would have been unaffected by drought (in fact, by reducing sediment loads carried by runoff, drought often benefits nearshore marine ecosystems). How would conflict over control of wild resources (both marine and terrestrial) be triggered? How would conflict over control of trade for food be triggered? How would the spatial patterns of wild food resources look different from those triggered by negative impacts on agricultural resources?

This set of questions should be archaeologically testable if we have cultural deposits with good faunal or botanical preservation spanning pre- and post-drought times. Thus far, this kind of site has been elusive in northern Timor Leste, but even compromised deposits may provide some insight into wild versus domesticated food sources.

Other areas that require more investigation are the social dynamics of agricultural production, particularly risk management strategies and climate variability. In Lape and Chao (2008), we proposed that ENSO droughts impacted farmers not just because of lower average precipitation, but also because ENSO changes the timing of seasonal precipitation. In El Niño years, rains come one to two months later than average, and they also tend to be heavier than average. This can be disastrous for farmers who plant seeds too early, as the seeds do not germinate and/or get washed away when the rains come to newly cleared and burned swidden fields. Farmers often develop strategies to deal with climate variability, at least variability that is within human memory timescale. Unfortunately, current ENSO data (and archaeological data) are uncertain at the century level, which is probably just outside typical human memory timescale. This means that our data do not work well for investigations of agent-based models of risk management. But with higher chronological resolution, we should be able to do more in this regard.

4.4.3 Conflict Metaphors in Contemporary Sacred Practice

As detailed in other publications, most fortifications in the Lautem district continue to be used today for sacred practice and memory (Lape 2006; Lape and Chao 2008; McWilliam 2006, 2007, 2011; Pannell 2006, 2011; Pannell and O'Connor 2005, 2013). This is also true in Manatuto, although currently it is much less documented in the anthropological literature, and on the surface, the cultural practices seem somewhat different from those in Lautem (Chao 2008). Although it cannot be directly linked to initial causes of war hundreds of years ago, the contemporary cultural use of fortified landscapes and sites in Timor Leste supports a link between food resources and warfare. Most Lautem fortifications contain physical markers that show the location of underground-dwelling spiritual beings (*tei*). *Tei* are also found in other places on the landscape besides fortifications, including rock art sites, graves, caves, or in people's houses. These spirit beings are potentially dangerous creatures or forces that must be regularly "fed" to control. They always hold the potential to emerge and cause damage to humans, such as eating them or making them sick (they can also be beneficial forces in some situations). The job of feeding *tei* falls to spiritual leaders, who are repositories of memories about *tei* characterization and location. They make regular visits to various *tei* to feed them, based on the events and needs. These might include planting and harvesting cycles, death or illness of community members, or national or international problems needing attention, such as providing support for warriors during the struggles for independence from Indonesia in the 1970s through 1990s. Feeding *tei* can require the sacrifice of chickens, pigs, or larger animals, or eggs and rice and other foods, along with fermented or distilled alcoholic drinks.

The overall metaphor of this sacred practice is that hunger equals danger. Danger, in the form of illness, accidents, violence, and environmental uncertainty, is always present in communities and on the landscape. Controlling this danger requires knowledge of *tei* stories, as well as the location of dozens or hundreds of *tei* locations on the landscape and the appropriate ritual protocol for each one and, above all, food. During our archaeological surveys in the Lautem area, we were strongly encouraged to work with spiritual leaders for our own and the community's protection. Wandering off course would lead to potential disaster, and areas of sacred knowledge were strictly circumscribed. If we needed to work beyond the boundaries of one practitioner's expertise, we were referred to someone else who could reliably guide and protect us.

A functionalist interpretation of these cultural practices might view it as a way to bring food production, land tenure, and leadership into synchronicity in order to manage the risks of uncertainty and variability in food production. The meme of a landscape filled with hungry, dangerous beings will limit people's willingness to transgress into new territories and will increase reliance on certain spiritual leaders who know the *tei* needs and locales. In the course of their regular travels over the landscape to feed *tei*, spiritual leaders gain knowledge of environmental and social conditions. They regularly see how things are growing in everyone's fields, how wild plants and animals are doing, and which people are working in which areas. The highest level of these leaders (lords of the land) are responsible for allocating swidden fields to people based on clan membership and history, which is partly embodied in fortified village locales and the stories attached to them. These leaders also take into account relative fertility of the land, time since last burning, and other factors.

If El Niño frequency indeed increased greatly between 1100 and 1600 C.E., then we can speculate how this system might have evolved in the face of unprecedented drought. Hunger may have become linked to a wide array of other social disruptions, and "feeding" or alleviating this hunger (both literally and figuratively) came to depend on leaders having a deep knowledge of ecological and social landscapes and their histories.

4.5 Conclusions and Future Research

Any model is necessarily and by definition a simplification of real social situations. Indeed, ethnographic studies of group conflict show that every group conflict situation has multiple and complex causes that are historically situated. Most of these causes are far beyond the reach of archaeological investigation, either because they have no archaeological or material correlates or because the timescale of archaeology is far too coarse to get at rapidly evolving social dynamics. Indeed, even contemporary violent conflicts, where we have access to living participants in real time, defy easy explanation. Our challenge is to use models in productive, archaeologically relevant ways to identify causal factors that might otherwise be hidden from view, while at the same time maintaining awareness that reality will always be more complex.

In Timor Leste, future model building and data collection will ideally proceed in tandem. To properly test the Lape and Chao (2008) model, we need local paleoenvironmental data (particularly rainfall) at the century scale or better. This may be obtainable from local reef cores, speleothems, or lake sediments (such as Lake Ira Laloro in Lautem). Accurate and precise dating of fortification building needs to continue and must be done in a way that addresses geoarchaeological complexities and targets initial building episodes. Poor organic preservation and local sensitivities have limited the data available from human skeletal evidence, but where possible, skeletal data could provide information about past violence as well as nutrition (Lape et al. 2015). Finally, foodways need much more intensive focus in this region. We need to target fortified sites with good organic preservation and minimal post-depositional disturbance.

Timor Leste is one of the world's newest nations, and its inhabitants have a keen interest in investigating their history. Research into the original causes and triggers of violent conflict is especially relevant for this nation, which has been ravaged by war for nearly 30 years before entering a new era of relative stability and peace beginning in 2000. Archaeological research thus has an important and ongoing role to play.

Acknowledgments Fieldwork in Timor Leste was conducted with permission from the Ministerio da Educacao, Cultura, Juventude e Desporto, Timor Leste, and community leaders in Tutuala, Ira Ara, and Manatuto. Special thanks for fieldwork collaboration and stimulating debates to Sue O'Connor, Sandra Pannell, Andrew McWilliam, and Chin-yung Chao. This manuscript was greatly improved by the comments from participants in the 2013 Archaeology of War and Food Conference at UC Santa Barbara, as well editorial suggestions by Amber VanDerwarker and the anonymous reviewers.

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Chapter 5
War, Food, and Structural Violence in the Mississippian Central Illinois Valley

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Archaeological research in the Late Prehistoric Eastern Woodlands has revealed situations where the intensity of intergroup violence resulted in the abandonment of homesteads, villages, and even entire regions (Cobb and Butler 2002; King 2003; Morse and Morse 1983; O'Brien 2001; Price and Griffin 1979). Palisade walls, catastrophically burned villages, and violence-related skeletal trauma are the most obvious archaeological indicators of these ancient hostilities. And although such evidence informs us about the scale and intensity of these conflicts, it tells us little about what it was like for Native American groups to *live with war* on a daily basis. Did chronic warfare compromise or constrain subsistence pursuits and other basic practices related to the social and economic reproduction of households and communities? Did such constraints have an impact on health or food security?

Drawing on a perspective of structural violence (Galtung 1969), we evaluate the impacts of chronic and intensive warfare on the subsistence pursuits of thirteenth-century C.E. Mississippian groups in the Central Illinois River Valley of west-central Illinois. Our investigation of this issue derives from an analysis of archaeobotanical and microfaunal assemblages from a two-hundred-year period bracketing the outbreak and intensification of warfare in the region. On the basis of our findings, we argue that the chronic threat of attack led villagers to limit their foraging mobility such that they suffered significant food shortages and nutritional insufficiency. Ultimately, the escalation of direct, intergroup violence in the region

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_5

created broader socioeconomic conditions that inflicted considerable structural violence on regional inhabitants.

5.1 Structural Violence, Warfare, and Food Insecurity

Anthropological scholarship has shifted away from conceptualizing warfare as isolatable acts of physical violence toward a perspective where such conflict is understood as a historical phenomenon with extensive spatial, political, and economic dimensions. From a historical perspective, war neither begins nor ends in the combat zone but is produced by and generative of a network of broader relationships. We argue in this chapter that the concept of structural violence, introduced by sociologist Galtung (1969), is useful for conceptualizing warfare in this way. Galtung (1969, p. 168) defined violence as any situation where an individual is avoidably prevented from achieving his or her social, economic, or biological potential. This broad definition encompasses the full spectrum of direct and indirect forms of violence (Galtung 1969, p. 170). Direct violence can occur between individuals or groups but entails a clear subject/object relationship in terms of the affliction of physical harm on people, places, or things (Galtung 1969, p. 170). Military assaults, raids, and ambushes are violent acts that are often made highly visible through their punctuated execution and a direct relationship between assailants and victims. In cases of structural violence, however, there may not be a clearly identifiable individual or group who directly harms another (Galtung 1969, pp. 170–171). Instead injury, death, or other hardships result from the broader economic and political circumstances in which individuals are embedded (Galtung 1969, p. 171). This indirectness often causes structural violence to be chronic, invisible, and normalized by regular and repeated experiences. Structural violence, however, may result in as many or more deaths as direct violence although the damage is slower, subtler, and more difficult to repair (Galtung 1969, p. 173).

Direct and structural forms of violence are often causally interrelated. Marginalized groups may resort to direct violence in the attempt to improve their circumstances. Moreover, direct violence may result in far-reaching political, economic, or ecological conditions that lower the quality of life and promote human suffering. Vulnerability to either dimension of violence may vary on the basis of age, gender, and ethnicity. Indeed, cross-cultural research has revealed that women and children often tend to be the most vulnerable to various forms of direct and indirect violence (e.g., Martin 2008; Walker 1998). Not only can domestic violence increase in times of war (Walker 1998), but also women and children can become targets of abduction and slavery when on the losing side of village raids (e.g., Alt 2007; Keener 1999; Kohler and Turner 2006; Martin 2008).

The concept of structural violence has most often been used to theorize situations in which rigid patterns of social inequality have resulted in discrimination against and victimization of particular groups of people (but see Klaus 2012). However, we believe that the concept is relevant to any situation in which *systemic* social, political, or economic conditions result in the affliction of social or physical harm or hardship on human beings. Ethnographic and ethnohistorical research provides important insight into this phenomenon that can inform archaeological enquiry on the topic of warfare. For example, historical research on the Civil War, World War I, and World War II has demonstrated that the transmission of epidemic disease due to squalid living conditions in the combat zone often claimed more lives than the fighting did (Zinsser 2000).

Warfare can also lead to the displacement of large groups of people fleeing arenas of conflict (Mertus 2000). Abrupt and devastating attacks may leave refugees with little time to prepare for what can sometimes be arduous and distant journeys. The sick and elderly may not survive such journeys at all. Those that do survive may have relatively few options when seeking a safe refuge and end up trapped in marginal environmental areas or forced into socially subordinated positions. Women and children refugees are often targeted for various kinds of mistreatment and can suffer from malnutrition (Lowell 2014; Mertus 2000). Moreover, the loss of family members, exchange partners, and other allies due to violent conflict may also generate conditions of social and economic insecurity from which it is difficult to recover. Thus, the broader social, economic, and ecological conditions generated by war can radically lower the quality of life in ways that archaeologists should consider when engaging with issues of violence in the ancient past.

Thinking about violence in these broad terms is an initial step toward the archaeological recognition of both the direct and indirect impacts of war that can threaten food security. For example, embargoes and blockades are intentional military strategies that may lead to food shortages. Food security may also be directly compromised by the deliberate destruction or theft of agricultural fields and food stores. For example, the Iroquois of the northeastern USA used a variety of indirect assault tactics against French and Native groups to create food insecurity (Keener 1999). In dealing with the French specifically, the Iroquois sometimes employed siege tactics; these tactics were quite effective at starving settlers at the French forts, as attested by reports of inhabitants suffering from scurvy and dying of hunger (Keener 1999, pp. 797–798). In addition to pinning enemies behind their walls, the Iroquois also actively attacked enemies' food supplies by destroying crops (e.g., burning fields and storehouses), killing cattle, and disrupting supply lines (Keener 1999, pp. 796, 798).

Other negative impacts may be more indirect and *structural* in nature. For example, Netting's (1973, 1974, p. 156) research among the Kofyar of northern Nigeria has revealed that escalating violence led agricultural groups to eliminate shifting cultivation. This shift in agricultural strategy was partly a result of creating buffer zones between warring groups, but also served as a means to keep farmers closer to villages (Netting 1973, p. 173). The net effect was an increase in population pressure through a reduction in agricultural land (held in buffer zones) and a shift to more intensive farming as the Kofyar focused cultivation on nearby infields, which led to declining soil fertility (Netting 1973, p. 175). Ultimately, agricultural production declined, leading to higher rates of malnutrition and increasing susceptibility to illness (Netting 1973, p. 175), a situation which was compounded by higher rates of disease transmission caused by increased village nucleation (Netting 1973, pp. 175–176). Kofyar subsistence stress was further exacerbated by the burden of incorporating refugee groups who had evacuated or lost their homes (Netting 1973, p. 173). The Kofyar case is particularly relevant to our present case study, as it highlights the combined impacts of expanding village population, increased nucleation, increased cultivation intensity, reduced mobility, and the resulting negative health consequences.

The Kofyar is not the only case that demonstrates peoples' reluctance to venture unprotected from the safety of the village perimeter. Ethnographic research among both the Dugum Dani of west New Guinea (Heider 1970, p. 115) and the Yanomamo of Brazil (Chagnon 1968) demonstrates that escalating violence often stresses populations by diverting warrior-age men away from other tasks to guard vulnerable community members engaged in subsistence activities outside the village. We suggest that this reallocation of male labor toward protection may also impact women by placing an even greater subsistence burden on them, as women incorporated additional tasks into their daily workloads that were previously shouldered by men.

Archaeologists are just beginning to explore the relationship between warfare and structural violence. Indeed, most archaeological research on warfare has focused on the immediate and direct impacts of violent conflict. However, an increasing number of archaeologists are documenting the more indirect and lingering impacts of war. For example, Langlie and Arkush (this volume) argue that the Late Intermediate Period (1100–1450 C.E.) inhabitants of the Lake Titicaca Basin, Peru, made a series of important socially and economically detrimental tradeoffs in order to minimize exposure to violent attack during an era of intensified regional hostilities. Roscoe (this volume) makes a similar argument for contact-era New Guinea. Moreover, Milner and colleagues' (1991) bioarchaeological research on the war-torn early fourteenth-century C.E. Central Illinois River Valley of west-central Illinois documented a high frequency of *cribra orbitalia* and *porotic hyperostosis*, as well as other skeletal lesions likely indicative of subsistence stress (see also Milner 1999; Santure et al. 1990). On the basis of their results, they postulated that the constant threat of attack compromised the subsistence practices of Native American communities living in compact fortified villages (Milner et al. 1991; Santure et al. 1990; see also Chacon and Mendoza 2012; Johnson and Earle 2000 for additional examples).

5.2 Mississippian Warfare and Subsistence in the Eastern Woodlands

The Late Prehistoric Southeast and Midwest witnessed the pan-regional development of a cultural tradition known as Mississippian, beginning around 1000 C.E. (Fig. 5.1). Mississippian societies are generally characterized by their regional

Fig. 5.1 Map of the Eastern Woodlands

political hierarchies, earthen platform mounds, and the interregional exchange of symbolic and ritual paraphernalia; most had agricultural economies and hereditary leadership positions of some form (King and Myers 2002, p. 113). However, Mississippian societies varied considerably in terms of geographic scale and political complexity (Pauketat 2007; Wilson et al. 2006). Some large polities like Cahokia in southwestern Illinois were comprised of multiple large settlements inhabited by thousands of people (Pauketat 1994). Most other Mississippian groups such as those in the Central Illinois River Valley were smaller in scale and less complexly organized than Cahokia with towns and villages inhabited by hundreds not thousands of people (Wilson 2012).

In general, the Mississippian period is credited with heralding the transition from foraging and small-scale food production to intensive maize (*Zea mays*) agriculture, although there is a great deal of regional variation through the southeastern and midwestern USA in terms of the relative importance of maize and the degree of cultivation intensity (Fritz 1990, 2000; Gremillion 2003; Scarry 1993). Regardless of the relative importance of plant cultivation, Mississippian people continued to forage extensively for myriad nuts, fruits, and fresh greens (Gremillion 2003; Scarry 2003). Foraged plants ran the gamut from primary/secondary staples (e.g., hickory nuts [*Carya* spp.]) to supplementary resources (e.g., fresh seasonal greens). A diverse range of wild edible plants would have been necessary to provide nutritional balance to a diet based on maize, which is deficient in niacin and essential amino acids lysine and isoleucine (Bodwell 1987, p. 264; Giller 2001, p. 140). Protein was procured through hunting and fishing, activities that were important throughout the prehistory of the region as there were no native animal domesticates[1] (Compton 2009; Lapham 2006, 2011). While the relative proportion of terrestrial versus aquatic fauna (and the species targeted) varied by region and in relation to settlement location, the most common animal prey included white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), migratory waterfowl, turtles, and various species of fish (Compton 2009; Lapham 2006, 2011).

The region that forms the basis of the current case study is the Central Illinois River Valley (CIRV) which consists of a 210-km segment of the Illinois River that extends from the town of Meredosia in Morgan County, Illinois northeastward to the town of Hennepin in Putnam County, Illinois (Fig. 5.2). The Mississippian-period occupation of this valley dates from around 1100 C.E. and ends with the abandonment of the region around 1450 C.E. (Conrad 1991; Esarey and Conrad 1998). This region represents an interesting example of Mississippian origins and development in that its late prehistoric occupation was fundamentally shaped by political and religious interactions with Mississippian groups in the greater Cahokia area 110 miles to the south (Conrad 1989; Harn 1991). Despite or perhaps *because* of this entangled history with Cahokia, a large-scale regionally consolidated polity never developed in the CIRV. Early Mississippian settlements in the region consisted primarily of small and widely dispersed homesteads. Different localized settlements appear to have been ceremonially and politically associated with a number of small temple and mortuary complexes.

By 1200 C.E., this Early Mississippian settlement pattern of dispersed communities was replaced by fortified and nucleated towns linked with smaller outlying settlements (Conrad 1989, 1991). The vast majority of these towns were built

[1]Domesticated dog (*Canis familiaris*) is the one notable exception, and although dogs were consumed by some groups, they did not represent a staple meat source.

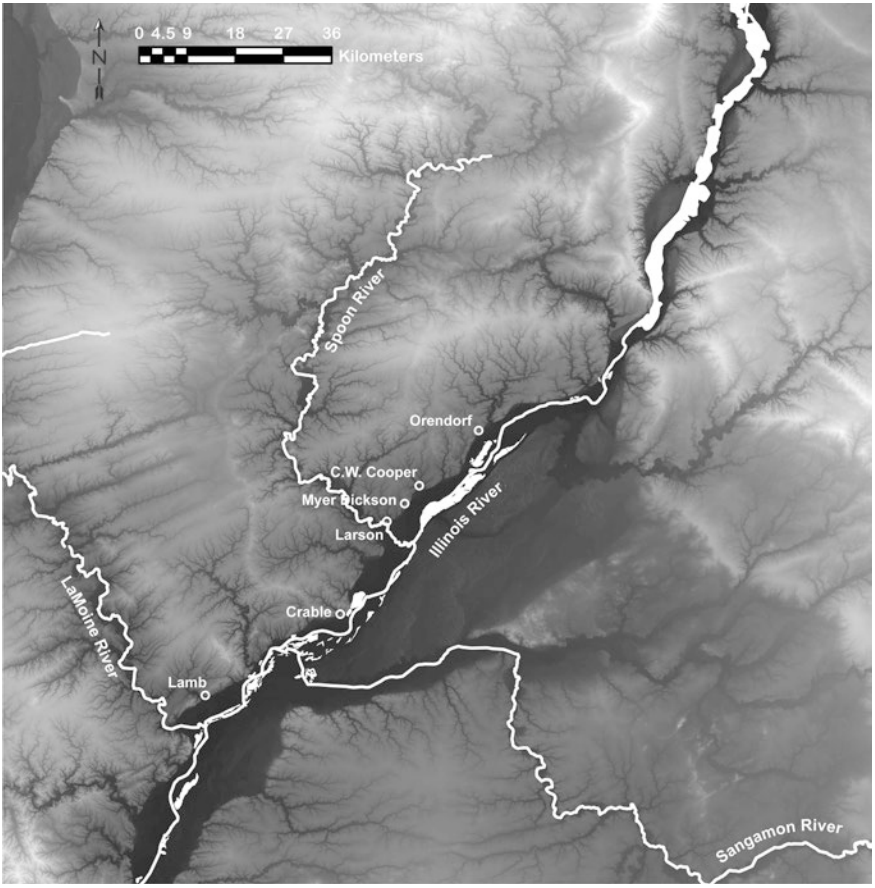


Fig. 5.2 Map of the CIRV with study sites labeled

on defensible bluff-crest locations on the western side of the Illinois River Valley. These bluffs generally range from 38 to 45 m in height and are usually cut into sharp ridges by the valleys of the small streams that drain the adjacent country. Such topographic settings would have allowed a broad expanse of the floodplains to be visually monitored, providing commanding views that would have hindered attempts by enemy forces to launch surprise offensives. Moreover, an assault force approaching a fortified town from the valley below would have been faced with a precarious charge up a steep incline while dodging volleys of arrow fire from archers strategically placed along a wooden palisade wall. Despite the high risks associated with attacking fortified villages situated in these locales (e.g., Keeley 1996), several such villages met their ends as a result of enemy attacks in which they were set ablaze either during large-scale direct assaults or after sudden, strategic abandonments. These catastrophic burnings have created a rare "Pompeii-like" snapshot of Mississippian life in the region, consisting of well-preserved settlements with whole pots, stone tools, and ritual objects left in place on dwelling floors.

Warfare appears to have been particularly intense in the CIRV in comparison with many other portions of the late prehistoric Eastern Woodlands (Emerson 2007). Steadman's (2008) recent analysis of the human skeletal remains from the thirteenth-century C.E. Orendorf village site in the northern portion of the region revealed a higher adult rate of violence-related skeletal trauma than any other Mississippian site in the entire Eastern Woodlands. Violence-related mortuary patterns include a mass grave with 15 plus interments and numerous other individuals with embedded arrow points, scalp marks, and blunt force cranial trauma (Steadman 2008). By 1300 C.E., much of the regional population had relocated to fortified towns (Conrad 1989, 1991), indicating that it was no longer safe to live outside the protective boundaries of palisade walls. George Milner's (Milner et al. 1991) analysis of human skeletal remains from the early fourteenth-century C.E. Norris Farms #36 site revealed that regional mobility was likely hindered by safety concerns as a number of individuals from this town were killed in remote locations while alone or in small groups and were later found and brought back to their home village for burial.

5.3 Expectations of Food Insecurity in Times of War

As recently stated by Emerson (2007, p. 139), "[t]he fear and likelihood of violent death at the hands of enemy groups must have kept the people in a constant state of anxiety." During actual attacks, such low-level anxiety would have peaked. For example, while conducting fieldwork in Amazonia, Chacon (2007) witnessed an attack on an Achuar village. Chacon (2007, p. 540) notes that the stress that villagers were subjected to during the actual conflict was intense; women and children huddled for safety in a central location. Although no one was killed in this raid, the raiding party was nevertheless successful in terrorizing the community (Chacon 2007). Thus, in order to understand how an increase in regional hostilities would have affected the food quest, we consider different subsistence activities in terms of their relative safety values. Our primary expectation is that villagers would seek to limit their exposure to violence by minimizing the number and duration of excursions that required them to venture beyond their palisade walls (see also Roscoe, this volume, regarding trade-offs between defensibility and subsistence strategies). We envision this as a trade-off between foraging and farming. The diversity of wild plants identified at Early Mississippian sites indicates that CIRV residents foraged in a variety of local ecological zones, including oak–hickory forests, open prairie grasslands, riparian areas, and swampy marshes (VanDerwarker et al. 2013). With the advent of warfare at the beginning of the Middle Mississippian period, we suspect that foraging excursions would have been significantly reduced, leading to a lower abundance and diversity of wild plant foods (e.g., nuts, fruits, and wild seeds and greens). In addition, people also may have contracted their hunting ranges with respect to faunal exploitation, leading to a decline in fishing pursuits. While palisaded settlements were located on bluff tops adjacent to the Illinois River, riverine fishing along the Illinois would have left fishermen dangerously exposed to raiding parties traveling in canoes or by foot along the eastern bank of the river. A good defensive strategy would have been to reduce fishing excursions and/or shift fishing locales toward less visible water sources, such as marshes and oxbow lakes. Thus, we can expect either a decline in the relative abundance of fish, or a shift in species representation toward brackish water habitats, or both.

Given these expectations, we hypothesize that Middle Mississippians living in the war-torn CIRV would have shifted their focus toward foods that could be exploited within proximity of the village, where farmers and foragers could be more easily defended by archers stationed at the village walls. The contraction of foraging ranges would have placed greater pressure on local wild foods, the consequences of which "would have been felt when people desperately tried to find alternative foods during hard times" (Milner 2007, p. 196). In terms of changes in hunting game, we expect a focus on animals that prefer environments disturbed by humans, as these could be found in relative proximity to villages. Most disturbance fauna are mammals and include a range of sizes, from vermin to opossums (*Didelphis virginiana*) to white-tailed deer; therefore, in broad terms, we expect that faunal assemblages postdating the intensification of regional warfare would be more greatly dominated by mammals, especially those that could be "garden-hunted" (e.g., Emslie 1981; Neusius 2008; VanDerwarker 2006). In terms of plant foods, we expect a contraction of diet breadth whereby subsistence became more limited to farmed produce (maize, squash [*Cucurbita* spp.], starchy/oily cultigens), with wild, foraged plants (fruits, nuts, wild greens) becoming substantially reduced. Some cultigens could have been grown in small garden plots within the palisade, and maize could have been grown at infields located immediately outside the limits of the palisade, within easy range of arrow volleys (e.g., Keeley et al. 2007, pp. 73–74). Certainly, planting all your maize in one area adjacent to your village is risky, in that raiding parties could easily burn an entire harvest in a single raid (for an example of aggressors burning food stores, see Snead, this volume). However, given the very real danger of being picked off by attackers while foraging and/or farming at a distance from the village (e.g., Milner et al. 1991), villagers may have decided the risk of burned crops was preferable to dying on a subsistence-related excursion. Additionally, if raiders had already come close enough to the village to burn the fields, then their primary goal was probably village attack. From the perspective of villagers defending themselves, an attack on their village might not be avoidable, whereas getting killed while foraging outside the village's palisade is something that could have been prevented. Finally, we must question the goals of the aggressors. If these aggressors set out to raid villages for food stores, then they are unlikely to burn the fields; rather, we might expect raiding parties to wait until after the harvest is complete before raiding a village to pilfer their stores.

Ultimately, these proposed changes in diet would reflect a very real trade-off between a diverse nutritious diet and a narrow one focused on a few carbohydrate-loaded staples that can maintain caloric intake but sacrifice overall vitamin and mineral nutrient content. Such a shift in diet would likely have ramifications for human health, which can be assessed through bioarchaeological analysis of human skeletal remains. Indeed, the high rates of *porotic hyperostosis* and *cribra orbitalia* identified in the subsequent fourteenth-century C.E. occupation of the region (see Milner et al. 1991; Santure et al. 1990) may be partly attributable to the legacy of this dietary shift. Moreover, the very real fear of moving beyond the walls of the village may have even extended to the discard of organic trash and human waste (see Pauketat 2004, 2009), creating a sanitation problem in increasingly compact villages that would have contributed to declining health conditions.

5.4 The Study Sites and Subsistence Datasets

To evaluate these expectations, we begin by examining the archaeological floral and faunal assemblages from four sites that date consecutively throughout the Mississippian period (1100–1300 C.E.) (Table 5.1). The earliest site is the Lamb site, which dates to the Early Eveland phase (1100–1150 C.E.) marking the first half of the Early Mississippian period (see Bardolph 2014). In terms of its settlement organization, the Lamb site represents a farmstead or hamlet dating to the period of culture contact with Cahokia to the south. Salvage excavations conducted at the site in 1990 exposed 33 pit features; no structures were documented. The materials excavated from these features all represent secondary refuse in their final context. All flotation samples collected from the Lamb site excavations are included in this analysis ($n = 14$) (see also VanDerwarker et al. 2013).

Occupied during the Late Eveland phase (1150–1200 C.E.), the C.W. Cooper site was a small village located on the western bluff near the intersection of the Sister Creeks and the Illinois River Valley floodplains (Conrad 1991). Excavations conducted during the summers of 2011–2013 uncovered numerous pit features and portions of seven structures. We focus our analysis on the materials from the 2011 excavations, which include nine pit features, three postmolds, and one wall trench structure, totaling 30 flotation samples (see also VanDerwarker et al. 2013). The contexts of all the C.W. Cooper flotation samples considered in the current analysis are that of secondary or tertiary refuse. The one exception is an earth oven that

Table 5.1 Chronology of the study sites

Site	Period	Phase	Dates (C.E.)
Lamb	Early Mississippian	Early Eveland	1100–1150
C.W. Cooper	Early Mississippian	Late Eveland	1150–1200
Orendorf B/C	Middle Mississippian	Orendorf	1200–1250
Myer-Dickson	Middle Mississippian	Larsen	1250–1300

represents intact abandonment refuse of a failed corn roast, including an estimated 90 ears of maize (Wilson and VanDerwarker 2015); we exclude this context from the present study.

The third site is represented by Settlement B/C at the Orendorf site which dates to the subsequent Orendorf phase (1200–1250 C.E.); this settlement is a fortified village and its occupation corresponds to the increase in warfare that swept the region, leaving burnt and razed villages in its wake (Conrad 1989, 1991). Excavated in the 1970s by Western Illinois University (UMVARF), the Orendorf B/C Settlement consists of several structures and 33 associated pit features, the contents of which all represent secondary refuse. All flotation samples collected from the Orendorf B/C Settlement excavations are included in our analysis ($n = 33$).

The final site we consider is Myer-Dickson, dating to the Larsen phase (1250–1300 C.E.), a time when heightened warfare and violence continued to be a regional problem. The site was excavated in the late 1960s and early 1970s in advance of the construction of Dickson Mounds Museum. Like Orendorf, this site represents a nucleated village, although we cannot be certain whether it was fortified. Although a palisade was not encountered, excavations at the site were not extensive enough to confidently rule out the possible presence of one surrounding this nucleated community. A total of 62 features could be assigned to the Mississippian period (Conner 2009, personal communication), the majority of which represent pit features filled with secondary refuse. For the purpose of this analysis, we analyzed all the flotation samples that could be confidently assigned to the Larsen-phase Mississippian period ($n = 35$).

5.4.1 Methods for Data Collection and Analysis

A total of 112 flotation samples were analyzed from these four sites (Table 5.2). All flotation samples were sorted in the Integrative Subsistence Laboratory (ISL) at the University of California, Santa Barbara (UCSB), using standard archaeobotanical methods for macrobotany (Pearsall 2000). All samples were sorted and identified under the direct supervision of Dr. Amber VanDerwarker, ensuring the comparability of species identifications and sorting methods across these four sites. Plant data from the Lamb site and the C.W. Cooper site (2011 excavations only) have been recently reported (VanDerwarker et al. 2013). Full reports on the Orendorf B/C and Myer-Dickson plant data are forthcoming.

Both light and heavy fractions of all flotation samples were analyzed. Although the materials from the light and heavy fractions were processed and sorted separately, data from the two fractions were combined for analysis. According to standard practice, the light fractions were weighed and then sifted through 2.0-, 1.4-, and 0.7-mm standard geological sieves. Carbonized plant remains from both fractions were sorted in entirety down to the 2.0-mm sieve size with the aid of a stereoscopic microscope (10–40×). Residue less than 2.0 mm in size was scanned

Table 5.2 Specimen counts for relevant plant groups by site

	Lamb	C.W. Cooper	Orendorf B/C	Myer-Dickson
No. of flotation samples	14	30	33	35
Plant weight (grams)	52.56	167.34	66.49	896.76
Hickory nutshell	172	2483	190	9430
Fruits	6	15	2	37
Wild greens	95	21	2	6
Maize (all parts)	802	3088	900	14,860
Maize kernels	171	1963	486	9201
Maize cupules	631	1125	414	5640
Maize cob fragments	–	–	–	19
Common beans (bean cf.)	–	1 (2)	0 (2)	218 (17)
Starchy seeds	107	523	59	338
Oily seeds	8	8	6	34

for seeds, which were removed and counted; in addition, taxa encountered in the 1.4-mm sieve that were not identified from the 2.0-mm sieve were also removed, counted, and weighed. Maize cupules and acorn (*Quercus* spp.) nutshell were also collected from the 1.4-mm sieve as these materials tend to fragment into smaller pieces and can be underrepresented in the 2.0-mm sieve. Botanical materials were identified with reference to the macrobotanical comparative collection at the UCSB ISL, various seed identification manuals (Martin and Barkley 1961; Delorit 1970), and the USDA pictorial website (United States Department of Agriculture 2012). All plant specimens were identified to the lowest possible taxonomic level. Wood was weighed but not counted. Generally, most of the seeds identified in the samples were too small to weigh, and thus, only counts were recorded. Hickory nutshell and maize remains were identified only as fragments and were both counted and weighed.

Unfortunately, metric volume was not recorded for the soil samples collected from Orendorf B/C or Myer-Dickson prior to flotation, making a density-based comparison impossible. Thus, in lieu of density measures, we choose to standardize our plant datasets using standardized counts (Scarry 1986; see also VanDerwarker 2006). Standardized counts are calculated by dividing taxonomic counts by the total weight of carbonized plant material (by sample or context). This form of data transformation allows the analyst to examine the abundance of a given plant species in terms of the overall plant assemblage. For example, if we identify a substantial increase in the standardized count of maize through time, then that means that maize usage became more prevalent at the expense of other plants in the diet. Indeed, standardized counts seem more suitable to our analysis than density measures. An increase in maize density (maize counts/soil volume) may not indicate an increase in maize usage relative to the rest of the plant diet. Given that regional settlements became more populated and nucleated after the intensification of violence (Conrad 1989, 1991), an increase in maize density could simply reflect a larger, more concentrated population of people as opposed to actual production increases—in such a situation, maize may be recovered in denser amounts but still represent the same proportion of the plant diet. For these reasons, we focus our abundance analysis around specimen counts standardized to plant weight.

In addition to sorting carbonized plant materials, all bone specimens greater than 2.0 mm were removed from the flotation samples analyzed here. Under the supervision of VanDerwarker, a trained laboratory assistant sorted the bones into their respective taxonomic classes (mammal, bird, fish, etc.). Once sorted into class categories, specimens counts (NISP) were recorded. We use these data to create basic measures of mammal and fish abundances in order to provide a basic test for our hypothesized decrease in fishing and corresponding increase in disturbance fauna. A more detailed faunal analysis of the screened bone assemblages is forthcoming, pending the completion of species-level identification.

5.5 Results: The Effects of Warfare on Subsistence Pursuits

5.5.1 Reduction in Plant Foraging

We test the expectation that CIRV villagers reduced their rate of foraging excursions as regional violence intensified by examining changes in the abundance of nuts, fruits, and wild greens/seeds. Given the high prevalence and abundance of hickory nutshell within flotation samples from these four sites, we choose to display the data as distributions in which each sample is represented as an individual data point. Thus, we calculated standardized counts of hickory nutshell by sample and display these values as site distributions in a box plot format (see also Cleveland 1994; McGill et al. 1978; Wilkinson et al. 1992). This method of graphing the data displays the entire range of the distribution (the whiskers or lines), the middle 50 % of the data points (the box), the median value (area of maximum constriction within the box), and any outliers (asterisks and open circles). In addition, the notched areas of the boxes (that give the boxes their hourglass shape) denote the 95 % confidence intervals around the distribution's median value; if the confidence intervals of any two boxes fail to overlap, then those two boxes are statistically significantly difference at the 0.05 level. In addition, we use a dotted line to indicate a division between the sites that predate (Lamb, C.W. Cooper) and sites that postdate (Orendorf B/C, Myer-Dickson) the intensification of violence in the region.

The box plot displaying distributions of standardized hickory nutshell reveals a clear drop in hickory nut abundance after the rise in regional violence (Fig. 5.3). Indeed, both the Orendorf B/C and Myer-Dickson hickory distributions are significantly lower than those documented at the preceding C.W. Cooper site. While the

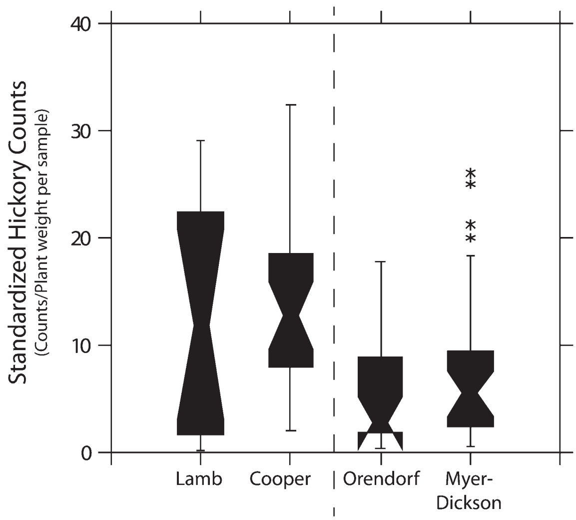


Fig. 5.3 Box plot showing distribution of hickory nutshell standardized counts by site, notched to show 95 % confidence intervals. The dotted line marks the division between sites occupied before and after the regional intensification of violence

Lamb site distribution is not significantly different than the other sites, its median value is almost identical to the median value at C.W. Cooper, which stands in contrast to the later sites.

Given the smaller sample sizes of fruit seeds and wild green seeds from these sites, we choose to calculate standardized counts for these taxonomic groups using the site as the primary aggregate. In general, fruit seeds get consumed along with fruits—this is true of small fruits such as wild blueberries (*Vaccinium* sp.), strawberries (*Fragaria* sp.), and raspberries (*Rubus* sp.). While fruits with larger seeds (e.g., persimmons [*Diospyros virginiana*], plums [*Prunus* sp.]) have a greater chance of being discarded and ending up in hearth fires, these seeds would have significantly fewer opportunities for carbonization than nutshell which was often used intentionally as a secondary fuel source. The seeds of wild greens are also less likely to get burned and discarded in archaeological deposits as most greens are collected before the plants go to seed. Thus, we can expect that seeds from wild fruits and greens will have significantly lower sample sizes in comparison with nutshell. To mitigate for this, we calculate a single index of abundance for each site by summing all fruit seeds and green seeds, respectively, and then dividing these sums by the total plant weight from the site's flotation samples (see Table 5.2). The resulting values are graphically displayed in bar chart form (Fig. 5.4). The overall pattern of decreasing abundance of fruits and greens parallels the pattern observed for hickory nutshell. Fruit abundance is comparable for the Lamb and C.W. Cooper sites, but is much lower for the Orendorf B/C and Myer-Dickson sites. The abundance of wild greens also decreases through time, but this trend begins with the occupation at C.W. Cooper, and then continues to decline at Orendorf B/C and Myer-Dickson. It is clear that CIRV residents collected fewer nuts, fruits, and greens as regional violence intensified.

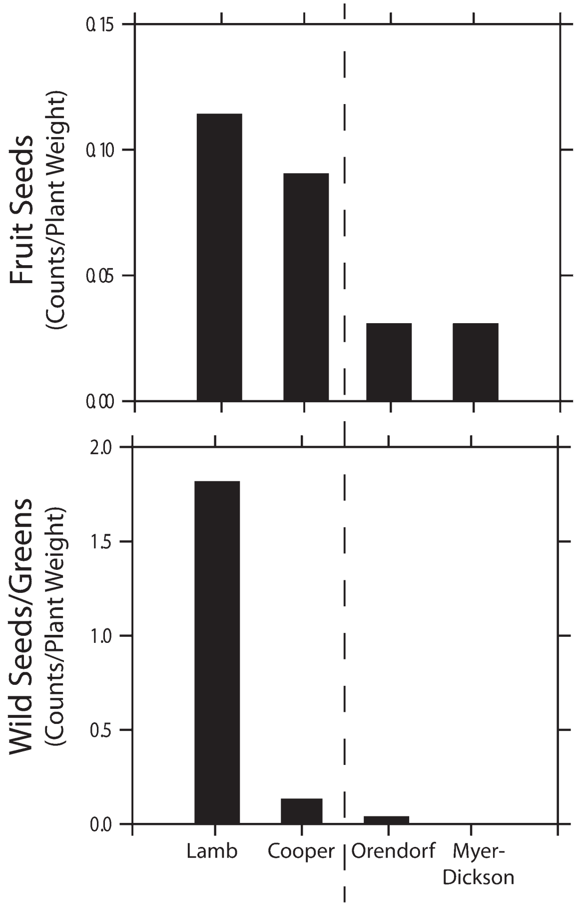


Fig. 5.4 Bar charts showing standardized counts of wild fruits and wild greens by site. The *dotted line* marks the division between sites occupied before and after the regional intensification of violence

5.5.2 Contraction of Plant Diet Breadth

This reduction in wild plant abundance likely reflects a broader pattern of declining dietary diversity. To explore if diet breadth contracted in concert with rising levels of regional violence, we calculate measures of richness and evenness using the DIVERS statistical module (Kintigh 1984, 1989, 1991). Richness refers to the numbers of categories within an assemblage; for example, a plant assemblage with 20 species is richer than one with 10 species. Evenness refers to the distribution of specimens among these categories—if each category is represented by two specimens, then the assemblage has an even distribution and will produce a high evenness value. One the other hand, if an assemblage's distribution is skewed toward a few taxa, then that assemblage will produce a low evenness value.

To calculate these measures of diversity, we use the DIVERS computer simulation because this method deals with sample size when calculating richness and evenness.

It stands to reason that larger assemblages will yield a richer array of taxa than smaller assemblages (Baxter 2001; Jones et al. 1983; Kintigh 1989; Rhode 1988). Moreover, larger samples are more likely to yield rare taxa than smaller samples. Thus, it is problematic to assume that assemblages with more taxa have greater diversity than assemblages with fewer taxa without first ruling out whether differences in richness or evenness are structured by differences in sample size (Baxter 2001; Jones et al. 1983; Kintigh 1989; Rhode 1988).

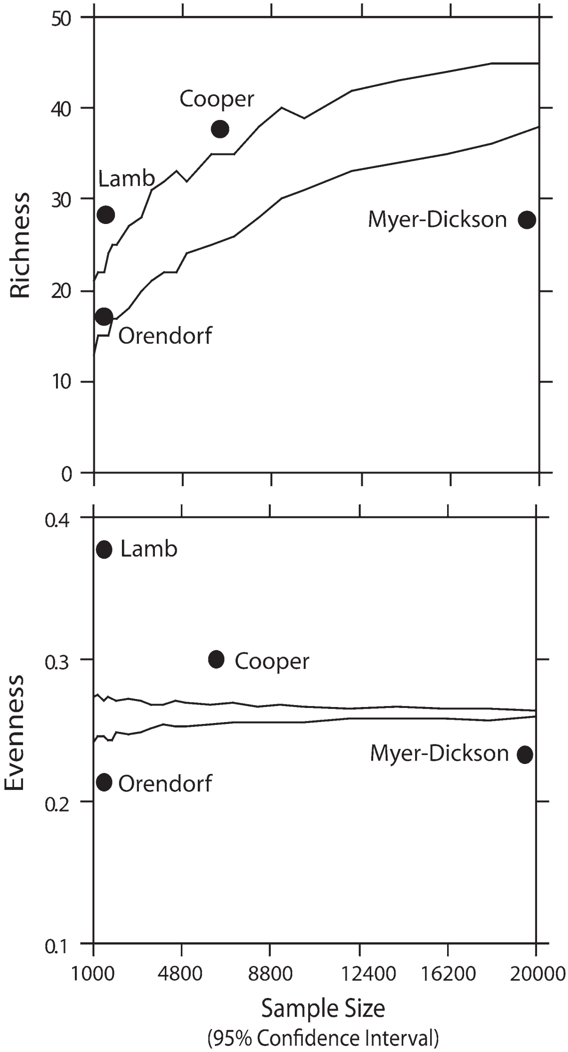
In calculating diversity, the DIVERS program simulates a large number of assemblages based on the categories and sample size of a given archaeological assemblage and produces expectations that can be compared with the actual data (Kintigh 1984, 1989). Thus, it is possible to judge whether the archaeological assemblage is more or less diverse than expected by comparing the richness and evenness of the actual assemblage to the expected values that are randomly generated by the simulation (Kintigh 1984, 1989). Archaeological assemblages, then, are not directly compared to each other. Rather, actual diversity values are compared with expected values for the same sample. The actual values are then plotted against sample size with a 95 % confidence interval that is based on the expected values. If a value falls above the confidence interval, then it is more diverse than expected. Conversely, if a value falls below the confidence interval, then it is less diverse than expected.

We present the graphical results as a bi-plot with richness values in the top graph and evenness values in the bottom (Fig. 5.5). Both of the Early Mississippian sites (Lamb and C.W. Cooper) fall above the confidence interval for expected richness and evenness, indicating that these assemblages are both richer and more evenly distributed than would be expected given their sample sizes. Orendorf B/C falls within the expected parameters for richness, but below the confidence interval for evenness, and the Myer-Dickson plant assemblage is both less rich and less even that would be expected, falling below the lower 95 % confidence interval. Both of the later sites are less rich and less even than the two early sites. Collectively, these patterns reveal a clear, statistically significant contraction of plant-based diet breadth corresponding with the occupation at the fortified Orendorf village and continuing during the subsequent nucleated occupation at Myer-Dickson. Thus far, analysis of the plant data suggests that villagers living in the constant shadow of violence chose to severely limit their plant collection excursions.

5.5.3 Contraction of Hunting Ranges

Microfaunal data lend further support to the pattern of decreased mobility related to wild food procurement (Table 5.3). We present percentages of bone fragments (>2.0 mm) identified to class (e.g., mammal, bird, fish); as discussed above, these bone specimens originate from the heavy fraction component of the flotation samples from which the plants derive. Relative percentages were calculated based on

Fig. 5.5 DIVERS richness and evenness plots of plant species for the study sites (*lines* represent the 95 % confidence intervals)



the NISP data, excluding specimens that could not be identified; the percentages of fish and mammals are presented as bar charts in a bi-plot form, with fish on top and mammals on bottom (Fig. 5.6). The two bar charts reveal a clear decrease in fish and a corresponding increase in mammals throughout the region's occupation. As mentioned above, all four sites are located on bluff tops, requiring travel time to water sources in order to exploit aquatic fauna. The decrease in fish strongly suggests that the region's inhabitants decreased the time they dedicated to fishing excursions. We are still in the processing of speciating the fish in order to determine whether fishing activities were relocated away from the Illinois River proper and toward smaller tributaries, marshes, and oxbow lakes. The shift to a focus on

Table 5.3 Class-based counts (NISP) and percentages of bones from flotation (>2.0 mm) samples by site

	Mammal (Count/ Percent)	Bird (Count/ Percent)	Fish (Count/Percent)	Reptile/ Amphibian (Count/ Percent)	Crawfish (Count/ Percent)	Total count
Lamb	286/5.3	32/0.6	5076/93.5	33/0.6	0/0	5427
C.W. Cooper	1800/8.6	371/1.8	18,407/87.8	79/0.4	301/1.4	20,958
Orendorf B/C	266/17.8	29/1.9	1179/78.9	14/0.9	6/0.4	1494
Myer-Dickson	1189/49.9	17/0.7	1126/47.3	23/0.9	24/1.0	2379

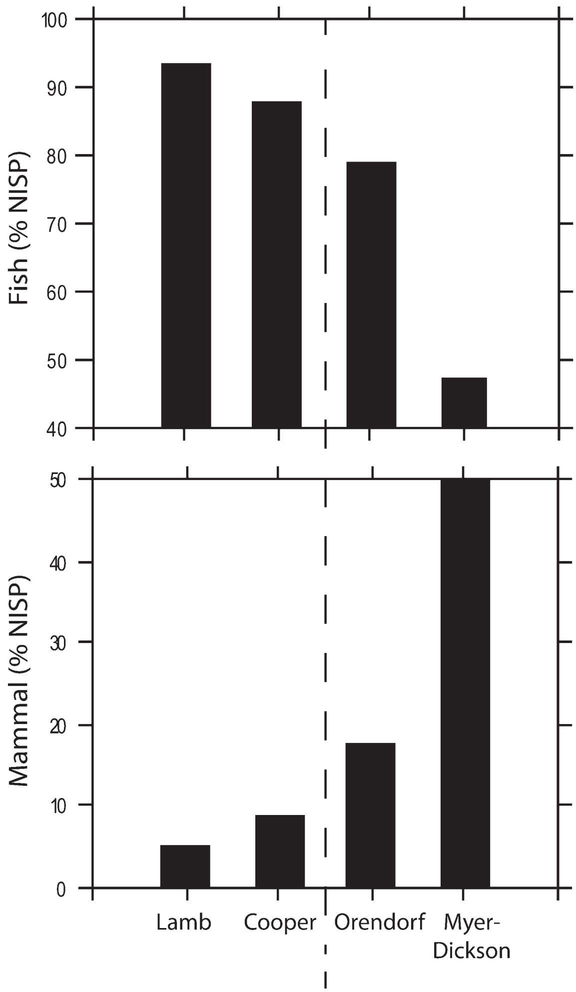


Fig. 5.6 Bar charts of relative percentages of fish and mammal bones from the heavy fraction components of the flotation samples (>2.0 mm) from the study sites. The *dotted line* marks the division between sites occupied before and after the regional intensification of violence

mammals may be indicative of increased garden hunting in fields and edge locales located nearby these settlements. As with the fish, analysis of the mammal assemblage is ongoing; once data analysis is complete for these faunal assemblages, we will examine changes in hunting strategies to further evaluate the possibility that hunting ranges contracted in concert with the reduction in plant foraging.

5.5.4 Trade-Offs Between Foraging and Farming

Given the reduction in fishing and foraging that occurred alongside the increase in regional warfare, we might expect that CIRV villagers sought to offset these dietary decreases by increasing their investment in farming pursuits. The evenness statistic we presented reveals that the Orendorf B/C and Myer-Dickson assemblages were heavily skewed toward a few plant resources. Indeed, a consideration of the plants identified at these two sites in descending order of absolute abundance reveals that both assemblages are biased primarily toward maize remains, with hickory nuts a second-line resource (see Table 5.2). We examine the possibility of such a trade-off by considering the maize data more closely. Given the large sample sizes of maize, we display the maize data similarly to the hickory data, as box plots showing each site's distribution of values by sample. We produced three box plots of maize standardized counts, for maize kernels, cupules, and summed values of kernels and cupules (Fig. 5.7).

These three box plots reveal a clear lack of change in maize through time. The fact that the Orendorf B/C and Myer-Dickson assemblages are skewed toward maize, but that maize production did not increase to offset decreases in wild resources suggest that villagers living with war in the CIRV were unable to make a dietary substitution between wild and domesticated plant foods. Rather, the continuity in maize abundance and the decline in wild plant foods together suggest that villagers reduced their subsistence-related mobility, and that a possible consequence was an overall reduction in the availability of food, which may have resulted in periodic food shortages and elevated levels of subsistence stress.

To further explore possible changes in the reliance on cultigens, we also consider the abundance of native cultigens, including starchy seeds (goosefoot [*Chenopodium berlandieri*], knotweed [*Polygonum* sp.], maygrass [*Phalaris caroliniana*], little barley [*Hordeum pusillum*]), oily seeds (marsh elder [*Iva annua*] and sunflower [*Helianthus annuum*]). In addition, we present data on common beans (*Phaseolus vulgaris*). Because the seeds of these cultigens nearly all represent the edible portion of the plant, they tend to be underrepresented in comparison with plants which produce copious amounts of inedible by-products whose structures are sufficiently dense enough to carbonize without turning to ash (e.g., nutshell, maize cobs/cupules). For these reasons, we quantify these data in the same manner as the fruits and wild greens by displaying aggregate site values as bar charts (Fig. 5.8; see also Table 5.2). The bar charts of both starchy and oily seeded cultigens show significant declines in abundance following the Early

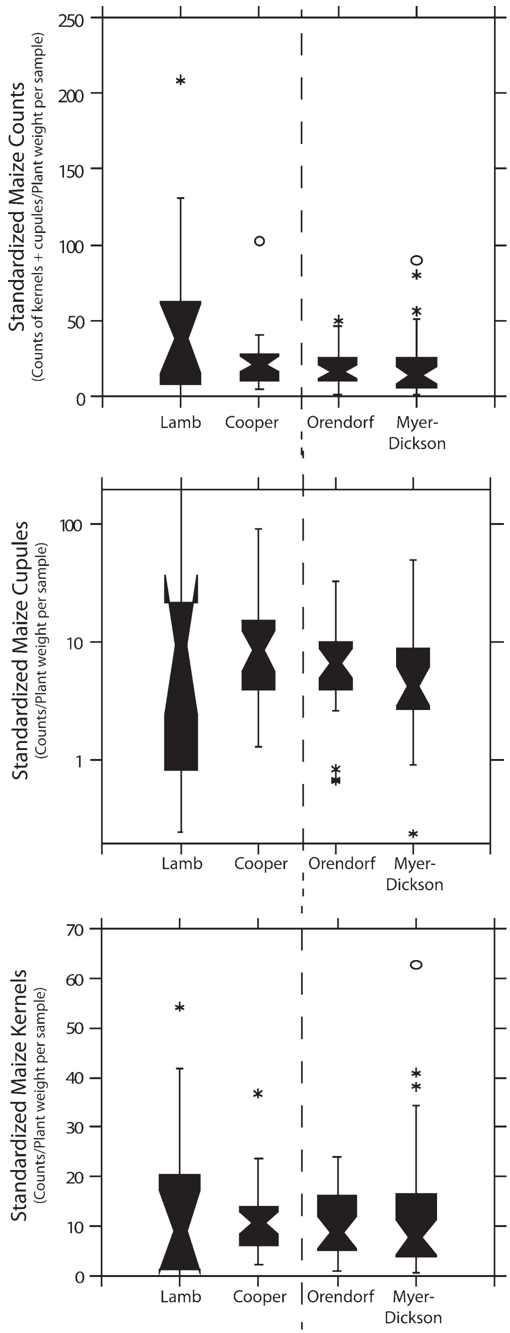


Fig. 5.7 Box plots of maize standardized counts, for maize kernels, cupules, and summed values of kernels and cupules

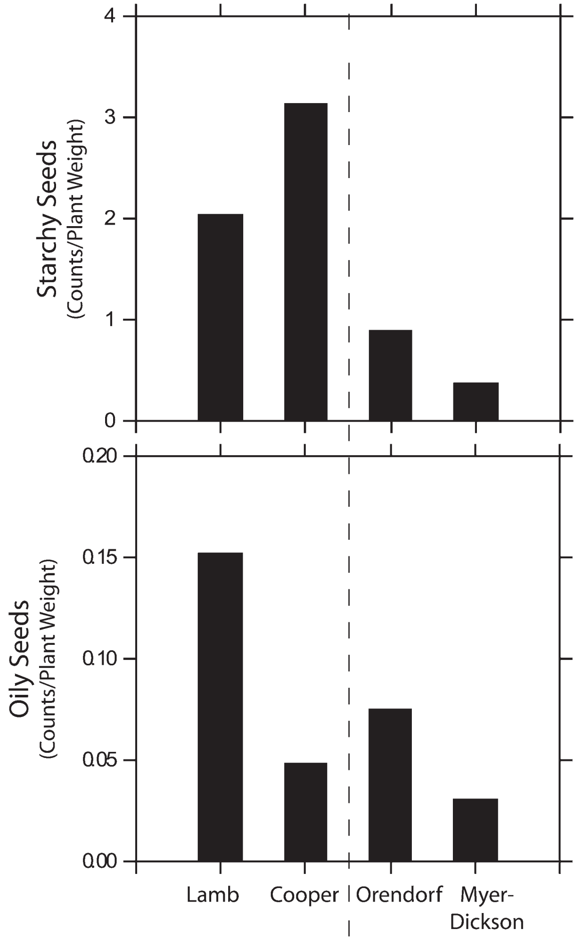


Fig. 5.8 Bar charts of starchy and oily seeds

Mississippian period, with oily seeds dropping after the occupation at Lamb and starchy seeds after the occupation at C.W. Cooper. These patterns parallel those identified for wild fruits and greens. In contrast, bean abundance increases significantly with the occupation of the Myer-Dickson site. Beans are almost absent from the C.W. Cooper and Orendorf B/C assemblages; indeed, only one of the specimens from these two sites can be definitively identified as a common bean, with the other specimens categorized as possible bean fragments.

It is not surprising that there is an inverse pattern in the abundance of native grains versus exotic cultigens (maize, beans) through time, as these different crops had very different production strategies (see Scarry 2008; Scarry and Scarry 2005). Native seeds were typically broadcast by hand with little prior field preparation. In contrast, maize kernels and beans were planted in individually dug holes (via digging sticks), often within prepared mounds. Thus, it appears that as

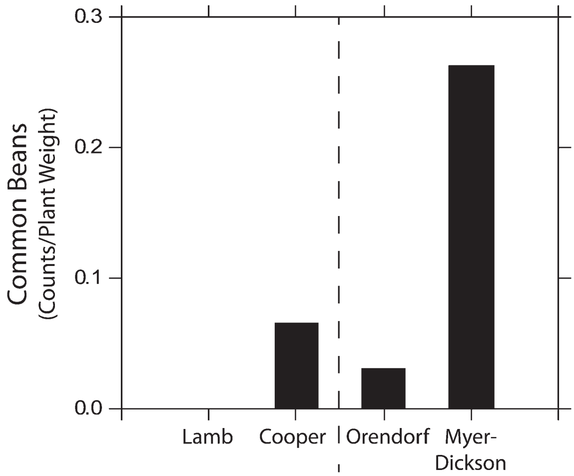


Fig. 5.9 Bar charts of common beans

maize production became more entrenched as a primary subsistence strategy, that cultivation of native grains declined significantly. It is possible that farmers had already intensified maize production as much as they could by the time the threat of regional violence escalated during the Orendorf phase. At the Orendorf B/C settlement, people were unable to increase maize yields to offset declines in foraged foods and may have suffered food shortages and malnutrition as a result. However, by the subsequent Larsen-phase occupation at Myer-Dickson, farmers began planting substantial amounts of beans (Fig. 5.9). In terms of production costs, adding beans to the repertoire would have required little additional planting effort as beans would have been easily intercropped with maize, and the benefits would have been substantial. Intercropping maize and beans is beneficial in that maize stalks support the bean vines throughout plant growth, and intercropping also reduces the risk of pest and disease outbreaks (Smartt 1988, p. 149). Maize and beans are also complementary in terms of nutritional value; maize is deficient in essential amino acids lysine and isoleucine, which beans have in abundance (Bodwell 1987, p. 264; Giller 2001, p. 140). Thus, in addition to the benefits of cropping maize and beans together, there are also benefits to eating maize and beans together. It is possible that Larsen-phase villagers were able to produce enough beans to offset the potential food shortages and nutritional deficits likely experienced during the preceding Orendorf phase.

5.5.5 Summary of Dietary Patterns

The patterns identified in these subsistence datasets paint a picture of a deteriorating regional subsistence regime defined by increasing caloric and nutritional inadequacy that corresponds with the intensification of intergroup violence.

Villagers living in the constant shadow of war (at Orendorf B/C and Myer-Dickson) significantly reduced foraging excursions that took them away from the safety of their defended villages; this inferred reduction in travel is supported by decreases in wild plants (fruits, nuts, greens) and fish, in addition to a clear contraction of plant diet breadth. The lack of diachronic change in maize abundance and the decrease in native starchy/oily seeds indicate that Orendorf villagers were unable to offset reductions in wild resources by increasing crop yields. Together, these data suggest that the outbreak of regional warfare at the beginning of the thirteenth century C.E. likely led to seasonal food shortages and chronic nutritional imbalance—conditions likely exacerbated by increasing village size and nucleation resulting from the incorporation of refugees fleeing from nearby decimated communities. By the mid-thirteenth century C.E., residents at Myer-Dickson may have bolstered the nutritional content of their diets by incorporating common beans into their agricultural regime; the continuation of the other dietary trends, however, suggests that seasonal food shortages likely continued to plague local Larsen-phase communities.

5.6 Discussion: Warfare and Structural Violence in Central Illinois

> Perhaps the major impact of such long-term, chronic violence is its destabilization of a society's subsistence strategies, political and social patterns, and general lifeways. This pattern of low-scale, continuous, and persistent violence can destroy or entirely transform a society long before it kills large numbers of the society's members (Emerson 2007, p. 139).

Beginning around 1200 C.E., the Central Illinois River Valley was transformed from a relatively peaceful region inhabited by small, dispersed groups of farmer–foragers into a bellicose landscape of nucleated, palisaded villages defended by warrior–farmers (Conrad 1991; Milner 1999; Wilson 2012). Direct evidence of warfare in this region includes several catastrophically burned villages, the positioning of villages on defensible bluff edge locations, the sudden appearance of palisades surrounding villages, and the highest rate of adult violence-related trauma in the Eastern Woodlands, which includes a mass grave, embedded arrow points, and various examples of scalping (Conrad 1989, 1991; Harn and Weedman 1975; Milner 1999; Milner et al. 1991; Steadman 2008). While it is difficult to identify the cause(s) of intensified regional violence, it is possible to document the effects of chronic and pervasive warfare on the lives of the regional populace. As ethnographic research has demonstrated (see discussion above), families and communities often reorganize their households and communities and restructure their daily and seasonal subsistence practices when living under extremely bellicose conditions. These types of indirect, structural changes in daily life that occur in the context of chronic violence create conditions (e.g., nutritional deficiencies, sanitation problems, domestic violence) that have the potential to claim more lives than the actual battles and skirmishes in which warriors fight (see also Cobb and Steadman 2012).

As our archaeological case study demonstrates, warfare in the Mississippian-period Central Illinois River Valley transformed both settlement and subsistence practices. When faced with the constant and very real threat of violent death, families coalesced into larger communities behind defensive walls, a common pattern cross-culturally (e.g., Beckerman and Yost 2007). These communities perceived the dangers to be so great that they went to extreme measures to minimize their exposure to threats outside the protected limits of their villages. We argue that limiting foraging and fishing trips was an extreme measure because of the severe consequences this decision had on dietary quality and seasonal resource availability. Not only did villagers focus their diet around a single nutritionally deficient crop, but their inability to increase maize yields likely resulted in periodic shortfalls, the consequences of which would have been felt most keenly by children and women of child-bearing age (see also Walden 2012).

Why couldn't villagers living in the war-torn CIRV increase their maize output? Perhaps agricultural strategies were structured around the same principle as foraging and fishing strategies: to minimize exposure to danger. Adhering to this principle would have meant focusing cultivation in infields located within close proximity to the village walls—close enough to allow lookouts stationed on the walls to warn farmers of approaching enemies and close enough that farmers would have ample time to retreat behind those walls. The need for maize fields to be situated in such close proximity would have limited the total acreage that could be safely cultivated. Moreover, given that most villages were strategically located adjacent to the western bluff line of the Illinois River, the total acreage of safe farmland would be further reduced as maize could not be grown on the bluff-facing side of the village. Thus, the logistical limits on the amount of safe farmland available to villagers may have prohibited shifting cultivation strategies necessary for replenishing soil nutrients. Continual cropping of the same upland soils year after year without a fallow period, however, would have eventually led to *declining* maize yields. It is no wonder that villagers could not *increase* their maize yields under these conditions. However, given that the archaeobotanical data demonstrate that maize yields did not *decline* either, it is possible that adjacent acreage was indeed minimally sufficient to allow for limited crop rotation, perhaps every second or third year; this short fallow period may have been enough to at least maintain annual production output. By the Larsen-phase occupation at Myer-Dickson, the addition of the common bean to cultivated fields would have helped somewhat to bolster declining soil fertility.

We argue that these changes in subsistence practices and dietary constituents are indirect outcomes of increased regional violence. As such, the nutritional deficiencies and seasonal periods of insufficiency resulting from these subsistence changes represent structural violence experienced by the villagers (see also Cobb and Steadman 2012, p. 45). It is difficult, however, to directly link these patterns in the subsistence data to evidence for nutritional deficiencies identified on skeletal populations (Cobb and Steadman 2012, pp. 43–47). Although adult skeletal populations from the CIRV dating after 1200 C.E. present more evidence of periods of growth disruption (linear enamel hypoplasias) than preceding Early Mississippian groups, the osteological paradox (see Wood et al. 1992) cautions us to remember that these are the adults who *survived* those periods of stress during their childhoods (Wilson 2010). Perhaps a better way to assess the relative health and nutritional well-being of local villagers is through the use of recently developed paleodemographic and paleoepidemiological models developed in light of the problems raised by Wood and colleagues (1992). In a recent publication on Central Illinois skeletal populations (including Late Woodland, Mississippian, and Oneota period samples), Wilson (2010, 2014) employed Gompertz and Gompertz–Makeham hazard models to examine diachronic mortality patterns within the region. His findings reveal a striking pattern in which adult women living in fortified Mississippian villages during the thirteenth through early fifteenth centuries C.E. experienced decreased survivorship and a higher age-specific risk of death than women from early periods. Survivorship for adult men, however, does not appear to have changed from Early to Middle Mississippian times, indicating that men were not as negatively affected by the shift to fortified village life as women.

Reasons for these sex-based differences in mortality likely relate to the increased susceptibility of women to pathogens during pregnancy and shortly thereafter, a condition that would have been magnified upon the movement into nucleated village arrangements (Wilson 2014, p. 277). Indeed, it appears that females of child-bearing age were disproportionally impacted by these changes, while “those females surviving their ‘fertile years’ were heartier for it and could expect to live longer lives than most males” (Wilson 2014, p. 277). In short, women of reproductive age became a premium in fortified Mississippian villages.

We are not able to make a direct connection between these diachronic changes in diet and mortality at this preliminary research stage. However, it is worth noting that the narrowing of diet breadth revealed by the macrobotanical and microfaunal analyses likely compounded the health risks for young women due to resulting propensity for food shortages and nutritional deficiencies. This probable connection is reflected in the age-related patterning of oral health indicators such as cavities, with young Mississippian females experiencing worse oral health than other cohorts (Wilson 2010, p. 377).

These sex-based differences in mortality and disease susceptibility beg consideration of broader changes in gender relations that may occur in the context of heightened regional conflict (see also Pauketat 2009). While it is rare for archaeological warfare studies to closely consider gender relations, various insights can nevertheless be gleaned from the ethnographic and archaeological literature. Several scholars have noted a marked emphasis on male warrior status in societies engaged in warfare (Arkush 2011; Chacon 2007; Chagnon 1988; Moore 1990; Resic 2006). It is not unreasonable to suggest a linkage between heightened notions of masculinity and elevated levels of gender inequality. Indeed, Philip Walker’s (1998) analyses of trauma from skeletal collections spanning the globe have demonstrated that increases in warfare were often associated with increases in domestic violence against women and children (see also Lambert 1997). More recent studies have highlighted practices of female captive-taking among raiding societies (Alt 2007; Keener 1999; Kohler and Turner 2006; Martin 2008). Martin's (2008) bioarchaeological work in the southwestern USA has demonstrated marked abuse of this vulnerable demographic of enslaved females. Tentative evidence of captive-taking in the CIRV is represented in mortuary remains dating to the early 1400s at the Crable site. Excavations into the residential portion of the site uncovered the skeletal remains of a young adult woman in her early 20s who had been haphazardly dumped into an abandoned storage pit and covered with domestic refuse. Meanwhile, other excavations at the Crable site have uncovered spatially extensive cemeteries where deceased individuals were laid to rest with great care, sometimes accompanied with elaborate artifacts. By comparison, the callous manner in which this young woman was interred indicates she was of exceedingly low social status within the Crable community, a pattern consistent with her identity as a captive. While a consideration of gender inequality is beyond the scope of the current paper, we highlight this issue because it bears further examination.

We have argued that the onset of chronic and pervasive intergroup violence in the CIRV resulted in significant structural violence on local populations, in the form of food shortages and nutritional deficiencies. Wilson's (2014) bioarchaeological analysis reveals that young women were the most negatively affected age/sex category living behind palisade walls, and we further suggest that the perils of fortified life (e.g., increased susceptibility to disease) were exacerbated by dietary insufficiency (see also Milner et al. 1991). It is not hard to imagine a scenario in which female status declined inversely with the increase in male-warrior status, especially as women became increasingly sequestered behind village walls. Ultimately, structural violence reaches into myriad aspects of daily life that transcend food insecurity. Nevertheless, food shortages and nutritional inadequacy were undoubtedly very keenly felt in these local war-torn villages, making food insecurity itself a significant catalyst for local conflicts within communities. It is within this context that domestic violence and elevated gender inequality have the potential to take root. By considering food insecurity within the broader context of the effects of warfare on daily life, it is clear that the outcomes of structural violence can be as dramatic and morbid as the outcomes of individual pitched battles and raids.

Acknowledgments Foremost we acknowledge Michael Conner, Lawrence Conrad, Duane Esarey, Alan Harn, and Dorothy Lamb for graciously providing access to the datasets considered in this paper. Thanks also to Gayle Fritz for providing definitive specimens of erect knotweed for comparison with our regional archaeological specimens. We thank our anonymous reviewers for their comments and suggestions. Thanks also to Larry Keeley, Richard Chacon, Danielle Kurin, James Brooks, and Charlie Cobb for engaging us in discussions of warfare and structural violence. Finally, we acknowledge the help of various undergraduate and graduate assistants in the sorting and identification of the floral and faunal samples, including Jennifer Alvarado, Dana Bardolph, Caroline Dezendorf, Katie Tardio, and Geoffrey Taylor. This material is based upon work supported by a National Science Foundation under Grant No. 1062290, in addition to an Academic Senate Grant from the University of California, Santa Barbara.

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Chapter 6
Cycles of Subsistence Stress, Warfare, and Population Movement in the Northern San Juan

Kristin A. Kuckelman

The vagaries of prehistoric farming in the northern San Juan region of the US southwest influenced the culture history of ancestral Pueblo peoples in numerous profound and far-reaching ways. During the past few decades, data regarding environmental downturns, subsistence stress, violence, warfare, and population movement in this region have mushroomed, revealing repeated sequences and crucial dynamics between these natural and cultural phenomena. The success of Pueblo farming was largely dependent on a suite of specific environmental conditions. Paleoenvironmental data suggest that farming in this region would have been compromised by episodic, and periodically severe, drought as well as by adverse shifts in seasonal precipitation patterns (Benson et al. 2006; Douglass 1929; Larson et al. 1996; Van West and Dean 2000; Wright 2010). In addition, periods of cooler temperatures, exacerbated in some areas by the high elevation of the terrain, could result in a growing season of insufficient length for maize (*Zea mays*) to reach maturation (Adams and Petersen 1999; Petersen 1988; Salzer 2000; Wright 2010). In the northern San Juan, the amount and timing of precipitation were so variable (Wright 2010, p. 78), and the length of the growing season was so unpredictable, that families were compelled to maintain a level of mobility that enabled them to periodically seek out and resettle within the current dry-farming belt (Petersen 1988), the size and location of which shifted unpredictably across the northern San Juan through time (Van West and Dean 2000; Wright 2010). Other types of environmental downturns included drought-reduced wild resources, the depletion of wild resources through over-exploitation, and the nutrient depletion of crop fields.

Evidence of violence and warfare among ancestral Pueblo peoples was first recognized in the northern San Juan more than 100 years ago, as were defensive

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_6

aspects of the architecture and settlement locations of the late 1200s C.E. (Holmes 1878; Jackson 1876, p. 373; Morley 1908, pp. 597–598; Morris 1939, p. 42; Newberry 1876, p. 88; Nordenskiöld 1979, pp. 29, 35, 58, 67, 170), but compelling empirical evidence of widespread violence on human remains in this region has been documented only within the past 30 years (Billman 2008; Billman et al. 2000; Dice 1993a, b; Errickson 1993a, b, c, d; Kuckelman 2010a; Kuckelman et al. 2000, 2002; Lambert 1999; LeBlanc 1999; Martin et al. 2001; Stodder et al. 2010b; Turner and Turner 1999; White 1992; see also Snead, this volume). Achieving a more comprehensive and nuanced understanding of these violent events is contingent upon discovering more about the contexts in which they occurred. The data have now amassed sufficiently that with the aid of abundant tree-ring dates to provide fine temporal anchoring of structures, settlements, and communities across the region, substantial spatial and temporal patterning of such events can be discerned.

Population movements and migrations of Pueblo peoples in the northern San Juan through time have been recognized as a key element of Pueblo culture history and have thus been studied intensively in recent decades through a variety of survey, excavation, and tree-ring data (e.g., Berry and Benson 2010; Glowacki 2010; Hill et al. 2010; Lipe 2010; Ortman 2012; Varien 1999; Varien et al. 2007). Determining the causes of such population shifts is essential to a comprehensive recreation of Pueblo culture history.

In this chapter, I present and discuss data that define and clarify relationships between environmental downturns, subsistence stress, violence and warfare, and associated population movements in the northern San Juan region. Further, I define escalating cycles of these interrelated phenomena during three discrete periods in this region: the early 800s C.E. (or early Pueblo I period), the middle 1100s C.E. (or the late Pueblo II/early Pueblo III transition), and the late 1200s C.E. (or the terminal Pueblo III times), which were the final years of Pueblo occupation of the region. For the purposes of this chapter, I use Ferguson's (1984, p. 5) definition of warfare as "organized, purposeful group action, directed against another group that may or may not be organized for similar action, involving the actual or potential application of lethal force".

6.1 The Early 800s C.E. (Early Pueblo I)

The earliest cycle of severe environmental downturn, subsistence stress, violence and warfare, and subsequent population movement yet defined for the northern San Juan was revealed as a result of excavations associated with the recent Animas-La Plata Project, which yielded abundant evidence of these events for the early 800s C.E. in the Ridges Basin area southwest of present-day Durango, Colorado (Fig. 6.1). The landscape in this area adjacent to the Animas River valley, at an elevation of more than 2100 m, was populated by small groups of

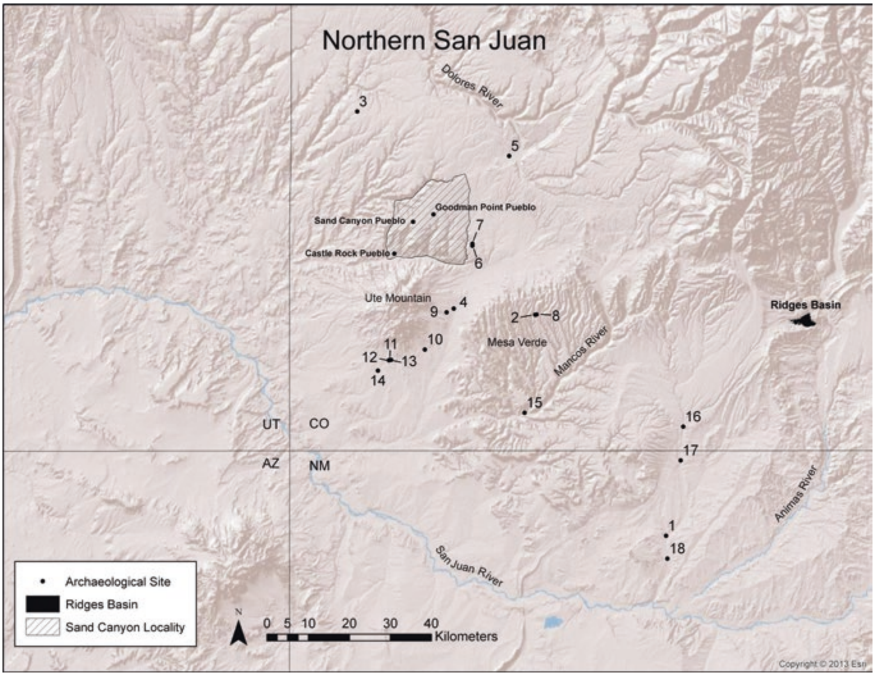

Fig. 6.1 Northern San Juan region showing the locations of Ridges Basin, of mid-1100s C.E. sites with evidence of violence and extreme processing (keyed to Table 6.1) and of terminal Pueblo III sites Castle Rock, Sand Canyon, and Goodman Point Pueblos within the Sand Canyon locality. Copyright Kristin A. Kuckelman

early Pueblo peoples at least as early as the Basketmaker II period (500 B.C.E.–500 C.E.). Fully sedentary farmers began settling Ridges Basin about 700 C.E., and a relatively warm and wet climatic regime between 760 C.E. and 794 C.E. drew a wave of new residents into the Basin (Potter et al. 2010a, p. 140), swelling the population to as many as 300 individuals (Potter 2010a, p. 125) who resided in scattered farmsteads and small villages. Blue Mesa, a few kilometers to the southeast (Fig. 6.2), boasted a contemporaneous population of comparable size (Chuipka and Potter 2007, p. 243).

The archaeobotanical record from Ridges Basin indicates that maize was consumed during the entire Pueblo occupation of the Basin (Adams and Murray 2008, p. 240); indeed, by the 700s C.E., maize had been cultivated by Pueblo peoples in the northern San Juan for more than a thousand years (Coltrain et al. 2007; Matson 1991). However, environmental studies reveal that the Basin experienced severe drought between 795 and 809 C.E. (Anderson 2008, p. 32). Just as important for successful crops was a growing season of adequate length, but a cooling trend that began in the late 700s C.E. culminated in cold temperatures from 804 C.E. to 824 that would have curtailed the growing season and reduced crop yields (Anderson 2008, p. 13).

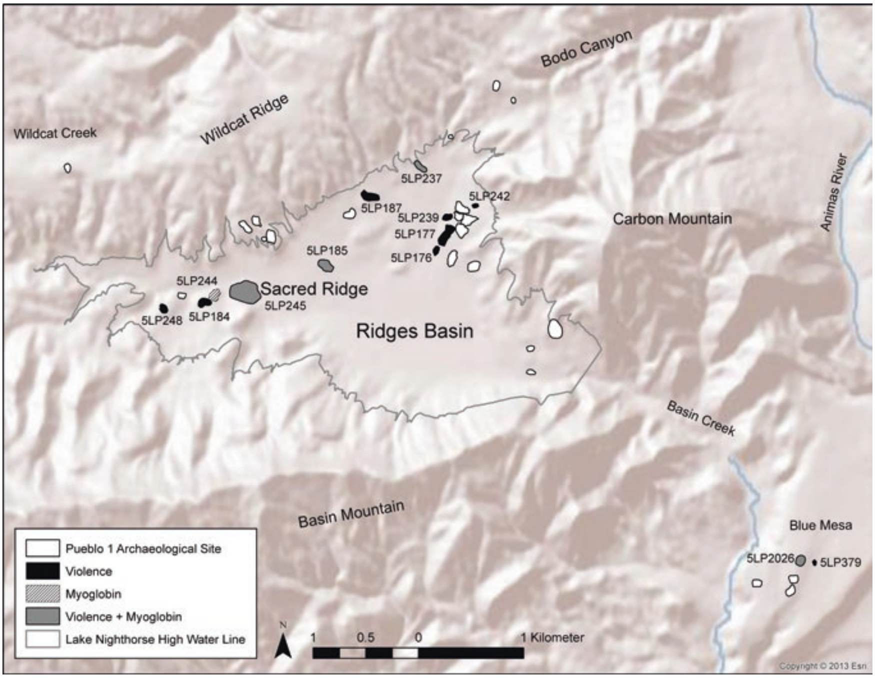

Fig. 6.2 Early Pueblo I sites in Ridges Basin and selected Pueblo I sites on Blue Mesa. Copyright Kristin A. Kuckelman

Adams and Murray (2008) found that the availability of maize declined steadily throughout the Pueblo occupation of Ridges Basin, and that the relative presence of maize pollen in cultural contexts dropped by nearly 50 % from the earlier to the latter part of the occupation. Maize crops may have failed repeatedly during successive years. Other data indicate a shift to an increasing exploitation of, and dependence on, wild plant foods through time; during the final 30 years of occupation of the Basin, residents began consuming a minimum of 17 additional wild plant foods (Adams and Murray 2008, p. 239), which in turn resulted in a landscape of significantly depleted resources (Potter 2010b, pp. 327–328).

The Ridges Basin archaeological record of sites dating from the early Pueblo I period (see Fig. 6.2) contains abundant evidence of violence and violent death (Stodder et al. 2010b). Evidence of violence includes cranial depression fractures that had been inflicted antemortem (which were healing or healed) and others that were perimortem (inflicted around the time of death) as well as trauma such as perimortem postcranial battery. Many remains also exhibit evidence of trophy-taking, which presumably also occurred perimortem. Further, numerous tools and vessels from four sites in the Basin and one site on Blue Mesa (see Fig. 6.2) tested positive for human myoglobin, a protein found only in human skeletal muscle tissue and cardiac muscle tissues (Marlar et al. 2000; Marlar and Potter 2010). The presence of this protein on tools is inferred to result from contact with one of those specific types of tissue during the dismembering and processing of human remains, and its presence in vessels to result from cooking, serving, and consumption (Billman et al. 2000; Kuckelman et al. 2002; Potter et al. 2010b, pp. 320–321), also called anthropophagy.

Among the sites and structures excavated as part of the Animas-La Plata Project, a site called Sacred Ridge contained the largest cluster of human remains exhibiting evidence of violence (Stodder et al. 2010b). At this site, Feature 104, a pithouse, contained the most abundant evidence of perimortem trauma and the largest deposit of processed remains in the Basin. The remains in the fill and on the floor of this structure exhibit abundant evidence of blunt force trauma, extreme processing, and other anthropogenic modifications and represent, minimally, four infants, one child under 12 years of age, seven juveniles, seven subadults, one non-adult younger than 18 years of age, 11 young adults, and seven middle adults; at least 10 men and seven women are represented among the adults. A minimum of 35 individuals are represented (McClelland 2010, Table 7.1). It is worth noting that this MNI (Minimum Number of Individuals) was calculated on the basis of redundant glabellae (a portion of the frontal bone); however, age-category data for glabellae and dentition combined (Stodder et al. 2010b, Table 13.12) suggest that at least 47 individuals are actually represented in this structure.

Many characteristics of remains inferred by researchers to have been subjected to anthropophagy (Billman et al. 2000; Kuckelman et al. 2002; Turner and Turner 1999; White 1992) are observable in the assemblage from pithouse Structure 104 including, for example, cut marks from disarticulation, spiral fracturing and lengthwise splitting suggestive of marrow extraction, end polish from abrasion inside a cooking vessel, and patterned burning indicative of roasting on long bones (Stodder et al. 2010b). In addition, on the floor, splintered human remains were found on a metate, and a cooking jar tested positive for human myoglobin (Marlar and Potter 2010, Table 3; Potter et al. 2010b, p. 314).

Mixed with these deposits were the sparse, butchered remains of fauna such as deer (*Odocoileus* sp.) and jackrabbit (*Lepus* sp.). Similar to the human remains, many of these elements were burned, and many had been split lengthwise, presumably to access the marrow. The presence and condition of these faunal remains, characteristic of food refuse, support an interpretation of anthropophagy for the associated human remains, which were processed similarly. Also noteworthy is the presence of abundant elements from a minimum of four butchered domestic dogs (*Canis familiaris*)—dog meat was a non-preferred food that was rarely consumed by ancestral Pueblo people in the northern San Juan (Fugate 2008). The implied consumption of these animals can be interpreted as additional evidence of intense subsistence stress and nutritional shortfalls.

The most parsimonious interpretation of the Ridges Basin abandonment-context data as a whole is that, about 810 C.E., residents of Sacred Ridge captured a large group of men, women, children, and infants, possibly an extended family (Stodder et al. 2010b, p. 415) who, dental and nonmetric cranial biodistance data suggest, were genetically more affiliated with each other than with any other residents of Ridges Basin, including those formally interred at Sacred Ridge (Douglas and Stodder 2010, p. 220; McLelland 2010, p. 237). Thus, the captives had probably not been residents of the Basin but might have been members of a nearby community, perhaps in Bodo Canyon (Fuller 1988), along the Animas River (Carlson 1963), or on Blue Mesa (Chuipka et al. 2007). At Sacred Ridge, the captives were subjected to various forms of severe blunt force trauma to the shoulders, back, and hips. Defensive actions by the captives resulted in parry fractures to forearm elements (Stodder et al. 2010a, p. 154). Trauma also included beating the sides and soles of the feet to hobble the victims (Stodder et al. 2010b, pp. 407–408); these actions were presumably strategies used to quell resistance and forestall attempts to escape from Sacred Ridge.

The victims were probably killed one or a few at a time, dismembered, and the remains distributed among the residents of the settlement for further processing and consumption. Also consumed during this time were domestic dogs, possibly those belonging to the victims, and wild fauna, as well as many taxa of wild plants, but few crop foods. The killing of the captives and the processing of their remains probably occurred over the course of at least several weeks. Stratigraphic data indicate that the roof of pithouse Feature 104 was then intentionally collapsed onto the disarticulated remains and the artifacts that had been left on the floor (Potter et al. 2010b). Many additional remains and artifacts were gathered from around the Sacred Ridge settlement and were deposited onto collapsed roofing debris in the remaining pithouse depression (Potter et al. 2010b); these materials were found in three fairly discrete clusters near the walls of the pithouse. The clustering of bones around the structure edges might have resulted from specific positions around the perimeter of the pithouse depression from which basket loads of processed remains had been dumped. Additional clean fill was added above this layer (Potter et al. 2010b). The Sacred Ridge settlement was abandoned shortly thereafter, and the entire Basin was abandoned about this same time (Potter 2010b). The collapsing of the roof, gathering of extramural remains, and placement of additional fill might have been effected by the aggressors to conceal these materials or might have been a considerate ritual by sympathetic individuals after the perpetrators departed.

These new data for the early 800s C.E. in the Ridges Basin area of the northern San Juan thus reveal evidence of a severe environmental downturn co-occurring with subsistence stress, with indicators of violent death on the remains of many individuals, with extreme processing of human remains, and with depopulation. Although pithouse Feature 104 contained the most abundant evidence of violent death and anthropophagy in Ridges Basin, those events did not occur in isolation. Other structures at Sacred Ridge, other sites in Ridges Basin, and at least two sites dating from the same period on nearby Blue Mesa also contain evidence of violence and anthropophagy (see Fig. 6.2). Cranial trauma was detected on 22 of 71 assessable individuals for the Animas-La Plata Project as a whole (Stodder et al. 2010a, p. 154). The events reflected by the remains in pithouse Feature 104 thus occurred in a broader spatial and temporal context of warfare and strife and against a backdrop of considerable subsistence stress resulting from environmental conditions that were disastrous for the resident farming families. These events occurred just before the Basin was completely and permanently vacated by Pueblo people. Although the data reveal an intense level of violence, the scope of the violence is not clear; there are insufficient data as yet to indicate whether warfare was region-wide during this time period (Billman 2008, Table 3.1; Bustard 2008, Table 4.2; Kuckelman et al. 2000, p. 148, Table 1; Turner and Turner 1999, Table 3.80). Nevertheless, Ridges Basin is especially significant as the earliest well-documented case of lethal violence and associated anthropophagy in the northern San Juan, and its early date further undermines the theory that outbreaks of anthropophagy in the northern southwest were perpetrated by warriors from Chaco Canyon (Turner and Turner 1999), a theory challenged by many researchers (Billman 2008; Bustard 2008; Dongoske et al. 2000; Kuckelman et al. 2000; Lipe and Varien 1999a; McGuire and Van Dyke 2008; Walker 2008).

6.2 The Middle 1100s C.E. (Late Pueblo II/Early Pueblo III)

A similar suite of conditions and events occurred across the northern San Juan during the middle 1100s C.E. Pueblo residents of the region during this period constructed and resided in habitations that varied widely from scattered, single-family farmsteads to large villages such as Yellow Jacket Pueblo (Kuckelman 2003). Data indicate that during the previous millennium, Pueblo families had become increasingly dependent on crop foods, especially maize, for sustenance and suggest that by the middle 1100s C.E., residents relied heavily on maize, both as feed for their flocks of domesticated turkeys (*Meleagris gallopavo*) and for their own consumption (McCaffery et al. 2014). Because deer populations had been substantially thinned by this time, turkey flocks provided an important and reliable source of animal protein for the residents of the region (Driver 2002, p. 157).

However, tree-ring and abundant other data document a period of extremely adverse environmental conditions throughout the middle 1100s C.E. (Berry and Benson 2010; Figs. 3.2, 3.4; Burns 1983; Dean and Van West 2002, Tables 4.1, 4.3; Van West and Dean 2000). In a study of the climatic variability between 900 C.E. and 1500, Dean and Van West (2002) conclude that the worst drought, both in intensity and duration, occurred from about 1130 to 1180 C.E. The harvesting of timbers for building construction declined sharply during this period, which Berry and Benson (2010, p. 69) interpret to have resulted from a substantial drop in population density. Food refuse deposited during this time contains the remains of a wide variety of wild plant foods, but domesticates are sparsely represented (Billman et al. 2000, pp. 154–156; Brandt 1993a, Tables 15.6, 15.8, 15.9; Brandt 1993b, p. 64; Errickson 1993a, p. 329). Thus, persistently unfavorable environmental conditions in the middle 1100s C.E. undoubtedly resulted in severe nutritional hardship for farming communities dependent upon maize and other crops for their survival.

Archaeological evidence of violence and warfare across the northern San Juan during the 1100s C.E. has accumulated for the past 75 years (Billman 2008, p. 51; Bustard 2008; Kuckelman et al. 2000; McGuire and Van Dyke 2008; Turner and Turner 1999; White 1992), revealing that the period from 1130 to 1180 C.E. might well have been the most violent 50-year period in the entire Pueblo occupation of the region. At least 18 sites dating from this brief span of time have yielded evidence of violence (Table 6.1, see Fig. 6.1), including both antemortem and perimortem violence and extremely processed human remains. Evidence of trauma was found primarily on cranial and facial elements, but numerous cases of postcranial injuries were also noted.

The results of multiple meticulous analyses such as those reported by White (1992) and Billman et al. (2000) on anthropogenically modified human remains dating from this period provide compelling argument that such perimortem processing was associated with anthropophagy, and several lines of evidence indicate that these cases were directly associated with violent death rather than with natural death from disease or starvation. Some processed remains do exhibit evidence of violent death, but most such remains were so reduced anthropogenically that evidence of perimortem trauma is difficult to differentiate from modification from disarticulation and processing.

Evidence of violence, violent death, and processing of human remains that occurred in the northern San Juan during the middle 1100s C.E. has been documented on the remains of a minimum of 120 to 210 individuals (see Table 6.1). Violence-associated antemortem injuries include depression fractures of the cranium, fractured noses, and fractures of ribs, humeri, radii, ulnae, metacarpals, and cervical vertebrae. Perimortem trauma includes depression fractures of the cranium and tooth avulsion. Perimortem anthropogenic modifications inferred to have occurred shortly after death include cutmarks, chopmarks, crushing, anvil abrasions, burning, fracturing, and a host of other modifications associated with trophy-taking and processing. Most remains with evidence of perimortem violence, whether processed or not, were found in abandonment contexts, thus representing the final actions in those structures and habitations.

Two of what are perhaps the most revealing incidents of warfare and anthropophagy during this period are those that occurred at Cowboy Wash (Site 5MT10010) and in Mancos Canyon (Site 5MTUMR-2346) (see Table 6.1, see Fig. 6.2). At the Cowboy Wash site, about 1150 C.E., the remains of a minimum of seven people—two adult males (one with a healed cranial depression fracture), one probable adult male, one adult female, one adolescent with two healed cranial depression fractures, and two children—were subjected to extreme processing and deposited in abandonment contexts on the floors of two pit structures (Billman et al. 2000). A human coprolite containing human myoglobin was found on the fill of a hearth in a third pit structure at the site, which is the most compelling evidence of anthropophagy in the northern Southwest to date.

At the Mancos Canyon site, about 1180 C.E., the remains of a minimum of 29 individuals comprising 17 adults and 12 children were subjected to extreme processing (White 1992) and were deposited on floors and in the fills of abandoned

Table 6.1 Incidents of violence and perimortem processing in the northern San Juan dating from the middle C.E. 1100s

ID No.*	Site name/ designation	Date of violence C.E.	Trauma/ processing	MNI	Age	Dating source
1	LA37601 (La Plata Highway)	1125–1180	AV	4	3 adults, one child	Martin et al. (2001)
2	5MV499	1150–1180	PV	1	adult	Lister (1964):88
3	Charnel House	1150–1225	PV	14	nd	Billman (2008): 66; Turner and Turner (1999): 142
4	Snider's Well	1130–1180	PV	90?	nd	McNitt (1966): 74–75
5	5MT2235 (Marshview Hamlet)	~1150	PV, EP	6	4 adults, 2 children	Wilshusen (1988): 49
6	5MT3876 (Hanson Pueblo)	~1150	EP	2	1 adult, 1 subadult	Morris et al. (1993): 29–30
7	5MT3892 (Seed Jar Site)	~1150	EP	12	2 adults, 3 probable adults, 1 subadult, 6 children	Fetterman et al. (2005)
8	5MV820 (Coyote Village)	1100–1200	EP	1	child	Turner et al. (1993): Table 1
9	5MT13510 (Grinnell)	1135–1150	EP	7	5 adults, 2 children	Luebben and Nickens (1982): 73
10	5MT7723	1125–1200	EP	1	adult	Errickson (1993b)
11	5MT10206 (Aztec Wash)	1147–1175	EP	2	1 adult, 1 subadult	Errickson (1993a)
12	5MT10207 (Aztec Wash)	1125–1175	PV, EP	13	7 adults, 1 subadult, four children, 1 infant	Errickson (1993c)
13	5MT7704	1130–1180	EP	2	1 adult or adolescent, 1 child	Errickson (1993d)
14	5MT10010 (Cowboy Wash)	~1150	AV, PV, EP	7	4 adults, 1 adolescent, 2 children	Billman et al. (2000)
15	5MTUMR-2346 (Mancos Canyon)	1150–1180	PV, EP	29	17 adults, 12 children	Nordby (1974)
16	LaPlata/Morris 23 Rockshelter	1100+	EP	5	2 adults, 2 subadults, 1 infant	Turner and Turner (1999): 146

(continued)

Table 6.1 (continued)

ID No.*	Site name/ designation	Date of violence C.E.	Trauma/ processing	MNI	Age	Dating source
17	LaPlata/ Morris 41	~1150	PV, EP	6	4 adults, 1 adolescent, 1 child	Morris (1939): 105
18	LA37592 (La Plata Highway)	1100+	EP	8	3 adults, 1 adolescent, 2 juveniles, 2 infants	Turner and Turner (1999): 312

*Keyed to Fig. 6.1
Note *MNI* minimum number of individuals, *AV* antemortem violence, *PV* perimortem violence, *nd* no data, *EP* extreme processing

rooms of an earlier roomblock (Nordby 1974). The victims were probably too numerous to have resided in this small unit pueblo, and thus they or their remains were probably brought to this settlement for processing and consumption. Their remains were discarded into six abandoned rooms in the farmstead.

Violence in the middle 1100s C.E. thus included men, women, children, and infants and involved nonlethal trauma as well as violent death and anthropophagy. These events occurred at a regional scale in a society heavily dependent on crops during a period of severe, prolonged, and widespread drought, and they were typically the final events that occurred in those structures and settlements. That significant population movement out of the region also occurred during this time is reflected in the archaeological tree-ring record, which indicates that many fewer structures were built during this time than either before or after this span (Berry and Benson 2010, p. 69). Although the region was not completely depopulated during this cycle, the intensity of the violence and processing was similar to that in the early 800s C.E. In addition, the scope of events was much wider geographically, and population movements were much more pervasive than in the earlier cycle.

6.3 The Late 1200s C.E. (Terminal Pueblo III)

Another set of environmental downturns, escalation of violence, and population movement occurred during the late 1200s C.E. in the northern San Juan. In the early 1200s C.E., most residents of the region inhabited dispersed farmsteads or small hamlets in upland settings. Sometime during the first half of the thirteenth century, population densities within the central portion of the region reached unprecedented levels (Glowacki 2010; Kohler et al. 2007; Varien et al. 2007). About the middle of that century, many families relocated to aggregated settlements in canyon-rim settings; numerous large villages with defensive features were constructed in cliff alcoves or around canyon-head springs (Kuckelman 2000, 2006, 2007; Kuckelman et al. 2000; LeBlanc 1999; Varien et al. 2007).

A drought referred to by Southwestern archaeologists as the Great Drought, which descended on the northern San Juan by 1276 C.E. and persisted until 1299 C.E. (Berry and Benson 2010, Figs. 3.2, 3.4; Douglass 1929), converged with other unfavorable environmental conditions that included a variety of natural and anthropogenic degradations (Dean and Van West 2002, p. 97). The farming belt might well have pinched out completely during this time as a result of low summer and winter precipitation at the lower end of the belt and cooler temperatures at its upper edge (Petersen 1988, p. 124).

During the past 30 years, relatively little excavation in the northern San Juan has focused on terminal Pueblo III sites; however, the Crow Canyon Archaeological Center conducted multi-year excavation projects at the sites of three late thirteenth-century villages in the Sand Canyon locality (see Fig. 6.1): Castle Rock (Site 5MT1825), Sand Canyon (Site 5MT765), and Goodman Point (Site 5MT604) Pueblos (Kuckelman 2000, 2007, 2010a; Kuckelman et al. 2002, 2009). These three villages were occupied between 1250 and 1280 C.E., and in all likelihood, Sand Canyon (Fig. 6.3) and Goodman Point (Fig. 6.4) Pueblos were the two largest settlements in the northern San Juan during their occupations. Even though Crow Canyon archaeologists excavated 5 % or less of each of those three sites, our investigations yielded copious data and revealed evidence of environmental conditions and a series of sociocultural events similar to those documented for the early 800s C.E. in Ridges Basin and the middle 1100s C.E. region-wide (see Fig. 6.1).

Fig. 6.3 Three-dimensional reconstruction of Sand Canyon Pueblo superimposed on the actual landscape (reconstruction by Dennis R. Holloway, Architect; aerial photo by Adriel Heisey). Copyright Dennis R. Holloway and Adriel Heisey

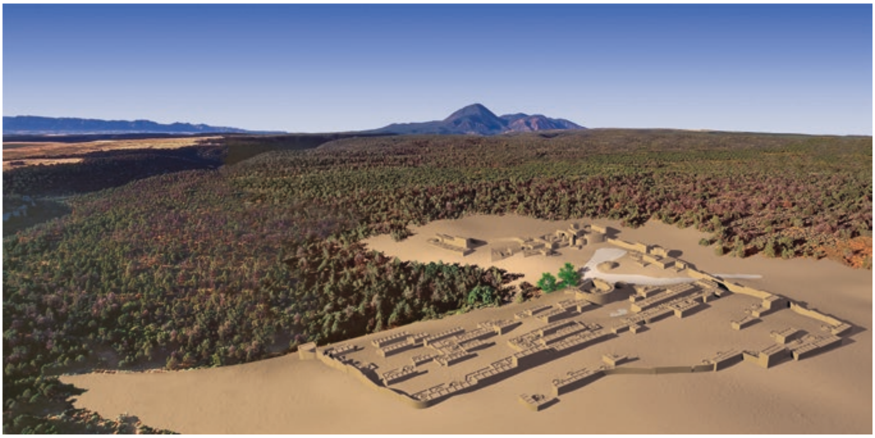

Fig. 6.4 Three-dimensional reconstruction of Goodman Point Pueblo superimposed on the actual landscape (reconstruction by Dennis R. Holloway, Architect; aerial photo by Adriel Heisey). Copyright Dennis R. Holloway and Adriel Heisey

Midden contents reveal that the subsistence base of Pueblo farmers during the occupations of these three terminal Pueblo III villages was very heavily and precariously weighted toward crop foods and domesticated turkeys. This dependence probably resulted from the over-exploitation of wild resources by a dense population. Turkeys, which were fed maize, appear to have supplied much of the animal protein in the Pueblo diet, and this crucial resource was supplemented by the prolific cottontail rabbit (*Sylvilagus* spp.); the preferred meat—deer—had been largely depleted by the mid-1200s C.E. through over-exploitation (Driver 2002).

Subsistence data, specifically that for food remains, for Castle Rock, Sand Canyon, and Goodman Point Pueblos, have revealed marked shifts in the diets of these villagers just before the region was depopulated about 1280 C.E. (Kuckelman 2010a, b). Comparisons of food refuse that had been discarded in middens with food refuse in abandonment contexts—i.e., the remains of the final meals, left on surfaces and in hearths—reveal that the typical diet, structured around maize and turkey, was supplanted by a diet dominated by wild plants and animals, some of which were non-preferred by Pueblo peoples. In his study of the fauna from Sand Canyon Pueblo, Muir (1999) found that the variety of taxa for this site was lower than expected for middens and greater than expected for other, mostly abandonment, contexts.

Considered together, multiple types of data reveal that consumption of domesticated turkey, clearly a primary source of animal protein during most of the occupations of these villages, was dramatically reduced and the consumption of wild animals increased just before regional depopulation. The faunal data thus indicate that residents relied heavily on maize-fed turkeys for animal protein until nearly the end of village and regional occupation, when they began instead to procure and consume the meat of an atypically broad variety of wild and non-preferred game.

Similarly, the remains of crop foods such as maize, squash (*Cucurbita* sp.), and common beans (*Phaseolus vulgaris*) were found almost exclusively in middens, where the ubiquity of maize underscores its role as the predominant domesticate. However, a low incidence of maize kernels in hearth fills and on surfaces suggests that maize was not being widely prepared just before occupation ended (about 1280 C.E.), and a coincident increase in the overall diversity of wild plant foods was documented for late contexts at these villages. Thus, domesticated crops composed the bulk of the diet of these villagers during the occupations of these settlements until just before regional depopulation, when villagers apparently had less access to domesticates, and a wider variety of wild plant foods was consumed. These data constitute compelling evidence of subsistence stress experienced during the Great Drought, just before the permanent depopulation of the northern San Juan.

At Castle Rock, Sand Canyon, and Goodman Point Pueblos, most of the human remains encountered during excavations were located in abandonment contexts, and many exhibited one or more of the following indicators of violent death: perimortem trauma, sprawled positioning, trophy-taking, disarticulation, and weathering. Anthropogenic disarticulation, spiral fracturing, patterned thermal alteration, and the commingling of the remains of multiple individuals, especially at Castle Rock Pueblo, suggest anthropophagous activity, probably by the attackers (Kuckelman et al. 2002).

In abandonment contexts, a minimum of 35 individuals were represented at Sand Canyon Pueblo (5 % of the site was excavated), a minimum of 41 individuals were represented at Castle Rock (5 % of the site was excavated), and a minimum of 16 individuals were represented at Goodman Point Pueblo (less than 1 % of the site was excavated), and each assemblage includes the remains of men, women, children, and infants. The remains at Castle Rock and Sand Canyon were either in articulated but sprawled positions, or were scattered. Some remains display skeletal evidence of lethal-level perimortem trauma that in all likelihood contributed to the death of the individual—especially depression fractures of the cranium resulting from blunt force trauma, probably inflicted by stone axes hafted onto wooden handles—as well as evidence of scalping and other trophy-taking, and of anthropophagy.

Although the human remains encountered at Goodman Point Pueblo were exposed only minimally, their scattered disposition and their locations on floors and in roof- or wall-collapse debris are similar to the more fully exposed and analyzed remains at Castle Rock and Sand Canyon Pueblos. The weathering, antemortem and perimortem trauma, and burning observable on the remains at Goodman Point Pueblo also closely resemble these characteristics on the remains at Castle Rock and Sand Canyon Pueblos. In addition, unlike Castle Rock and Sand Canyon Pueblos, burned remains were found at Goodman Point Pueblo in midden contexts. These remains clearly reflect actions of residents before the attack that ended village occupation. The data are insufficient to establish whether anthropophagy occurred; however, the fracturing and burning of human remains and the subsequent discard of those remains into existing refuse areas by Pueblo people are suggestive of that activity and reflect, at the very least, inconsiderate treatment, probably of the remains of enemies during turbulent times. Further, the only middens containing burned remains were associated with extra-residential structures—a great kiva and a multistory, D-shaped bi-wall building—which is suggestive of ritual actions or actions by special-status individuals. These data add to our knowledge of the array and sociocultural significance of violent interactions that occurred before the final attacks that ended village and regional occupation in the late 1200s C.E.

The latest tree-ring date for Sand Canyon Pueblo is 1277vv[1] C.E., for Castle Rock Pueblo is 1274vv C.E., and for Goodman Point Pueblo is 1269vv C.E. Tree-ring dates for the region as a whole indicate that complete and permanent depopulation of the region occurred about 1280 C.E. Thus, tree-ring dates confirm that the occupations of these three violence-plagued villages ended while regional depopulation was underway, and it is reasonable to infer that residents who survived the subsistence stress and violence ended their habitation of these settlements in order to migrate from the region.

6.4 Discussion

Data reveal that ancestral Pueblo peoples of the northern San Juan region experienced significant subsistence stress during cycles of environmental downturns, and that this stress fostered sub-lethal and lethal violence, warfare, anthropophagy, and consequent population movements. The hardships associated with failed crops and a drought-ravaged landscape must have also generated significant psychosocial stress (Billman 2008) that might have contributed to eruptions of violence. Sand dunes, still visible today, that formed along the South Platte River in northeastern Colorado during the widespread megadrought of the mid-1100s C.E. (Wright 2006, p. 116) raise the specter of the suffering endured in the Dust Bowl region of the USA during the Great Depression of the 1930s (Duncan and Burns 2012; Egan 2006; Henderson 2003).

That violence escalated in the northern San Juan during the three cycles defined here is indisputable, and it is likely that at least one motivator for the violence was intense competition for both domesticated and wild resources; thus, raiding for food, as well as social or political feuding, might have all been factors. Climatic variation itself might have played a role; according to Hsiang and colleagues (2013, p. 1), an increasing body of research across numerous disciplines on relationships between environmental conditions and violence among human groups worldwide suggests that "past climatic events have exerted significant influence on human conflict," and that large deviations from normal levels of precipitation increase the risk of intergroup conflict. Thus, "existing research has successfully

[1]The suffix "vv" indicates that there is no way of estimating how far the last ring is from the true outside; many rings may be lost.

established a causal relationship between climate and conflict but is unable to fully explain the mechanisms" (Hsiang et al. 2013, p. 7). Additional research to verify such findings and clarify the mechanisms involved could significantly advance our understanding of relationships between environmental downturns and violence in prehistory.

Who were the aggressors in the violent events of the northern San Juan? The warfare of the early 800s C.E. and the subsequent middle 1100s was clearly among pueblo communities; no other culture group was within striking distance of the northern San Juan at those times. A lack of evidence of any culture group other than Pueblo Indians in this region earlier than 1300 C.E. suggests that the violent events of the late 1200s C.E. were also inter-pueblo (Bradley 2002; Kuckelman et al. 2002, pp. 505–506; LeBlanc 1999, pp. 52–54; Lightfoot and Kuckelman 2001, p. 64; Lipe 1995, pp. 161–162) and not perpetrated by Numic-speaking nomadic peoples such as the Utes; available data indicate that Athapaskans (Navajo and Apache) probably arrived in the northern San Juan much later (Anschuetz and Wilshusen 2011; Lipe and Varien 1999b, p. 341; Wilshusen 2010; Wilshusen and Towner 1999).

It is not possible to determine how specific groups in the northern San Juan were selected as victims; such decisions might have been political, social, or economic in nature or some combination of these; but economic gain from raiding stored consumables and from anthropophagy was one benefit of lethal warfare that was both anticipated and realized. Anthropophagy might well have been motivated at least in part by famine—by the desperation of starvation or impending starvation of families or communities. The spoils of warfare, including pilfered food stores and the flesh of victims, would have supplemented a diet that had become impoverished by both poor crop yields and depleted or drought-reduced wild resources; these consumables could have been dried or otherwise processed to provision pending long-distance emigration from the area.

The intensity of processing that typifies many of the assemblages of human remains discussed in this chapter has been used by various researchers as evidence to support inferences such as corpse mutilation, witch destruction, ritual violence, or ethnic cleansing, as opposed to starvation anthropophagy (Darling 1998; Dongoske et al. 2000; Fetterman et al. 2005; Nass and Bellantoni 1982; Ogilvie and Hilton 2000; Potter et al. 2010b, p. 323; Walker 2008). That is, the processing in these cases is far more intensive than necessary for anthropophagy and thus must have resulted from motivation to actively obliterate one or more aspects of the personhood or identity of the victims. The well-known Alferd (sic) Packer self-admitted case of anthropophagy in the mountains of Colorado in the late 1800s supports this contention: The skeletons of Packer's five victims exhibited evidence of violent death in the form of abundant perimortem cranial trauma, but no evidence of anthropogenic disarticulation, and no bones were splintered or burned (Rautman and Fenton 2005, p. 324). On the other hand, in the documented incident of starvation and anthropophagy of the pioneering Donner party *en route* to California in 1846 (Grayson 1990), faunal remains were rendered to small splinters by intense processing and, according to eyewitness records, boiled repeatedly to extract all fatty lipids and nutrients from the bones (Dixon et al. 2010).

Thus, although multiple motivators might have stimulated events of extreme processing in the northern San Juan prehistorically, the variety of degree and intensity of processing associated with these events should not be considered reliable indicators of whether anthropophagy occurred. Intensity of processing might instead reflect differing circumstances and contexts of specific events of starvation anthropophagy, such as the quantity of hungry individuals to feed, the prospects and timing of anticipated relief, whether bone grease was being rendered, or other, unknown, circumstances (White 1992, p. 359). Rautman and Fenton (2005, p. 338) contend that the Alferd Packer case underscores that in the archaeological record, anthropophagy cannot be correlated with any one type of perimortem body treatment, and that the largely intact skeletal remains in the Packer incident might be considered the results of early-stage survival or starvation anthropophagy, whereas more anthropogenically modified and reduced remains result from a much later stage in the starvation process.

Other specific characteristics of extremely processed remains in the northern San Juan more clearly support a theory of starvation anthropophagy than the other possible motivators listed above. For example, the commingling, with processed human remains, of the remains of butchered and processed fauna such as the artiodactyls and domestic dogs at Sacred Ridge is more consistent with a deposit of food refuse. Also, many reduced elements in these processed human remains are split lengthwise—a time-consuming, labor-intensive process useful for extracting marrow for consumption but unnecessary for, and seemingly unrelated to, identity obliteration, witch destruction, or ethnic cleansing. White (1992, p. 363) states that for many processed human remains in the Southwest, “there is strong evidence that marrow was extracted and bone grease rendered”; split elements are thus compelling evidence of preparation for consumption. If so, then intense processing such as that at the early 800s C.E. site of Sacred Ridge and the mid-1100s C.E. site of Mancos Canyon, as well as other sites with split elements and extremely processed remains (see Table 6.1), would reflect late-stage starvation anthropophagy—or perhaps more individuals to feed—whereas terminal Pueblo III incidents such as those at Castle Rock and Sand Canyon, wherein remains were anthropogenically disarticulated, burned, and commingled but not intensely reduced, could reflect an earlier stage of survival anthropophagy or perhaps fewer consumers.

Tooth avulsion, documented in human remains from numerous sites with evidence of warfare (Billman 2008, p. 63; Hurst and Turner 1993; Kuckelman et al. 2002, p. 495; Lambert 1999, p. 151; Nass and Bellantoni 1982; Stodder et al. 2010b, p. 339) has also been cited as evidence of motivations beyond that of starvation-induced anthropophagy (Billman 2008, p. 63) and as evidence of intent to obliterate the identity or personhood of the victim (Potter et al. 2010b, p. 323; Stodder et al. 2010b, p. 339). Equally likely is that a blow to the mouth of a victim with a hafted stone axe or similar weapon, with enough velocity to shatter teeth, was an easy and expeditious means of neutralizing a victim through acute and intense pain and that also prevented the victim from communicating verbally, such as providing a shouted warning, to other residents of the village. Further, the remains of multiple individuals in other assemblages who had suffered perimortem tooth avulsion were not subjected to additional forms of battery to obliterate their identities (Kuckelman et al. 2002).

Numerous remains in assemblages from all three time periods exhibit perimortem marks characteristic of scalping. Although removal of the scalp could, in some cases, have been associated with anthropophagous processing (White 1992, p. 206), some scalps were removed from remains that do not appear to have been subjected to anthropophagy. It is thus likely that some scalps were taken merely as trophies. Among Pueblo groups in historic times, trophy scalps were imbued with water symbolism and were thought to promote rainfall (Chacon and Dye 2007; Ellis 1979, pp. 444–445; Parsons 1929, p. 138; Parsons 1939; Schaafsma 2007, p. 123; see also Allen et al. 1985, pp. 31–32). Therefore, it is possible that, even prehistorically, the taking of scalps, other warfare-associated actions, and warfare in general, received explicit societal sanction during times of severe drought, and that these actions were seen as strategies to restore precipitation levels necessary for successful crops and more plentiful wild resources.

Many of the processed remains in the northern San Juan were deposited in abandonment contexts, and the deposition of these remains represents the final actions that occurred in those settlements; the processing was thus likely to have been perpetrated by attackers on the residents. This association has led to a logical but admittedly somewhat weak assumption that in the absence of evidence to the contrary, the remains are those of the residents who were killed in their own habitations, thereby ending the occupations of those settlements. A few sites, such as Sacred Ridge and Mancos Canyon Site 5MTUMR-2346, do contain important evidence to the contrary: (1) Biodistance analyses indicate that individuals represented in the Sacred Ridge processed remains exhibit genetic differences, expressed in nonmetric cranial and dental traits, from those who were formally buried at that settlement; and (2) the number of individuals represented among the processed remains at Mancos Canyon appears to exceed the number who would have resided there. Additional contrary data include processed human remains found in middens or other contexts of secondary refuse, such as thermally altered remains at Goodman Point Pueblo and possibly at multiple Mesa Verde sites (see below), because it is unlikely that attackers would bother to follow the refuse-disposal customs of the residents. Such deposits of fractured and thermally altered human bone would thus likely represent anthropophagous events by the residents of the settlement during its occupation. The recognition of such exceptions is important to the careful and comprehensive interpretation of how and why violence and anthropophagy occurred in different contexts both spatially and temporally.

Many additional incidents of violence, warfare, or anthropophagy occurred in the northern San Juan during the Pueblo occupation of the region (Billman 2008; Bustard 2008; Kuckelman et al. 2000; McGuire and Van Dyke 2008; Turner and Turner 1999). Some of these additional incidents might have occurred during one of the three time frames discussed here or might cluster spatially and temporally in other ways and reflect additional significant outbreaks of violence, but dating is insufficient to place many of those incidents in a more precise temporal context. Other incidents of violence and probable anthropophagy in the northern San Juan are well dated but did not occur during one of the severe droughts defined here (Kuckelman et al. 2000; Turner and Turner 1999). Most appear to date from the late 800s, the 900s, the late 900s to early 1000s, and the mid-1000s C.E.; the social and environmental contexts of these events deserve further study.

Key sites, especially Mesa Verde cliff dwellings, most of which were last inhabited during the terminal Pueblo III period, probably contained evidence of attacks on those settlements (Nordenskiöld 1979, p. 170); Long House and Ruin 16 are specifically mentioned by Nordenskiöld (1979, pp. 29, 35) as exhibiting evidence of attack. Fewkes (1909, p. 24) reported evidence of lethal violence at Spruce Tree House: "In clearing the kivas several fragments of human bones and skulls were found by the author. The horizontal passageways, called ventilators, of four of the kivas furnished a single broken skull each, which had not been buried with care." Further, possible remains of anthropophagous events were reported by Fewkes (1911, pp. 39–40), who stated that calcined human remains were observed both in cliff dwellings and in association with mesa-top habitations, and that such remains were present in a refuse area at the back of Cliff Palace (Fewkes 1909, p. 17). Although Fewkes (1911, p. 39) posits cremation to account for these charred and fragmentary remains, he recognized that Pueblo Indians have no history of this practice.

These and other cliff dwellings undoubtedly held crucial information regarding environmental conditions associated with the final depopulation of the region. The disturbance, churning, and contamination of the uppermost, latest deposits of these habitations by early explorers and relic enthusiasts destroyed invaluable and irreplaceable data regarding the final days of Pueblo occupation of the region, as did the early historic focus on obtaining complete skeletons for analysis and museum display—incomplete remains were considered not "worth saving" (Nordenskiöld 1979, p. 45, 47). Additional evidence of violence and anthropophagy has no doubt gone unrecognized or under-recognized by less-experienced analysts or has been actively concealed by managing agencies, contractors, tribal representatives, or well-meaning analysts and archaeologists. Other evidence of violence is contained in reports that are not published commercially and are not widely accessible; such data are thus challenging to discover and study. These obstacles hinder research efforts to more fully understand many key aspects of Pueblo prehistory in the northern San Juan as wells as the causes and effects of warfare and anthropophagy worldwide.

6.5 Conclusion

Numerous types of evidence, including bioarchaeological, archaeobotanical, faunal, tree-ring, and stratigraphic data, reveal that episodic environmental downturns from the early 800s C.E. through the late 1200s C.E. initiated repeated and similar cycles of subsistence stress, violence, and warfare resulting in large numbers of fatalities, anthropophagy, and major population movements among ancestral Pueblo populations in the northern San Juan. The intensity of individual violent events appears to have been consistent from the earliest through the final cycle; however, the scope of violence and warfare increased with each successive cycle and was probably correlated at least partly with increases in population density and in the complexity and integration of Pueblo societal fabric through time. And, as population densities in the region increased, the social, economic, political, and historical impacts and consequences of each successive drought or megadrought cycle increased exponentially and played increasingly significant roles in Pueblo culture history. Although adverse environmental conditions were a major, even primary, catalyst that set the repeated chains of events in motion, social upheaval and political instability (e.g., see Cameron 1995; Glowacki 2010; Kohler 2010)—perhaps including land disputes or escalating inter-community feuds—no doubt exerted additional pressures that are less visible in the archaeological record and thus more difficult to define and support with empirical data. Nevertheless, I contend that had nutritional needs been adequately met during any of these three cycles of environmental downturns, other pressures alone would not have been sufficient to result in the population movements that occurred.

The reasons for differential levels of regional depopulation during the three cycles cited here are unclear but might relate to the particular characteristics of each associated environmental downturn. For example, environmental conditions during one cycle might have resulted in failed maize crops but affected wild resources relatively less, whereas both types of resources might have been severely impacted by the specific conditions of a different cycle; the latter situation would clearly have placed much greater subsistence pressure on the population. Another possibility is that the environmental downturns of the late 1200s C.E. followed closely enough on the heels of the horrific events of the mid-1100s C.E. that even though residents were loath to abandon their relatively new, large, fortified stone villages and proprietary springs, the collective cultural memory of that 50-year drought and the associated strife only a few generations earlier prompted a response in the late 1200s C.E. of complete and permanent depopulation of the region rather than the more conservative, wait-it-out strategy adopted during the earlier cycle.

The relationships between food and warfare among ancestral Pueblo peoples in the northern San Juan were undoubtedly more complex than the available data indicate, but in spite of the numerous constraints on the study of the incidence, geographic distribution, causes, and effects of subsistence stress, violence, warfare, anthropophagy, and large-scale population movements among Pueblo groups, the data reveal that in times of environmental downturns resulting in severe nutritional shortfalls, warfare was clearly a survival mechanism that facilitated the procurement of consumables in the form of the raiding of food stores and anthropophagy. The volume of available data relevant to these issues has amassed sufficiently to enable researchers to embrace a more comprehensive and nuanced understanding of the roles of these multilayered phenomena within a societal context. The cycles of environmental downturns endured by ancestral Pueblo peoples of the northern San Juan shaped and structured many aspects of their culture history, and evidence of these periods of desperation and hardship reveals crucial information about the complex array of conditions, choices, and actions of Pueblo farmers during particularly pivotal hinge points in the Pueblo past, when cycles of cascading events repeatedly altered the course of prehistory.

Acknowledgments I wish to thank Amber VanDerwarker and Greg Wilson for inviting me to participate in the Archaeology of Food and Warfare Conference at UCSB in February 2013 and for their hard work as editors of this volume. Thanks to the anonymous reviewers for their comments, to Dylan Schwindt for drafting the figures and to Dennis Holloway and Adriel Heisey for their excellent images. I thank Neal Morris for sharing his first-hand observations from the excavations at Sacred Ridge. Finally, a special thanks to all who braved the heat, cold, dust, wind, and gnats to conduct the field work that yielded the data used in this paper; such efforts provide the cornerstone of our profession. All errors and omissions are mine.

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Chapter 7
Burning the Corn: Subsistence and Destruction in Ancestral Pueblo Conflict

James E. Snead

How the roofs groan under the weight of the drying corn

—Cushing 1920, p. 212

Stepping onto the melted adobe landscape of Burnt Corn Pueblo brings the archaeologist into immediate contact with an obvious and yet perplexing aspect of this particular Ancestral Pueblo community: the burnt corn (*Zea mays*) itself. The surface of the site, stretching for 300 m of ridgetop in the Galisteo Basin of northern New Mexico, is dotted with carbonized cobs and kernels (Fig. 7.1). A scatter of potsherds and lithic debitage is more typical at sites of this type, making the pattern at Burnt Corn relatively unusual. Tracing vestiges of destroyed food resources across the topography of the settlement has repeatedly brought observers to the conclusion that here, 800 years ago, something terrible took place.

Eight years of work at Burnt Corn, in the surrounding landscape, and at neighboring Ancestral Pueblo communities has allowed us to develop an increasingly detailed picture of the catastrophe that overwhelmed the residents of the village (Snead 2004; Snead and Allen 2011). This research occurs within the context of the maturing subject of conflict in the Southwestern past (for example, see Haas and Creamer 1993; LeBlanc 1999; Wilcox and Haas 1994). Since the 1990s, several projects in the region have identified empirical evidence depicting complex patterns of violence in Ancestral Pueblo society (Billman et al. 2000; Kuckelman 2002; Rice and LeBlanc 2001; Wilcox et al. 2006; see also Kuckelman, this volume). New theoretical approaches have also made the region a testing ground for the archaeology of war in general (see Abbott and Lack 2013; Kohler and Turner 2006; Kohler et al. 2014; Lowell 2007; Solometo 2006; Wilcox et al. 2001).

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_7

Fig. 7.1 Burned corn cobs at Burnt Corn Pueblo

The Tano Origins Project, within which our efforts at Burnt Corn were conducted, was designed to address theoretical and empirical aspects of conflict in the Ancestral Pueblo context. Thus, one of the core issues of the project was the fate of the Burnt Corn community. On a daily basis, the field team faced the question posed by the burned corn: What circumstances led to such widespread destruction? And why had it involved a resource that—for village farmers, living in a semiarid environment—would have been irreplaceable?

7.1 Problematizing Destruction

Archaeologists studying warfare continue to negotiate a thicket of preconception and bias (Keeley 1996). Given the centrality of conflict to our own culture and history, it is hard to imagine that this could be otherwise. In fact, using material evidence to interrogate our own stereotypes regarding violence and war is an important archaeological contribution to the broader project of anthropology.

For example, evaluating the relationship between food, conflict, and destruction allows us to sharpen our focus on one of the time-honored materialist precepts of war: that it is, at its core, a fight over resources. In the case of middle range or “tribal” societies—small-scale, subsistence agriculturalists—the principal resource concerned (in the traditional sense) relates directly to food, either in its physical aspect, or (as associated with the means of production) the human labor needed to produce it. From such a perspective, conflict in societies such as these is a grab for food, for land to grow it on, and/or for captives to labor in the fields (see Ember and Ember 1997, p. 9; LeBlanc 2003).

Since the beginning of the current era of research on conflict in the Ancestral Pueblo Southwest, resource competition has been the dominant model for explaining causality (see Haas and Creamer 1993, p. 137, 1996, p. 211). This has been particularly well argued by Kristin Kuckelman, who uses a range of archaeological data to characterize the late occupation of Sand Canyon Pueblo as one of increasing subsistence stress and associated violence (Kuckelman 2010; Kuckelman et al. 2000, pp. 159–160; see also Kuckelman, this volume). Even some of the recent efforts to shift the discussion from overtly resource-based conflict toward models of political competition emphasize correlations between environment and subsistence (e.g., Abbott and Lack 2013, p. 151).

Whether or not competition for resources motivated Pueblo warriors, however, fighting over food is not the same thing as the deliberate destruction of food resources. In the context of an environment of relative scarcity, burning corn would have been an aggressively final act. Such a tactic would not only have denied the victors some of the potential fruits of their action, but also severely damaged the ability of any survivors among the defeated party to recoup their losses. In other words, burning food would have sacrificed some potential gain to inflict maximum damage. The goal would thus not have been to capture a resource, but to eliminate the competition, forever.

We take destruction in warfare as a matter of course. We should not. Destruction is both tactic and strategy: It eliminates resources that would often be immensely useful to whichever side possessed them. But it also takes time and planning (e.g., Gordon 1953). Acts of destruction put competitive forces in vulnerable positions in the fluid contexts of battle. Fire must be kindled; demolition organized; decisions made as to what gets salvaged and what can be left for obliteration; all the while in circumstances under which a subdued enemy might reemerge, and the tide of battle turn. Even under conditions in which mastery of the field has been achieved, warriors tasked with destruction might not be well positioned to defend against retaliatory raids against their own homes by the allies of their defeated rival(s). Making such a decision would thus be taking a risk, for which the potential gain would be compensatory for potential loss.

Archaeologists interpreting acts of destruction associated with warfare can also reflexively turn to a culturally familiar interpretation of such intentional devastation known as "scorched earth." The stereotype is simple: Attackers lay waste to the defender's resources in order to increase the cost of resistance and to "break their will." An alternative formulation is that defenders destroy their own resources to deny the attacker the ability to acquire provisions and thus—over the long term—win a war of attrition. The literature on historic warfare contains examples of these tactics as used in different times and places, including, for example, the early twentieth-century Boer War (Coetzer 2000) and Late Medieval Europe (McGlynn 2009).

As these examples suggest, "scorched earth" tactics are typically associated with states and empires. It is reasonable to presume that producers of agricultural resources would resist such tactics, since their own livelihood would be damaged or destroyed thereby. Thus, what seems to modern audiences to be a standard tactic of war may more realistically be an element of conflict in spatially extensive, hierarchical polities, in which damage to local production—and to local populations—is an acceptable cost to leaders distant in space and class, on either side of the conflict. In such a scenario, both advancing enemies and retreating allies would be dangerous to the vulnerable populace. It is thus perhaps not surprising that, even with well-documented warfare regimes such as that of the Greek polis, specific examples of destroying food to hinder foraging are "curiously rare" (Lazenby 1994, p. 11).

I have argued elsewhere (Snead 2008a) that destructive war among agricultural societies is a particularly distinctive phenomenon, intricately associated with concepts of place and identity. Ethnographic accounts often emphasize the impact of destruction as extending beyond the immediate significance of the event. According to Blier (2005, p. 178), for instance, in the context of Danhomé society in West Africa:

> [A]rchitecture played a particularly central part in retaining the memory of past individuals. Demolishing an individual's ancestral homestead is seen to be a deeply troubling event. Interestingly, the term most frequently used in reference to military destruction is to 'break' a town, i.e., to break [deny] it of its people, its goods, its future, and its past.

Other accounts of destruction in the course of war emphasize the relationship between territory and social legitimacy. In such formulations, obliteration is as much a political act as one of military advantage. This is particularly devastating over the long term, since the costs of being deprived of place in both material and social terms could be crippling (e.g., Bevan 2007; Bonnemaison 1994, pp. 304–305).

In the context of a place-based interpretation of destruction, the burning of food deserves particular scrutiny. In addition to the obvious association with subsistence, on a conceptual level food is deeply associated with place. Agricultural sustenance requires many things: land, seed, water, protection, and other investments that are inextricable with locality. Thus, the material correlates of food shade imperceptibly into its significance for community identity (Snead 2008b). Destroying food not only removes it from immediate utility—supporting the daily needs of its producers—but also eliminates an additional element of social legitimacy. Failure to "provide" for the future is not as immediate as starvation, but is as great a loss in the long term.

Understanding the relationship between warfare, food, and destruction from an anthropological perspective is thus a more challenging endeavor than a materialist interpretation of conflict alone might imply. In archaeological contexts, however, the core questions pertaining to this topic are inevitably those pertaining to physical evidence. Recognizing patterns and associations between different classes of data remain fundamental empirical issues. Our work at Burnt Corn Pueblo thus not only required grappling with the ramifications of disaster, but also with the challenges of correlation even in such relatively optimal archaeological circumstances.

7.2 Burnt Corn at Burnt Corn Pueblo

Burnt Corn Pueblo is a complex of nine adobe/masonry structures representing a village inhabited at the end of the thirteenth century C.E. It is located atop a north–south trending ridge along the northern boundary of the Galisteo Basin, a geographic and cultural district within the broader Northern Rio Grande region of New Mexico. The buildings themselves range from 6 to 60 rooms in size, with an estimated 150 rooms in the architectural core as a whole (Fig. 7.2). As presently

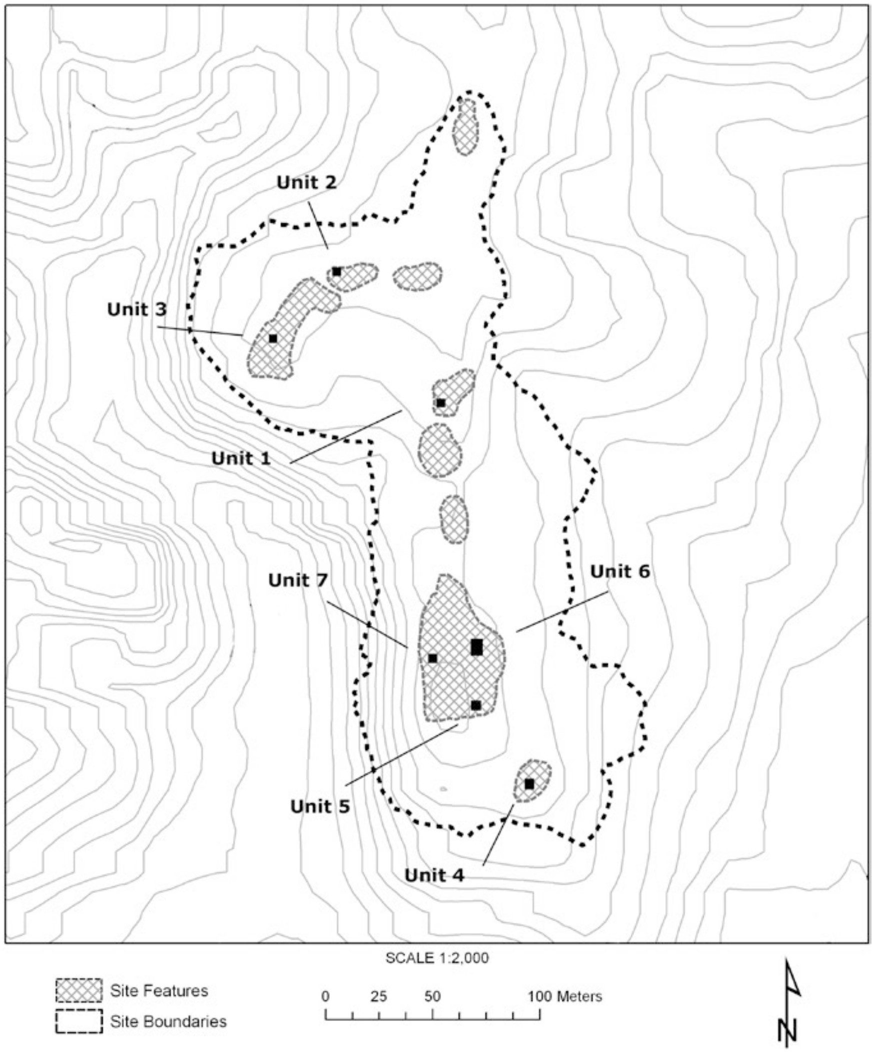

Fig. 7.2 Map of Burnt Corn Pueblo, showing distribution of architectural features (illustrated by G. Greene)

understood, the settlement represents the largest community in the vicinity at the end of the 1200s C.E.

It was not until the late 1990s that the site attracted any sustained archaeological attention (see the chapters in Snead and Allen 2011). Our initial field season in 2000 focused largely on surveying the surrounding community, but excavation and site mapping were initiated in 2002. More intensive fieldwork was conducted in 2005 under the sponsorship of the National Science Foundation (BCS #0352702). A total of seven units were excavated in these field seasons: Five different structures were sampled, with the largest unit (#6) exposing two rooms. Excavations beyond the central complex took place in 2006, focusing on two small structures in the associated community, Slope House and Cholla House.

Tree-ring dating of the burned roofing material allowed for a detailed site chronology to be established (see Snead and Thibodeau 2011). The 94 dates obtained from this evidence included 52 cutting dates, outlining a construction history spanning 1288–1302 C.E. There was no evidence that any roofs were rebuilt. Although a few outlying dates exist, and some of the structures were not sampled, it is nonetheless likely that Burnt Corn Pueblo was built, occupied, and "abandoned" within a single generation.

Evidence from excavation and mapping also allows us to characterize the destruction of the village. Much of the collapsed adobe matrix appeared to be fire-hardened, although not highly fired or vitrified. Burnt organic material was found in all excavation units. Fire-damaged construction wood—small-diameter secondary features of piñon pine (*Pinus* spp.), probably *latillas* or similar architectural elements—were widespread, although quantities varied.

The distribution of burnt corn was more complex; it was found in Units 1, 2, and 4, thus in three different structures in different parts of the site. In Units 1 and 4, the corn was found exclusively in contexts that implied it had been burned on top of the roof immediately prior to the collapse of the structure. Although a few kernels were found in similar contexts in Unit 3, corn was most notably present there as a small stack of carbonized cobs sitting directly on the floor of the room exposed in the west profile, *below* the roof fall. No formal inventory was made of surface manifestations of corn elsewhere on the site, but it was notably present at both sampled and unsampled structures. The principal exception was the largest structure, where corn was not significantly present on the surface or in any of the units (4, 6–7) excavated therein.

The nature of the burned corn itself proved to be informative regarding the burning episode. In several cases, masses of corn were found fused together, indicating high sugar content and thus a relatively fresh harvest at the time of the fire. This finding supported interpretations, based on the stratigraphic context of the material, that much of it had been drying on the rooftops at the time it was burned. One relevant implication was that the destruction episode had taken place at some point in the autumn, before the corn was put away in permanent storage (Richard I. Ford 2002, personal communication).

One distinctive aspect of the excavated floor contexts at Burnt Corn Pueblo was the scarcity of in situ material. Domestic debris was almost entirely associated with the collapse deposits, indicating that it had originally been located on the rooftops. The corn in Unit 3 was the only notable floor assemblage in any of the units excavated in 2004. This “clean” perspective was enhanced in Room 6A, where floor deposits in primary context were absent and three floor/wall features—a hearth and two wall vents—had been formally plugged. The overall impression was of a room that had been cleaned up and sealed.

Our current understanding of Burnt Corn Pueblo’s destruction is thus based on overlapping categories of evidence. Surface indications that the site burned in its entirety are supported by excavation data. The absence of reconstruction or reoccupation makes it most probable that all of the structures were destroyed at the same time. An accidental fire can be ruled out by the size of the complex and by the general difficulty of burning buildings made largely of mud and stone. Unpublished results of an experimental burning program witnessed at Homol’ovi State Park in Arizona in 2004 support this contention. The probability of natural causes, such as a range fire, is low. Local vegetation consists of dispersed piñon–juniper woodland that burns at relatively low intensity. It is also expected that anthropogenic factors, including woodcutting and trampling, would have minimized both tree and grass cover in the immediate vicinity of the village.

These patterns indicate that the burning of Burnt Corn Pueblo was an intentional act requiring premeditation and effort. The scale of the site and the thoroughness of the job imply that it was conducted systematically and within a time frame of many hours if not days. Ignition requirements of green corn are unknown, but clearly not optimal. The fact that mud roofs separated the corn on top from the beams below, indicating that separate fires would have been set (Tom Windes, personal communication), also suggests that time was required to complete the job.

Burnt Corn Pueblo was clearly inhabited immediately prior to destruction, at least in archaeologically measurable time. This is indicated by the ubiquity of drying corn, grown in nearby fields, and being prepared for storage; the presence of domestic assemblages on the rooftops; and by the fact that no trash, windblown sand, or any other sort of post-occupational deposit was present in the excavated rooms. This evidence, however, is complicated by the almost complete absence of artifacts in the interior spaces of the structure—even casually deposited refuse, such as debitage, was minimal. Much of the cultural material present came from secondary contexts and had probably been incorporated into the adobe matrix of the walls during construction.

Excavations at the two smaller structures in the Burnt Corn community add to our knowledge of the scope and character of the burning event (Fig. 7.3). Work at Slope House found no signs of structural burning; the character of the associated features and fill suggests that it had been abandoned and left to decay in place. In contrast, excavations at Cholla House exposed considerable evidence of destruction by fire. Roof debris—much of it burned—had fallen on the floor, which was sooty and blackened. Several valuable or useful tools were found in this mix of fill, with a projectile point lying directly on the floor. No significant fragments of corn were noted, supporting our interpretation of this structure as a facility used

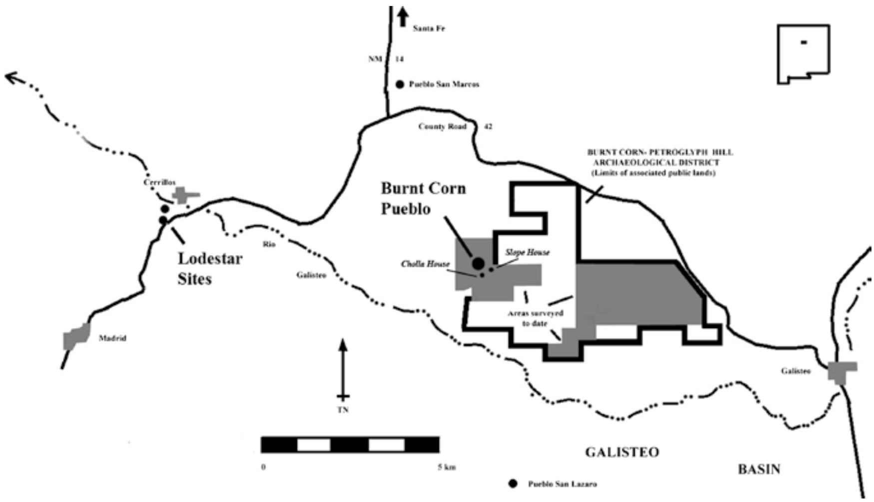

Fig. 7.3 Map of the Burnt Corn community

largely during the agricultural season, after which the harvested corn was moved to the pueblo nearby.

A final input of information about the destruction episode at Burnt Corn comes from research conducted in 2006 at a second site cluster, designated the Lodestar Community, eight kilometers to the west (see Fig. 7.3). Associated surface ceramics indicated that the two communities were occupied contemporaneously. Lodestar, however, consisted only of small farmstead-style structures, without a central pueblo. Preliminary fieldwork was conducted at four of these structures, with excavations focusing on Lodestar North and Lodestar South. Evidence for catastrophic burning was present at both sites, including a burnt floor with associated artifacts at Lodestar North and a 10–20-cm layer of burnt material along a wall at Lodestar South. Corn was not a notable feature of the fill at either location, nor was there clear evidence for post-fire reconstruction. This evidence suggested to us that the sites were burned, abandoned, and never substantively reused.

Aspects of destruction at Burnt Corn Pueblo, within the Burnt Corn community, and at neighboring settlements such as Lodestar, provide a material framework for understanding destruction in archaeological contexts. It is clear that the burning of structures was widespread throughout the vicinity during the late 1200s C.E., at intervals too close in time to be readily distinguishable from each other. The pattern evident at Lodestar—burnt farmsteads and destruction assemblages—correlates with what might be predicted from a rapid raid scenario. What happened at Burnt Corn, however, was qualitatively and quantitatively different, more systematic and requiring considerably greater investment of time and resources to accomplish.

7.2.1 *Site Burning in Regional Context*

Our ability to situate the destruction of Burnt Corn Pueblo within the context of the Ancestral Puebloan history of the Galisteo Basin is augmented by an extensive program of laboratory and collections research. Examination of site records from previously excavated sites dating between 1250 and 1450 C.E. (see Snead 2004) has identified both similarities and differences between Burnt Corn and its contemporaries, broadly conceived.

It has previously been established that destruction by fire was a relatively common event in the Northern Rio Grande region during this era. LeBlanc (1999, p. 249) identified 7–8 sites in the nearby Chama region, for example, that show evidence for such catastrophes, largely derived from excavated contexts. The fact that there is more than one site in the vicinity with the folkname "Pueblo Quemado" (Burnt Village) is illustrative.

It is thus not surprising that our review of data for the Galisteo region identified numerous sites with some evidence for substantive burning (Fig. 7.4). Evaluating this evidence, however—particularly due to idiosyncratic reporting/archival standards—is challenging. For example, primary information concerning one important site, Pueblo Largo, excavated by Dutton (1951, 1953, 1955) more than 50 years ago, indicates patterns of burning that at least superficially resemble those at Burnt Corn.

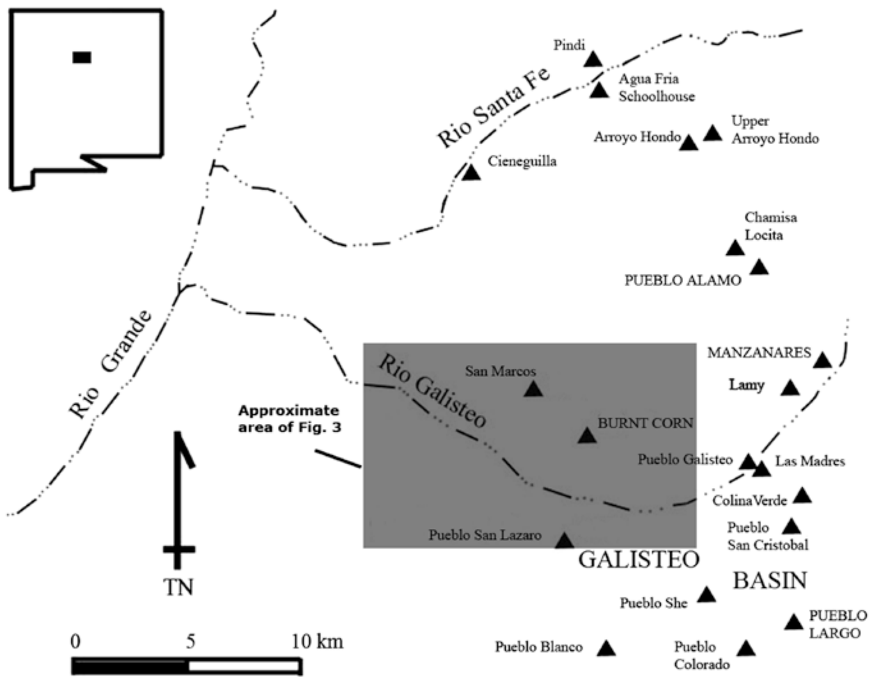

Fig. 7.4 The Galisteo Basin district of the Northern Rio Grande region, New Mexico

> There was evidence of a burned section, along the western side of the Plaza B area…so we excavated a room there…The plaster was burned in large part. Evidently, the earth and stones from the roof, the corn, vigas, and all else fused together - so we have various 'blobs' of stuff. Mostly, the corn kernels were charred, or fused (Bertha Dutton to Jeanne Ellis, 20 May 1957. 95PLE.005 Pueblo Largo corr., LOA).

No maps or similar documentation exist to allow for further scrutiny of this empirical pattern, however. It also played no substantive role in Dutton's interpretation of Pueblo Largo's history. The burning episode was mentioned in only one of her relevant publications, which otherwise described the archaeology as a "record of slow change at this site…[reflecting] a certain degree of social stability" (Dutton 1953, p. 351).

Thus, while we can accept the presence of burning at Pueblo Largo, in an era almost exactly contemporaneous with that of Burnt Corn Pueblo—and that the process involved the destruction of food resources—further characterization of the event is not presently feasible. A similar situation exists at Manzanares, a large village sampled by excavation in the 1970s at which burning was indicated but also not discussed (Steen 1980). A different problem shaped interpretation of burning at nearby Pueblo Alamo, where reoccupation seems to have obscured evidence for at least one burning episode early in the site's history. Despite suggestions that one of the unexcavated structures at Pueblo Alamo "was destroyed by fire," further research has not resolved the ambiguity (LA8,[1] HPD; Allen 1973. For discussion of these sites, see Snead and Thibodeau 2011).

More detailed examination is possible in three cases. The first—and most famous—of these is Arroyo Hondo, excavated by the School of American Research. With an estimated 1200 rooms, component I at Arroyo Hondo represents the most substantial occupation in the region by far in the era immediately following the occupation of Burnt Corn. Winifred Creamer's architectural study indicates that seven out of the 66 ground-floor rooms excavated, roughly 10 %, show signs of burning (Creamer 1993, p. 54), a frequency in line with accidental fires. In contrast, 40 % of the rooms associated with component II—a much smaller reoccupation of the village that occurred late in the fourteenth century C.E.—had burned. Included in these excavated contexts was at least one case of a corn storage room destroyed by fire (Creamer 1993, p. 54).

Excavations during the 1970s at the Wheeler site, an isolated habitation of 31 rooms constructed during the late 1300s C.E., provided another distinctive case of site burning associated with abandonment (Alexander 1971). At least 12 rooms in different parts of the site showed significant evidence of fire, including scorched walls and carbonized roofing material (LA6869, HPD). Low frequencies of burned corn were found in various parts of the fill: one "storage room" contained 4.14 cubic meters of husked, burnt corn (Alexander 1971, p. 89). In several locations,

[1]This represents a site number designated by the Laboratory of Anthropology (LA) at the Historic Preservation Division (HPD) of New Mexico; sites are numbered sequentially in the order in which they are discovered.

artifacts were found on room floors in patterns consistent with breakage at the time of the fire.

A final substantive case of site burning in the greater Northern Rio Grande region comes from Arrowhead ruin, a large pueblo of 100 rooms located on a hilltop in the Pecos Valley. Excavated over several years in the 1930s and 1940s, Arrowhead was contemporary with both Wheeler and Arroyo Hondo component II (Holden 1955; Windes 2002, p. 510). Preliminary review of unpublished data associated with the Arrowhead excavations indicates that, of the 47 rooms for which remarks concerning fill were recorded, 23—approximately 50 %—included some evidence of burning (Kayser 1940; LA251, HPD; Pearce 1937). Corn was present in some of these contexts, including one room in which "several sacks of charred corn, most of it on the ears, were found" (Pearce 1937, p. 50). Overall, however, the excavators noted a low frequency of artifact assemblages on the floors, leading them to suggest "that Arrowhead was evacuated in a leisurely and peaceful way" (Holden 1955, p. 113).

7.3 Discussion

This review of the evidence of burning at Burnt Corn Pueblo and at sites in the associated region allows for some characterization of the process of site destruction. In particular, it allows for a more thorough evaluation of the relationship between the burning of villages and the burning of food.

At the most general level, it seems clear that accidental burning was not a significant factor. The evidence from Arroyo Hondo component I suggests that, although such events did occur, their impact was generally restricted to the associated rooms and perhaps some adjacent spaces. It is likely that dried corn was particularly vulnerable to such events, but that such episodes did not trigger general catastrophe.

On the other hand, wholesale destruction of villages seems to have been a regular feature of life in the Northern Rio Grande region throughout the 1250–1450 C.E. era. With the exception of Burnt Corn, none of the other sites discussed here were selected for excavation on the basis of evidence for burning—quite the contrary, given that the implications of burned sites seem to have been undervalued by archaeologists prior to the 1980s.

Interpreting this pattern, however, is more complex than it might appear. These data regarding site burning situate Burnt Corn and its neighbors within a broader discussion among archaeologists working in the Southwest regarding destruction and causality. Schlanger and Wilshusen (1996, pp. 93–94), for instance, characterize the fiery destruction of series of pithouse structures as "decommissioning," a process that might have been of ritual or even housekeeping significance in addition to the possibility of warfare. Subsequent scholars have argued persuasively for ritual closure of kivas and related room suites, in contexts that included burning (Adams and LaMotta 2006, p. 60). Although such approaches usually pertain to relatively small spaces rather than sites as a whole, a division within the archaeological community has emerged between those who would see warfare-related destruction as widespread and those who see decommissioning as a complicating factor in the interpretation of such evidence (see also Van Keuren and Roos 2013; Walker 1998).

The possibility of decommissioning provides a useful contrast for evaluating the fate of the burned Galisteo sites. In most of the available cases, evidence does not support such an interpretation. The patterns of burning and debris on the floor at Wheeler and Lodestar, for example, are precisely the sort of pattern generally expected for site destruction via raiding: rapid attack, the inflicting of haphazard damage, and equally rapid withdrawal. Evidence from Arroyo Hondo component II is similar, leading Creamer to interpret the demise of the community as coming via "hostile attack" (Creamer 1993, p. 154). Without further detail, it is difficult to add other Galisteo sites with evidence for burning to this list, but the probability that such destruction took place elsewhere in the vicinity is high.

Burnt Corn Pueblo itself, however, remains an exception to this pattern of raid-related destruction. The distinctive character of the evidence at the site—relatively clean rooms, widespread and systematic burning—has held up under comparative analysis, indicating that what happened at the site was anomalous in time and space. The scale of destruction also makes it different from locations more typically argued to have been decommissioned, although some artifacts found in the fill are suggestive of ritual deposits.

It is in further parsing of the Galisteo evidence in support of these two scenarios—raiding and decommissioning—that the destruction of food comes into sharper focus. The pattern of burned corn discovered at the raided sites in this sample suggests opportunistic, rather than intentional, destruction. In such a scenario, it is entirely possible that some of the corn was looted, with only that which could not be carried away marked for destruction. This is a question of negative evidence, since we cannot identify what was not there. But it is more consistent with the dynamics of warfare in an environment of uncertainty.

The fact that much of the corn burned at Burnt Corn was relatively green is thus distinctive. It may simply be a coincidence of timing: If conflict broke out in autumn, newly harvested crops would have been vulnerable. Green corn would also have been a future resource, rather than one for immediate use. In such a case, the priority would have been to salvage the older, dryer corn, which could be immediately converted into food and may have been easier to transport. In this light, it is interesting that the one example of a room found with burned corn below the roof fall (Unit 3)—a small stack of cobs on a floor washed with apparent corn pollen—resembled what archaeologists might predict for a "cleared" storage space.

It is, however, the thoroughness of the destruction of Burnt Corn Pueblo that adds nuance to this interpretation. Of all the destruction reviewed here, it is by far the most systematic and complete. If the timing of the event was not coincidental, then it would have been particularly devastating: an apparently successful harvest obliterated, putting survivors at such a disadvantage for the medium term that any rebuilding would have been unlikely. It is difficult, in my interpretation, to account for such intentional obliteration as a straightforward by-product of mayhem, or the result of a fight to capture food resources alone.

If Burnt Corn Pueblo was decommissioned, in this scenario, it represents a remarkable and contingent event. The temporal proximity of the episode to the destruction of Lodestar—and probably other contemporaneous communities, such as Manzanares—indicates an episode of considerable complexity and regional scope. In such a scenario, different forms of conflict would have played out simultaneously, with "raiding" at Lodestar not necessarily antithetical to "decommissioning" at Burnt Corn Pueblo within the same time frame.

There are indications from elsewhere in the Southwest of conflict scenarios that might incorporate both tactical and strategic destruction. Kristin Kuckelman's work at Castle Rock Pueblo, for instance, documents the co-occurrence of the massacre of the population during an attack and the correlated ritual burning of kivas (Kuckelman 2002, p. 240; see also Kuckelman, this volume). In cases such as Castle Rock and nearby Sand Canyon (Kuckelman 2010), human remains were present in destruction contexts, and one of the distinctive differences between evidence for conflict in the Northern Rio Grande and other parts of the Colorado Plateau is the relative absence of casualties (but see Wendorf 1953, p. 93).

Identification of the perpetrators is a critical step in the delineation of scenarios for conflict. Elsewhere I have suggested two ethnographically derived models for the sort of "violence against place" in the Ancestral Pueblo context that may be reflected in the evidence from Burnt Corn. In an "Awat'ovi Event," the community was expunged from the locality by neighbors; in contrast, an "Orayvi Event" would be an act of auto-destruction in which the inhabitants decommission the village of their own accord (Snead 2008a, pp. 146–149). In either case, the burning of corn would have been an act of both economic and ritual significance in keeping with the destruction of place. Underlying all would be a deep sense of moral order linked to the locality—and some sense of fundamental disruption requiring definitive action to rectify (see Malotki 2002). A brief scenario of this sort is provided by an episode in the history of Tamaya/Santa Ana Pueblo, in which the discovery of a conspiracy affected the entire village. "When the people of Kwiiste Puu Tamaya learned of the plot," the history notes, "they decided to move on. They gathered food and supplies for the journey, packed all that they could carry, and then set fire to the village" (Bayer et al. 1994, p. 7).

Evidence suggesting the catastrophic end of Burnt Corn Pueblo was obvious from the beginning of work at the site. What could not be discerned at the time, however, was that these material remains would provide distinctive opportunities for interpretation. The destruction of food—superficially obvious, yet conceptually intricate—allows us to better understand the nuances of violence within an Ancestral Pueblo context. It also provides reminders that food itself was a complex interpretive field and that despite the challenges of the archaeological record, considering warfare as a contingent process within specific cultural frameworks must proceed alongside more generalizing approaches to human conflict.

Acknowledgments The "Archaeology of Food and Warfare Conference" at UCSB was a congenial and stimulating environment in which to discuss a challenging subject. Thanks to Amber M. VanDerwarker and Gregory D. Wilson for their invitation and hard work. Archaeology at Burnt Corn Pueblo was conducted under permit from the Bureau of Land Management and by permission of the owner of the northern portion of the site, Buck Dant. Thanks to Paul Williams for facilitating this arrangement and to both individuals for their support. Work at Lodestar was conducted under the auspices of the Archaeological Conservancy. Gratitude is due to the various local volunteers and student participants (George Mason University; California Polytechnic University, Pomona; UCLA). Mark W. Allen and Monica L. Smith are particularly acknowledged. Insights provided by various visitors to the sites and commentators on reports/presentations/publications have been extremely helpful. Funding for the project (2004–2007) was provided by the National Science Foundation (BCS #0352702).

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Chapter 8
Aztec Logistics and the Unanticipated Consequences of Empire

Ross Hassig

Food is often the focus of warfare studies as a coveted resource for which wars are fought or defended. But even in wars fought for other reasons, food remains a crucial element, at least to the extent that it is necessary to support military forces in the field. Thus, the relationship between food and war takes on the double aspect of goal and enabler.

The relationship between food and warfare, however, differs markedly throughout human history. Perhaps the most notable shift in the relation between food and war occurred with the advent of sedentary societies and the long-term storage of food surpluses these engender.

Food is a tempting target for nomadic raiders, especially in lean times, and thus food stores, such as granaries, create an artificial vulnerability for sedentary groups. Nevertheless, the benefits of stored food are greater for sedentary groups than nomadic ones, as there is a very real limit to the amount of food that can be carried away by nomads, especially in the absence of draft animals, wheeled vehicles, or ready access to water transport. But there is an asymmetrical threat to sedentary groups: Although nomads are incapable of carrying off all of the group's food, they can destroy it.

8.1 Food and Timing

The creation of valuable stores of foodstuffs may be the main focus of studies of food and war, but perhaps the most significant factor relating to war in food production and storage that results from agriculture is the resulting temporal shift.

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_8

Non-herding nomadic societies rely on traveling to foodstuffs as they become available, which is dependent on the seasons. To the extent they engage in warfare, this tends to occur in the summers in the Northern Hemisphere when foods are plentiful and war parties can travel easily by living off the land. But agricultural sedentism fundamentally changes the relationship of food and war.

Prior to agricultural sedentism, warfare over any appreciable distance was dependent on foraging, which both limited the size of war parties and restricted them to seasons that provided ample food by foraging, which is the summer. Agriculture, however, could produce large surpluses, and, depending on the food-stuffs and the society's preservation techniques, these groups could provision far larger war parties than could be dispatched based on foraging alone, and, more importantly, could do so at times of the year when foraging was impractical.

Agriculture thus shifted societal warfare away from the "natural" summer pattern when food was more plentiful and could be readily foraged, to a time more suitable to labor patterns of sedentary groups. This new timing for warfare would also be most devastating to a nomadic enemy. Nevertheless, transportation is an underlying constraining factor. Warfare cannot be carried out at a greater distance than the attacking party can either forage or carry its own supplies. Thus, in pre-Columbian North America, this usually meant foot transport, which limited both warfare patterns and societal integration to relatively restricted areas. Riverine areas, however, could still result in both widespread warfare and societal integration thanks to far more efficient canoe transport.

Agriculture shifts war seasons by absorbing considerable labor during the growing season, which prevented men from engaging in significant warfare at that time. But this shift away from offensive warfare during the agricultural season also altered the time of peace. Agricultural settlements were less likely to be the targets of nomadic raiders during the growing seasons as their stores of foodstuffs were at their lowest at that time, having been gradually depleted following the harvest and throughout the winter, which made such settlements unprofitable targets for raiders. Only after harvest, when a settlement's foodstuffs were at their largest, were these settlements likely the targets for war. Indeed, the mere fact of food storage encourages warfare, especially by nomadic groups whose economies are headed into the lean days of winter.

Societal complexity thus alters both warfare and its relationship with food. And while this relationship can be examined in considerable detail for various societies, the focus here is on the relationship between war and food in an archaic empire, specifically the Aztec empire of fifteenth and sixteenth-century central Mexico.

8.2 The Aztec Example

Among the Aztecs too, seasonality played a role, herding warfare into a season beginning in early December, after harvest, and extending into early April, prior to the preparation of the fields. In the Aztec case, this war seasonality was doubly patterned, not only by the summer agricultural season, but by the rainy season as well, which was inextricably linked to the former. Usually beginning in June in central Mexico and extending into September, the rains not only patterned the agricultural season, but they massively affected warfare on the imperial scale (Castillo Farreras 1969). The rains persisted off and on for months, but evapotranspiration, the water held in the soil and the gradual release and runoff, persisted for many weeks afterward.

Central Mexico had few year-round rivers and only two major lake systems (Lake Patzcuaro in present-day Michoacan, and the five-lake system in the Valley of Mexico). Coastal transport was by canoes and rafts, but affected only adjacent regions. Rivers cut through considerable territory, and while canoe or raft transport on rivers might be faster going downstream, it would be slower on the return journey. Lake transport was efficient, but necessarily limited to the dimensions of the lakes, and lacking sails, Mesoamerican water transport proved to be no faster than foot travel except where the routes were more direct (García Icazbalceta 1891, p. 3). Such vessels could, however, bring far larger loads, but where time was a factor, they offered few benefits. Throughout the rest of central Mexico, streams and rivers were typically seasonal, with dry streambeds filling and lake levels rising during and after the rainy season (Hassig 1985, pp. 137–39). But as they rose, these water courses formed significant obstacles to foot passage. Thus, despite the end of the rains in September, large bodies of men have found their march slowed, if not impeded completely, by these seasonal streams. Thus, in the case of the Aztecs and their central Mexican predecessors, the war season began months after the end of the rains. In that time, not only did the seasonal streams diminish enough to permit easy fording, but the Mexican roads, which were dirt, had time to dry and thus ease the passage of large-scale groups of men.

But beyond the constraints of seasonality, central Mexican warfare was conducted under severe transportation constraints that affected the relationship between food and warfare and that fundamentally altered the structure of their empires. The Aztecs are the best-documented case of what was arguably the most transportationally constrained empire in world history. Although its predecessors in central Mexico were equally constrained, the Aztecs benefitted from the circumstance of the Spanish conquest and the subsequent chronicling of this archaic empire. In their imperial expansion, the Aztecs expanded over hundreds of miles from their capital without draft animals, wheeled vehicles, sails, or the aid of any other form of mechanical transport (Hassig 1988).

The Mesoamerican transportation regime was based on tlamemes, human porters who normally carried loads of about 50 pounds with the aid of packs and tumplines (Hassig 1985, pp. 28–34). That transport was not without its own costs, however. At a minimum, distance reduced the load carried by the amount the porter consumed, which for an adult Aztec male engaged in arduous activity was at least two pounds of maize (*Zea mays*) a day. Thus, the normal maximum of a half-day's distance (approximately 8 miles) reduced the load received by about four percent, calculated for a round trip. Thus, maize produced half-day away from its market would necessarily cost at least that much more than locally grown food, not an unduly onerous additional expense. But extending the distance from which maize was imported to one-day walk from the center (approximately 16 miles one way, or 32 miles round trip) meant a consumption loss of eight percent of the cargo for the tlameme alone. But the practical loss would likely approach 40 %, since the porter doubtlessly had a family, typically calculated at a total of five members, whose consumption would have to be included as well. Beyond the one-day range, the losses in transport costs would be so great that bringing maize into the center was not economically effective. These constraints fundamentally affected the Aztec relationship between food and warfare, and consequently the nature of their empire.

8.3 Urban Spacing

Cities have been defined at their essence as intensively food-deficient places (Eighmy 1972, p. 299). Securing and tapping into a sustaining economic hinterland is essential. In Aztec-era Mesoamerica, cities were typically located approximately five leagues apart. Although there was a specific distance for a Spanish league, both "short" leagues and "long" leagues were employed, designating distinctively different distances. But the use of the term league was vague in practice and five leagues did not actually mean a set distance, but rather was used to indicate one-day journey. Thus, as Alexander von Humboldt noted in the early nineteenth century, a league uphill was shorter than a league downhill. Five leagues were thus intended to indicate a normal day's travel, regardless of the actual linear distance traversed, and five leagues were used to indicate the normal distance between cities. Since cities were typically a day's journey apart, their respective areas of influence, or hinterlands, were half that distance or half-day's travel (Hassig 1997).

These distances are not universal, as they depend on the society's normal transportation regime. Elsewhere in the world, horse transport might yield a far larger hinterland, but in the case of pre-Columbian Mesoamerica, since virtually all travel was by foot, a half-day's travel was approximately eight miles. Then as now, half-day's travel permits those within that range to travel to and depart from the center in the same day and return home. Any greater distance placed too heavy a burden on producers wishing to bring their goods into the city-state.

Mesoamerica was dotted with such city-states nestled within their own diurnal hinterlands. But empires, by their very nature, expand beyond their own political and economic hinterlands to incorporate and exploit other polities, as was the case with the Aztecs. The question is how far could they expand, and the answer depends on whether the question is an economic one or a political one.

Although a half-day's travel marked the boundary of the normal city-state's economic hinterland by land, Aztec political domination extended much farther. For economic purposes, they expanded out to at least a one-day travel distance, or two times the distance ordinarily controlled by city-states, and perhaps as far as two-day's distance.

Although Teotihuacanos, Toltecs, and Aztecs are the primary groups that arguably possessed central Mexican empires, the sixteenth-century historical record indicates that there were many smaller examples, most notably the Aztecs' predecessor, the Tepanecs. Operating with the same transport constraints as the later Aztecs, this lesser empire was relatively small and typically fell within the two-day range that the Aztecs also encountered.

This apparent imperial barrier was a function of the Mesoamerican transportation regime. Smaller empires tended to expand as far as they could and benefit from the resulting influx of additional foodstuffs. As a result, imperial warfare was harnessed to political expansion for the economic benefit of the capital, notably by producing an influx of additional foodstuffs beyond those normally available to a city-state from its half-day economic hinterland.

Although the Tepanec empire was the primary example of pre-Aztec empires, given the plethora of such small empires for which there is archaeological evidence in the Late Postclassic, as well as the empire of Eight Deer in eleventh-century Oaxaca and the likely empire of Xochicalco in seventh- and eighth-century Morelos, two days appear to have been the maximum range from which basic staples could have been beneficially brought into such centers (Smith 1963, pp. 276–277).

8.4 March Rates and Empire

In central Mexico, the effective distance military expansion could encompass and yield benefits for the capital's food supply, and the distance for which that center could effectively provide the food needed for its army to expand was a two-day march, within which it could easily carry its own supplies. Thus, under the Mesoamerican transportation regime, city-states had *normal* hinterlands of about half-day's travel and typical small empires had *normal* hinterlands of one- to two-day's travel. Within these zones, food could be acquired and drawn into the center which could then grow and prosper, and was arguably the primary motivation for such expansion. So, while each city-state necessarily controlled the economic hinterland within which it was located, which was stable and can be deemed *normal*, each also had a major motivation to expand their domination farther, if they had the ability, to incorporate the economic hinterlands of surrounding city-states up to the distance beyond which they could benefit from the additional influx of foodstuffs. Such mini-empires thus reached a second political normal range, which was relatively stable, as it resulted in the growth of that mini-empire's capital which, in turn, created a larger military capable of maintaining its expanded domain.

The Aztecs, however, created an empire that was far more expansive than the mini-empires that had previously populated Mesoamerica. Two questions then arise. How could the Aztecs dispatch these forces farther than they could supply them? And why would the Aztecs expand beyond the area of apparent primary benefit?

The first question can be readily answered. There were some alternative strategies for acquiring food on the march. Toasted tortillas could be carried for days without requiring additional preparation *en route*, thus eliminating the need for accompanying parties of women to prepare food, and the additional resource demand they would create (Crónica Mexicana 1975, p. 331). But carrying one's own food was nevertheless a limited strategy. The common alternative practice of foraging was of limited use for larger armies, as their sheer size rendered it difficult to procure enough food, and such massive extraction was even more alienating for the populace along the route of march. Indeed, both the alienation of the populace and the stripping of the land would likely force the army to return by another, longer and less satisfactory, route. And if this strategy became persistent, it might also prompt a scorched earth response that could deprive a force of food and strand it far from its source of supplies. Foraging might thus be an effective occasional expedient but not a permanent imperial strategy. So what alternative did the Aztecs adopt to achieve their empire?

8.5 Logistics and Expansion

Aztec armies were provided with their initial supplies by Tenochtitlan's market people, which minimized any need for resupply within the core of the empire (Zorita 1963, p. 198). A similar strategy was also available to mini-empires, although such limits apparently stymied further expansion by these smaller empires. The Aztecs overcame such limits by adopting the effective expedient of requiring conquered cities to cultivate certain lands (yaotlalli) for the use of the army as part of their tributary obligations (Clavigero 1787, vol. 1, p. 350; Torquemada 1975–83, vol. 4, p. 334). The Aztec then sent messengers two days in advance of the army to inform the local rulers of their imminent arrival and give them enough time to bring the foodstuffs from the yaotlalli to the road along which the army was passing (Crónica Mexicana 1975, p. 359). By thus adapting their tribute empire to the needs of the military, the Aztecs could dispatch armies to distances far beyond their own two-day economic hinterland. This system avoided foraging, insured a ready supply of food along the route, and effectively created a march zone through which the Aztecs could travel to strike as-yet unconquered cities, yet prevent distant enemies from traveling through it to strike at Tenochtitlan.

However beneficial this strategy was for the Aztec armies, it had an adverse impact on the tributaries. Supplying the foodstuffs to the Aztec armies meant an economic loss for that city-state, although it might also have stimulated the cultivation of new lands and lead to more intensive cultivation of existing fields (King 1971). Tributary populations are degraded by the loss of foodstuffs. Moreover, someone must have been dispossessed of the lands that became the yaotlalli. And although it is unclear who that was, the answer likely lies with the mayeques, a group of landless persons that did not exist within Tenochtitlan but was found elsewhere in the empire, most likely as a consequence of being dispossessed of lands appropriated by the Aztecs. Nevertheless, incorporation within the empire did bring benefits at least to the local nobility in the form of trade goods otherwise not available to them.

By forcing tributaries to provide supplies for their armies, the Aztecs extended the natural logistical limit within which they could dispatch their armies. But these more distant cities typically provided no benefit to Tenochtitlan in terms of additional foodstuffs. They were simply too distant from the Aztec capital to send food into that city. Thus, while food was a crucial goal in imperial expansion out to about two-day's travel from the capital, beyond that food was no longer a goal.

This circumstance thus raises the second question: Why would they expand to a distance beyond which they could benefit from additional foodstuffs? A partial answer has already been suggested that it created an imperial hinterland through which the Aztecs' enemies could not easily travel to attack their capital. But the greater answer lies in the fact that the goods imported by the Aztecs from their empire beyond their two-day limit, both as tribute and in trade, were typically not foodstuffs.

There were nevertheless exceptions. Staple foodstuffs were brought into Tenochtitlan as tribute from as far away as Oaxaca, nearly 200 linear miles and perhaps twice that by road (Matricula de Tributos 1980). At the usual 16 miles per day merchants traveled, the one-way journey would have taken many days, if not weeks. As a result, the round-trip cost of the trip in maize consumption for the porters would have considerably exceeded the total amount they would have carried. The net effect was to double or even triple the costs of the tribute demanded from those tributaries. In short, the demand for maize and beans from Oaxaca was unusual and imposed as a punitive measure. Exotic foodstuffs, such as cacao, also came from great distances, but as luxuries, these cannot be considered for their staple values.

In mini-empires, then, tributary food, or a large percentage of it, fed a growing populace in the center. But in the case of the Aztec empire, the tributary foodstuffs drained off for the army beyond the inner core of the empire meant both a loss to the tributary populations and no nutritional benefit to those in the imperial core.

Although there were no *domestic* benefits to a large empire in terms of staple goods, there were nevertheless benefits. The expanded Aztec Empire did not result in an appreciable additional influx of foodstuffs, but it did produce a major influx of tributary wares into Tenochtitlan. The empire also created a zone of relative security within which Aztec merchants (pochteca) could ply their trade. And furthermore, the empire also provided a logistical support area that allowed the Aztecs to send their armies to unprecedented distances to conquer still more distant cities.

The Aztec empire was, in effect, a Mesoamerican hybrid with an inner economic hinterland from which foodstuffs could be drawn and an outer political hinterland from which other goods were obtained. The inner hinterland benefitted the capital by providing additional foodstuffs, but the outer hinterland essentially did the opposite. Aztec armies traveling through the outer hinterland drained off resources as they passed, creating areas of lesser staple supplies, with none reaching Tenochtitlan itself.

Mini-empires expanded as far as they benefitted from the influx of staple supplies, which would benefit their entire populace. But the Aztecs reached that limit and pushed beyond. They devised or adopted strategies to overcome the usual limits on the projection of force even with exceptionally limited transport so they had the ability to expand, but that ability was not coupled with any greater capacity to benefit from the basic agricultural production of these additional territories. They continued to expand not simply into regions that could not benefit them with additional staple goods, but actually cost them these.

The inner-zone empire had been achieved by many Mesoamerican polities, but creating the outer zone required a more sophisticated organizational plan. Furthermore, although imperial expansion up to the limits of their economic hinterland (defined by staple foodstuffs) might benefit any expanding polity, once the Aztecs pushed beyond those limits, drawing other goods from the outer political hinterland had a considerable, if unanticipated, impact on Aztec domestic society.

To create and then maintain their far-flung empire, the Aztec required large armies, which were a direct function of population size, and by 1519, Tenochtitlan was the largest city in the New World (Calnek 1976, p. 288; 1978, p. 316). Yet if no additional foodstuffs were being drawn into the center, how was this population growth achieved?

8.6 Local Consequences of Imperial Expansion

Expanding beyond the two-day range created an empire that led to the influx of many elite goods and those that could not be produced in Tenochtitlan's highland ecozone, such as cotton, cacao, vanilla, and exotic feathers. On arrival, this tribute was variously consumed, redistributed, or sold. Many of these goods were exotic, but others, such as woven mantles, were also produced locally. And their influx as tribute undercut local production. When redistributed, they diminished demand for the local versions and when sold, they undercut local prices, having reached Tenochtitlan "free."

During the 90-year pre-Cortesian span of the Aztec empire, and especially since the late 1460s C.E. when expansion beyond the valley began in earnest, the economies of the surrounding cities in the valley underwent a change. Originally, each city was both a center for manufacturing and agricultural production. But once the influx of tribute goods grew large enough to challenge local production, manufacturing in these centers declined, apparently unable to compete with these new, less costly wares. The economic arena in which local producers could compete, however, was agriculture, since food could not be imported much beyond the two-day radius. Agriculture in the areas surrounding these Valley cities increased and intensified in the latter decades of the Aztec empire, primarily to feed the burgeoning population of Tenochtitlan (Brumfiel 1980). But hemmed in by transport costs, much of the new lands brought into cultivation were marginal, so the costs of production were higher than normal, and sustainable only because of the exceptionally high demand in Tenochtitlan and surrounding cities.

These valley-wide shifts were beneficial when viewed in terms of the imperial capital itself, as was the influx of both tribute and trade goods which increased the city's wealth. But there was also an unanticipated negative consequence for much of the city's populace that did not plague the mini-empires that remained restricted to their two-day economic hinterlands.

Enormous amounts of goods flowed into Tenochtitlan. Trade goods arrived from throughout the empire and beyond with the pochteca and their trains of tlamemes. But probably far more significantly, four times a year (twice/year for distant Xoconochco), the Aztecs' tributaries brought goods from throughout the empire (Matricula de Tributos 1980). This influx was accompanied by the tributary rulers and nobles, as well as by the porters needed to carry the goods to Tenochtitlan.

From the perspective of the Aztec rulers and nobles, the arrival of more and more trade and tribute was undoubtedly beneficial. But there was also a downside to this influx. Most of these tributaries and merchants imported wares from distant regions, and on entering the economic hinterland of Tenochtitlan, they were necessarily dependent on local supplies. Numbers are difficult to calculate, but each tributary's wares likely required dozens or scores of porters, and returning merchants would have been accompanied by similar parties of tlamemes. With at least thirty-eight tribute areas paying Tenochtitlan, and unknown numbers of pochteca arriving, many thousands of outsiders entered Tenochtitlan, as did others, such as parties of diplomatic envoys (Barlow 1949; Matricula de Tributos 1980). And all had to be fed, yet what they ate could not be readily replaced.

The mere presence of merchants, tributaries, and other outsiders added to the number of consumers in Tenochtitlan, yet did not add to the foodstuffs available. They therefore lowered the total amount of food available in the capital and by thus increasing demand, effectively raised its cost. That constant drain on local supplies was further augmented by each army that marched out of the capital to maintain or expand that empire, as they were all initially supplied by the market people. An army (xiquipilli) was 8,000 men, and multiple armies were typically dispatched (Crónica Mexicana 1975, p. 335). With the soldiers carrying their own weapons, blankets, and other gear, most of the food was brought by accompanying tlamemes which, at the most favorable ratio, amounted to one tlameme for every two soldiers. Thus, a xiquipilli might be accompanied by half again as many porters, each carrying 50 pounds of maize—an enormous drain on the domestic marketplace of 200,000 pounds for each xiquipilli, which would never be offset by a corresponding influx from the far corners of the empire.

Trade and tribute goods arrived from these distant regions, but they brought with them a hidden cost for the local populace in the form of higher prices for the available foodstuffs, as those conveying them added to the consumption of the limited foodstuffs available in the capital. That increase would naturally affect everyone, nobles and commoners alike, and might simply be considered one of the costs of urban life. But the goods imported that caused this rise in food prices did not convey equal benefits throughout society. The added costs of receiving elite goods from afar were shared by all classes, but since only elite goods were worth the enormous cost of transporting them by foot for great distances, the benefits of receiving these goods went overwhelmingly, if not exclusively, to the elites. Although some tribute wares were redistributed to commoner ward heads (calpoleque) for further distribution, and families of warriors killed in action received compensatory blankets, disproportionately, it was the nobles who received and/or purchased these goods. Yet the added cost of bringing them within the capital was overwhelmingly defrayed by the commoners who constituted as much as 96 percent of the populace.

Imperial maintenance, if not expansion, was essential to the Aztec empire, as the nobility depended on these goods. But the commoners increasingly bore the cost of these expansionary adventures through the rising cost of living. These opposing forces suggest an inherent instability within the imperial system. The difficulties in imperial expansion, especially with the extant transportation constraints in Mesoamerica, are suggested by the remarkable stability of city-states, many of which persisted for many centuries, while empires, and even mini-empires, do not appear able to sustain their expansion nearly as long.

8.7 Archaeological Implications

Empires should not be seen as homogeneous things, especially not hegemonic ones. At least within Mesoamerica, there were at least two distinctly different types, those limited to their expanded economic hinterlands and those that expanded far beyond by devising strategies to supply their armies with the necessary foodstuffs beyond the distances their home city could do so.

These distinctions are far easier to discern for periods with historical documentation; earlier Mesoamerican empires are difficult to detect archaeologically and are then seen only dimly. Trade goods can travel vast distances, rendering them unreliable indicators of actual imperial integration by military expansion. Even the same gods and rituals are poor indicators in large areas that have shared many of these features for centuries and even millennia, as they may reflect the movements of common ideologies rather than polities. The archaeological focus instead tends to be on the extent of trade goods found and, more convincingly, on similar architectural styles, as buildings are necessarily constructed locally and are not transported.

In the Aztec case, the primary architectural innovation that appears to be distinctively theirs is the dual pyramid venerating the widely shared and ancient god, Tlaloc, on one side and the Aztec patron god, Huitzilopochtli, on the other (Broda 1987, pp. 72–74; Matos Moctezuma 1984, 1988, p. 134; 1995, p. 66). Although there are few extant examples of these pyramids today, from these, early colonial depictions, and early documentary sources, the spread of this pyramid and Huitzilopochtli was quite restricted, being limited to within the Valley of Mexico and to adjacent areas beyond. It might be argued that this spatially limited spread was the result of the relative youth of the empire, having begun only in 1428, yet there is no evidence of the dual pyramids or Huitzilopochtli in some of the earliest areas incorporated into the empire, such as those in Guerrero. Their limited appearance, I suggest, is more indicative of the inner, economic hinterland of the empire. The areas beyond that were more politically dominated and fail to reflect this Aztec style and deity.

What, then, might this mean for the archaeological detection of earlier empires in Mesoamerica? There is very little archaeological evidence of an eleventh-century empire in Oaxaca founded by the ruler Eight Deer, but the documentary evidence for it is compellingly specific (Clark 1912). Similarly, the argument over whether there was a Toltec empire also rests on documentary claims that contrasts with the skimpier archeological evidence, but the Toltec situation is remarkably similar to that of the Aztecs (Boehm de Lameiras 1980). For the Aztecs too, there is slim archeological evidence of an empire, yet the documentary evidence for it is massive. But most of the Aztec empire falls beyond the more tightly integrated two-day distance from the center, and this looser integration foils most archaeological efforts to establish its expanse.

For early empires with better transportation, such as the Roman Empire, which possessed wagons, draft animals, and wind-powered ships, the size of their economic hinterland was far greater. Away from water transport, however, it may have been only about a hundred miles. But establishing colonies allowed them to replicate Roman architectural styles, import their gods and rituals, and exploit local resources that might benefit the greater empire by sea.

At least for the Aztecs, and perhaps for all archaic empires, archaeological efforts to define the role of food and warfare may prove less effective than documentary ones. The direct areas of military impact may be discernible, but the more distant, more indirectly affected areas for which the relationship of food to warfare is the most interesting, may remain hidden for the foreseeable future.

Acknowledgements I would like to thank the anonymous reviewers for their suggestions and also the two organizers of the conference and editors of this volume for allowing a cultural anthropologist into this archaeological event.

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Chapter 9
War and Food Production at the Postclassic Maya City of Mayapán

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Mayapán was the largest political capital of the Late Postclassic Maya world. It was strategically positioned in the western portion of the northern Yucatán plains, within a two-day walk from the Puuc Hills escarpment to the southwest. Mayapán is located within a ring of cenotes associated with the Chicxulub impact crater (Pope et al. 1996), and the site has a high density of these subterranean features that provide year-round access to underground water (Fig. 9.1). This capital was founded following the demise of Chichén Itzá (Andrews et al. 2003; Masson and Peraza Lope 2014a, b; Peraza Lope et al. 2006) and its apogee dates to the thirteenth and fourteenth centuries C.E. The population of Mayapán is conservatively estimated to have been between 15,000–17,000 people (Russell 2008). The city and the regional confederacy of Mayapán collapsed, probably in 1448 C.E., just

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_9

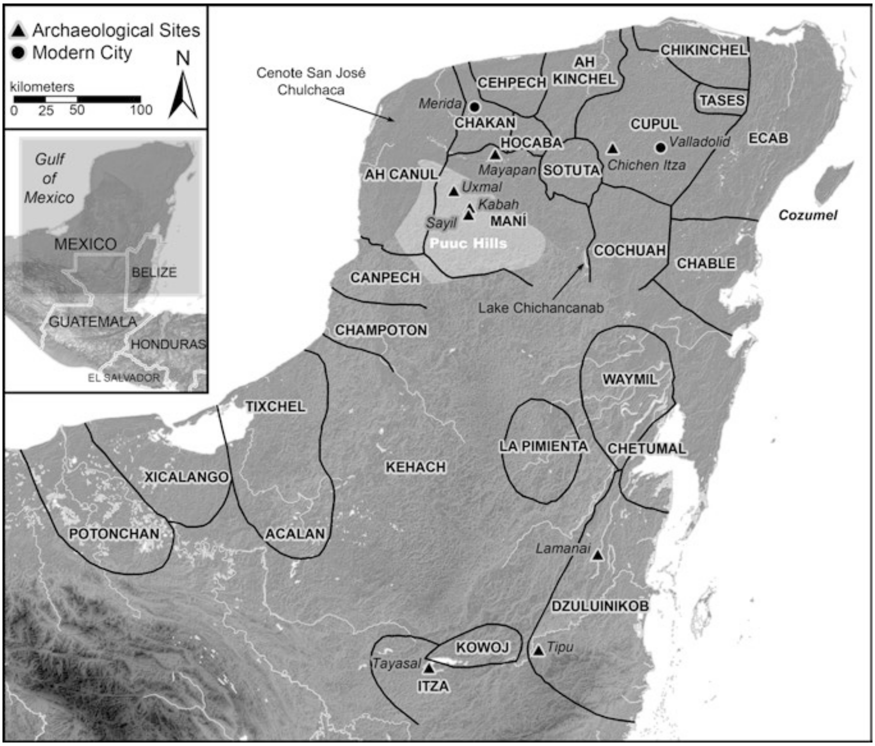

Fig. 9.1 Map of the Maya region and Yucatan Peninsula showing political territories at historic contact (after Rice 2009; Roys 1957) along with archaeological sites, modern cities, and geographic features mentioned in text. Graphical assistance from T. Harper

short of 100 years prior to the Spanish conquest of northern Yucatán in 1542. The abandoned city was probably used as an important pilgrimage center during historic times; it was not lost from social memory, and descendants recounted rich details of Mayapán society to Spanish chroniclers (Peraza Lope and Masson 2014, p. 55). At historic contact, the Kowoj of the central Petén lakes region in Guatemala claimed Mayapán descent with members of this ethnic group likely moving to this region during the late fourteenth or fifteenth centuries C.E. (Jones 2009; Rice 2009).

In this chapter, we explore the nature of food production systems at Mayapán within the context of increasing warfare and militarism during the Postclassic period (Serafin et al. 2014). Warfare here is defined as planned hostilities (battles, skirmishes, ambushes, massacres, violent usurpations) by groups of combatants, usually men (Leblanc 2014), who share a common interest (Webster 2000, p. 72). We focus on how the prospect of warfare and violence may have shaped Mayapán's subsistence institutions, specifically contributing to diversification of local food sources and those obtained through trade. This approach inverts

Carneiro's model that views warfare as an outcome of the constraints posed by demographic and environmental factors (e.g., Carneiro 1970). By the time Mayapán was founded, the prospect of warfare had long been a constant variable in the politics of northern Yucatán, as exemplified by the militaristic dimensions of its predecessor, Chichén Itzá. Mayapán's founders seem to have invested wisely in city infrastructure and in a system for effectively mobilizing citizen militia. Here, we review two forms of evidence for Mayapán's strategies for relative subsistence stability. First, we outline the diverse options for food production within and beyond the city walls. These food production systems include a sophisticated array of agricultural and faunal resources, including evidence for animal husbandry or game management (Masson and Peraza Lope 2008, 2013). Second, we present the results of a stable isotope palaeodietary study of 77 individuals from a variety of different spatial and social contexts in the city. We first describe Mayapán's fortified settlement characteristics and the changing cultural and environmental contexts underlying increasing hostilities in the late thirteenth and fourteenth centuries.

9.1 Mayapán as a Fortified Postclassic City

One of Mayapán's mostdefining features was a long (9.1 km) city wall that encircled a large (4.2 km^2) residential zone and the urban core (Russell 2013; Shook 1952; Smith 1962). The ruins of the wall today reach a height between 1.5 and 2.5 m and it is 3–5 m thick. Twelve gates, some vaulted, provided formal entrances for pedestrians. Prior to the wall's partial dismantlement in the final battle that led to the city's collapse (Roys 1962, pp. 47–48), it would have stood higher and probably supported a wooden palisade. In places, parapets form interior walkways (~1 m high, 2 m wide; Fig. 9.2) that served as viewing platforms for surveying the surrounding landscape. Parapets also gave defenders a height advantage in the event of attack, from which projectiles (spears, arrows) could be more effectively launched (Díaz del Castillo 1927; Russell 2013). Seven major and five minor gates were spaced along the wall to provide formal entranceways for the farmers, merchants, pilgrims, and all manner of visitors into the city. These gates also connected city dwellers to key forest and agricultural resources in the surrounding landscape. The city gates effectively constrained the entrance points of potential attackers, and, during peaceful times, the gates controlled and directed daily traffic in and out of the city. These portals also intersected with a network of stone-lined pedestrian lanes or roads that followed bedrock pavements that linked travelers to water sources, market plazas, and monumental groups within and beyond the city wall (Bullard 1952, 1954; Hare et al. 2014; Smith 1962, pp. 209–210). The existence of a second interior wall surrounding the civic–ceremonial core is also alluded to in historical documents (Landa 1941, pp. 23–26), but today, the only surviving candidate for this enclosure was reshaped by ranchers prior to 1950 (Shook 1952).

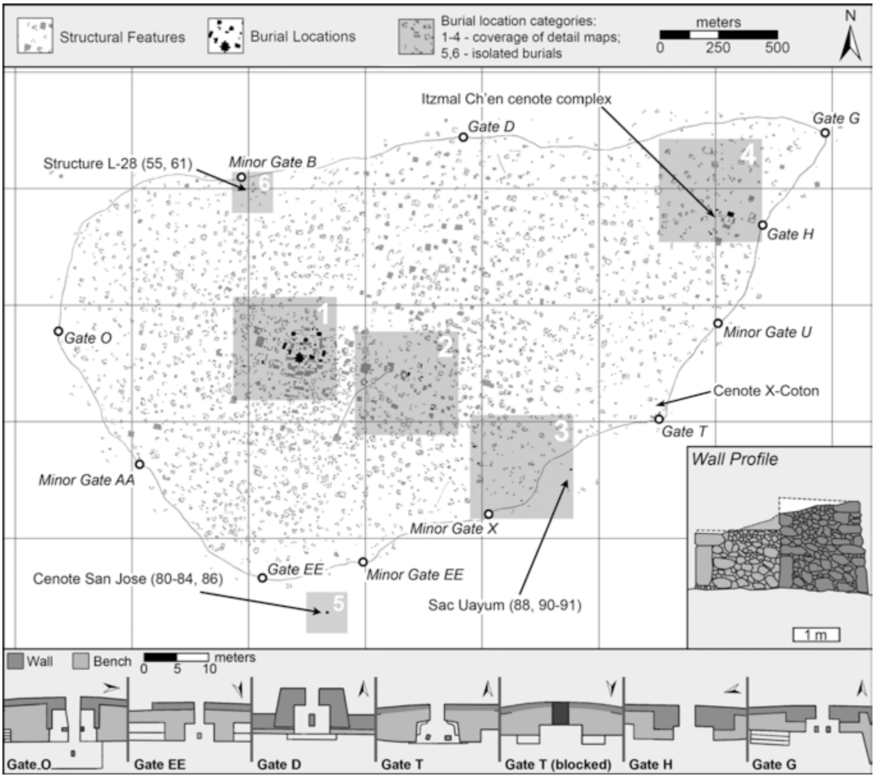

Fig. 9.2 Map of Mayapán showing city wall, locations of minor/primary gates, and stable isotope sample locations. Primary gate plans are based on Shook (1952). Detail of areas 1–4 provided in Fig. 9.5. Graphical assistance from T. Harper

Defensive systems were constructed elsewhere in the Maya lowlands and the earliest known examples occur in the Late Preclassic Period (~300 B.C.E.—200 C.E.; Webster 1978, 2000). Commonly, defenses at Maya sites were constructed to protect site epicenters that housed elite residential and public buildings; some later examples were built quickly and under duress (Demarest et al. 1997; Houston 1987). Defensive features are indicative of some type of external threat, and the relative labor investment in these systems tells us something about the scale and character of these risks. Mayapán's defensive wall is unique in its sheer size and its formalized city gate structure (Russell 2013). It also protected an extensive (4.2 km^2), nucleated residential zone in which the civic–ceremonial core was embedded. Within this enclosure were walled and open spaces suitable for gardens, small agricultural plots, and animal pens or corrals (Masson et al. 2014, pp. 247–250). Over 4000 structures have been recorded inside the wall, with an estimated additional 2000 edifices located within 500 m outside of the wall in all directions (Russell 2008).

The population of Mayapán not only lived within a walled city, but most residents also lived within houselot compounds demarcated by walls (Bullard 1952, 1953, 1954). Only a few northern sites exhibit this tradition, including Cobá, Chunchucmil, and Dzibilchaltun (Dahlin and Ardren 2002; Fletcher 1983; Kurjack 1974). The mazeway of pedestrian lanes formed by round or ovoid houselot enclosures also served a defensive purpose; the settlement zone was relatively impenetrable by invading forces not familiar with it, except by proscribed routes that linked gates to neighborhood cenote plazas and other communal public spaces (Hare et al. 2014). Such a defensive advantage has also been argued for the Chunchucmil urban zone that was similarly divided by hundreds of individual houselots (Dahlin and Ardren 2002). The Mayapán residential population living outside of the city wall also frequently built small, walled houselot enclosures that afforded privacy, and perhaps, protection. Termed ring *albarradas*, they tend to more tightly encircle dwellings and associated features than is observed in households within the city wall (Masson et al. 2014, Fig. 5.25).

The complexity of the city wall and the defensible configuration of the settlement zone associated with it reflect the fact that Mayapán was prepared for the threat of war (Russell 2013). Wall thickness increases with proximity to each major gate, and interior chambers were constructed to control pedestrian traffic in and out of the walled city. Gates could be blocked quickly and easily in the face of threat. As Bradley Russell (2013) points out, cross-cultural comparisons of gate configuration suggest that city gates with Mayapán's constricted design elements are effective impediments in a military situation and their presence is highly suggestive of the persistent threat of war (also see Keeley et al. 2007).

The mobilization of labor to construct this wall represents a large-scale coordinated effort that probably occurred when the city was first established in the late 1100s C.E. Tales of the city's founding emphasize the importance of the inner enclosure wall (Landa 1941, pp. 23–26), linking wall-building to the establishment of the new political capital. Also, the careful construction of vaulted gates and porticos, at regular intervals, reflects a degree of planning, as does the fact that gates align with key axes of monumental features within the settlement zone. The gates also mark major roads within the city that extended outward to nearby subject towns (Hare et al. 2014). The confederation was most stable and prosperous from the time of the city's founding around 1180 C.E. until around 1290 C.E. or a few decades following this date. During this time, it would have had the least trouble mobilizing a work force to build the defining feature of the city. Unlike rapidly erected defensive walls such as those reported from Petexbatún region sites, Mayapán's wall is expansive and does not cut through monumental features. The wall existed long enough for some families to construct their houselot enclosures adjacent to it (inside and out), using the city wall as one edge of their property (e.g., Hare et al. 2014, Fig. 4.5; Masson et al. 2014, Figs. 5.1 and 5.2). It is also probable that the existence of the city wall contributed to the nucleation and density of settlement growth throughout Mayapán's occupation. For these reasons, the idea that the city wall was built as part of the original effort to found Mayapán merits consideration (Masson favors this interpretation).

For a different view regarding the timing of the construction of Mayapán's wall, see Russell (2013). It is true that dry-laid walls are notoriously difficult to date, given the paucity of materials other than rubble within them. In Mayapán's case, a Postclassic period wall built anytime from 1180 to 1450 C.E. would have nearly identical ceramics, unless Ch'en Mul effigy censers were present, which date to the last half of the city's occupation. The defensibility of Mayapán's city wall has been treated in detail by Russell (2013). Across the Maya area, a concern for defense governed many choices to found settlements anew. For example, in northeastern Belize and in the Petén Lakes, island settlements were popular (Masson 2000; Rice 1986). In the Maya highlands, hilltop centers prevailed (Fox 1987). Along the east coast, both Tulum and Ichpaatun were walled (Escalona Ramos 1946; Lothrop 1924). In northern Yucatán, Webster (1978) describes walled sites or walled epicenters at Chacchob, Cuca, and Dzonot Aké. Evidence for increasing Postclassic era militarism and/or violence is also reflected in bioarchaeological data (Serafin et al. 2014).

The enclosure of Mayapán's settlement within a wall contributed to greater density of residences at this urban site. While this settlement would have afforded some level of protection against external threats, overcrowding may have negatively impacted human health (Cobb and Steadman 2012). However, evidence for excessive incidences of infectious diseases at Mayapán, compared to other less densely occupied Maya sites, is not observed on skeletal remains. In truth, Mayapán's residential density was variable, and most of the site's neighborhoods did not come close to the densities of 110 or so persons per hectare (pph) reported for northern medieval cities of Europe (Hansen 2006, p. 62). Mayapán's average pph is 33, which is comparable to earlier Maya sites such as Chunchucmil or Sayil (Masson et al. 2014, p. 265). Much of Mayapán's large walled enclosure thus encompasses neighborhoods full of amply spaced housing. In the downtown zone nearer to the epicenter, residential density is higher, ranging from 77 to 126 pph. Even so, dwellings in this portion of the site are situated within walled yards suitable for the cultivation of household gardens or orchards. The site does not have room block housing; instead, residents lived in small, independent dwellings that were organized into patio groups of the sort that are typical of Maya house groups of all time periods.

9.2 Warfare and Governance at Mayapán

The fortified city of Mayapán was the center of a large regional polity that influenced the Yucatán Peninsula during much of the thirteenth through fifteenth centuries (Roys 1957, 1962). Some of Mayapán's powerful families had roots extending back to Chichén Itzá's political domination of the peninsula during the Terminal Classic and Early Postclassic Periods (Andrews et al. 2003; Fig. 9.3). After Mayapán's fall, a patchwork of independent polities emerged across the peninsula and these were encountered by the Spanish in the early sixteenth century

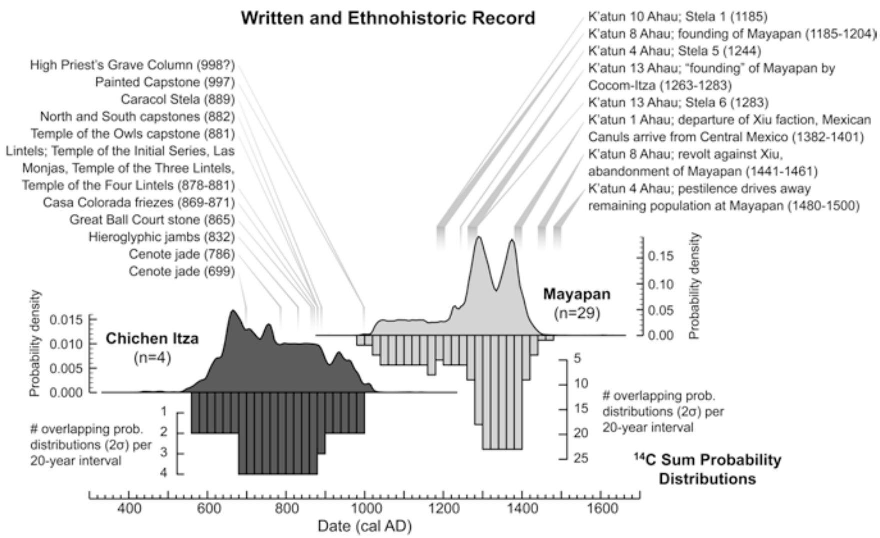

Fig. 9.3 Summed probability of available radiocarbon dates and historical references for Chichén Itzá and Mayapán. Radiocarbon dates and historical information for Chichén Itzá come from Andrews et al. (2003). Mayapan data come from Peraza Lope et al. (2006). Digitized provided by T. Hare. Graphical assistance from T. Harper

nearly 100 years after the downfall of Mayapán (Restall 1998; see Fig. 9.1). By most accounts, Mayapán was founded as a consequence of an orchestrated revolt and coup, referred to as the Hunac Ceel episode that pitted the powerful polities of Izamal and Chichén Itzá against one another (Milbrath and Peraza Lope 2003, 2009; Roys 1962; Schele and Matthews 1998). However, the sources are obscure regarding the timing of this event (Peraza Lope and Masson 2014). At a minimum, it reflects a longstanding tradition of intrigue and factional power plays in Yucatán politics.

Governance at Mayapán was dynamic during the thirteenth, fourteenth, and first half of the fifteenth centuries. Retrospective Colonial-era accounts reveal that the city's lords headed a confederacy governed by a council that was jointly ruled by key players in Yucatán (Tozzer 1941, note 141). This governing council was comprised of town leaders from each allied territory in the northwest part of the peninsula. In practice, the council espoused heterarchical ideals but embraced hierarchical principles, as suggested by clearly ranked nobility (Landa 1941, pp. 26, 62), as well as by evidence for ruling paramounts that yielded considerable influence over council affairs (Peraza Lope and Masson 2014; Ringle and Bey 2001). Some accounts refer to these paramounts as rulers, sometimes alluded to as kings (e.g., Roys 1962, p. 55), but at least three major families vied for control of the Mayapán confederacy (Restall 2001). One can only imagine the complex nature of this governance structure with periodic disputes and shifting internal alliances shaping the size and character of the polity. Despite the potential for disruption, it is important to recognize that the confederation held together for just over 250 years (Masson and Peraza Lope 2014b). Economic rivalries existed between elite lineages, especially the Xiu and the Cocom. According to historical accounts, town representatives maintained a residence in the capital city and members of their hometown polities were compelled to resettle at Mayapán (Landa 1941, pp. 23–26). A complex bureaucracy of officials worked to organize subject peoples living in the urban zone or in outlying townships in terms of corveé or military service, tribute, and other obligations to the state (Peraza Lope and Masson 2014; Restall 2001, Table 11.3; Ringle and Bey 2001, p. 271; Roys 1957). Upon the dissolution of Mayapán around 1448 C.E., members of the council retreated to their home polities (Landa 1941).

The Mayapán confederacy incorporated political territories that were concentrated in the northwest corner of the peninsula. Some polities, such as Chikinchel, remained independent and had more tenuous relationships with Mayapán (Kepecs 1999, 2003). The Campeche area and the east coast were also independent, but towns that represented strong allies and trading partners were present in these areas. Currently, it is not known with whom Mayapán waged war, but presumably the principal targets were polities within the Maya lowlands. Alliances may have been unstable at times, although Mayapán's influence on hinterland elites is clear from emulation of public and ritual architecture, effigy censers, k'atun turtle sculptures, and a wide variety of stone and pottery objects. One regular outcome of warfare was the taking of captives, some of whom were sold into slavery (Roys 1962, p. 47, 1972, pp. 34–35). Military service was required from subjects of the confederacy, and sources suggest that warfare was endemic. Mayapán's interests in mercantile exchange, distant cacao plantations in the southern lowlands, and other key economic resources needed protection.

Mayapán collapsed as a result of a political coup, orchestrated by one of the city's most influential families, the Xiu, who overthrew, and massacred most members of the Cocom family (Landa 1941, pp. 36–37). This terminal war was a large-scale event, in which the Xiu succeeded in rallying large numbers of participants; it is said that this force was able to tear down the city wall (Shook 1952, p. 8). Despite over a century of strife leading up to this final war, it is worth noting that the confederacy of Mayapán was resilient enough to remain intact. Environmental problems may have wreaked havoc on the agrarian food base during the fourteenth century, and again in the mid-fifteenth century, triggering famine, disease, and unrest (Masson and Peraza Lope 2014c). These problems are alluded to in ethnohistorical accounts as well as paleoenvironmental studies. Archaeologically, they are attested to by the presence of two mass graves (massacre sites) and rapidly abandoned or purposefully destroyed buildings that date to between 1270/1290 and 1400, C.E., at least 50 years before Mayapán's terminal war and collapse (Masson and Peraza Lope 2014b). That these conditions wrought escalated conflict is evident by the fact that Canul mercenaries (from the Gulf Coast) were brought to the city by the Cocom in the final decades prior to the collapse (Landa 1941, p. 61; Roys 1962, p. 46). This larger context facilitated the success of the Xiu-led revolt. It is important not to evaluate the power and centralization of the

Mayapán confederacy solely from the details surrounding its collapse, which emphasize fractious political structure. Through over two centuries, this polity represented a centralized state with resounding influence on the hinterlands of the Maya lowlands. A strong military capacity was an essential component of Mayapán's strength. This state also imposed severe punishment for offenses such as sodomy, adultery, homicide, or trespassing, which could result in hanging, decapitation, burning, stoning, disembowelment, or shooting (Landa 1941; Roys 1933; Serafin 2010).

9.3 Evidence for Persistent Warfare and Violence

The archaeological record complements documentary sources with respect to the emphasis on warfare and violence for the Mayapán state. The monumental center of the city has two prominent burial shaft temples, into which the bones of sacrificed men, women, children, and animals were thrown (Shook 1954). Mass graves are also reported from the site's monumental plaza and at the outlying Itzmal Ch'en group (Adams 1953; Masson and Peraza Lope 2014b), and at least two other public buildings in the site center have significant numbers of human remains that appear to represent sacrificial victims (Serafin and Peraza Lope 2007). During the Colonial era, individuals were also sacrificed and thrown into cenotes or crucified as sacrificial offerings to stave off drought and other disasters (Roys 1962; Scholes and Roys 1938). The importance of warfare to the Mayapán state is evident from the initial construction of its principal pyramid, the Temple of Kukulcan. A façade on this temple evinces themes of death, war, and sacrifice (Milbrath and Peraza Lope 2003; Peraza Lope 1998; Peraza Lope and Masson 2014). The Mayapán state used such spectacles in order to awe and subdue the large population within the city walls, and to promote cooperation, a strategy that was effective for many pre-modern states (e.g., Dickson 2006). The use of force helps with the suppression of internal conflicts of interest (see Bingham et al. 2013).

The many artistic programs in the urban zone, rendered in the form of stucco sculptures or murals on public buildings, reflect a pluralistic social composition among the site's governing elites. Milbrath and Peraza Lope (2003, 2009) consider these artworks in detail, attributing them to the agendas of the Cocom, Xiu, and other families. Clearly, the public buildings of the monumental zone were key facilities where political posturing, competition, and negotiation took place. The destruction or plastering over of certain art programs may also be related to shifting political dynamics, as various groups gained the upper hand (Milbrath and Peraza Lope 2009).

Bioarchaeological data indicate a high incidence of cranial trauma during the Late Postclassic Period consistent with heightened militarism associated with the Mayapán polity. Cranial injuries in men (anterior and left side) suggest open combat between military units, rather than raiding (Serafin et al. 2014). Perimortem trauma in women suggests that surprise attacks also occurred. Projectile wounds are relatively rare, and head wounds are consistent with small points embedded in wooden clubs (Serafin et al. 2014) and hand-to-hand combat.

Analysis of household artifact assemblages also reveals that the citizens of Mayapán were well-armed. One out of five tools found at the city's houselots is a projectile point, and this ratio includes informal unifaces such as retouched flakes that are ubiquitous in the archaeological record of most sites (Masson and Peraza Lope 2014c, Fig. 6.25). Another seven percent of household tool kits are lanceolate knives. Although these pointed knives were used for multiple purposes, they are present in sacrificial contexts and they are also displayed in art as weapons of war. Together, projectile points and pointed knives make up 28 % of formal tool assemblages; by contrast, agrarian axes form only three percent. Warfare was a condition of daily life, and the city's citizen militiamen were well-prepared. Vassals were regularly called upon to serve in Mayapán's military operations (Tozzer 1941, p. 230).

9.4 Spatial Organization of Food Production at Mayapán

Bishop Diego de Landa's description of contact period agricultural communities is generally consistent with archaeological observations at Mayapán. According to Landa (1941, p. 258), farmers lived in nucleated communities for defense, but cleared and farmed land in the surrounding landscape within walking distance of their houses. Maya farmers, along with other occupational specialists, preferred town life in the Contact Period (Restall 2001). Crops included maize (*Zea mays*), beans (*Phaseolus* spp.), squash (*Cucurbita* spp.), and chile peppers (*Capsicum* spp.). Landa also described orchards in the vicinity of these communities that were managed, and these assets were presumably owned by their cultivators (see Freidel and Sabloff 1984). Other Postclassic documents (e.g., Dresden Codex) suggest the importance of domesticated animals (dogs [*Canis familiaris*] and turkeys [*Meleagris ocellata*]) that were kept closer to home in houselot gardens, along with a range of other plants and trees. This infield–outfield agricultural system has great historical time depth in the Yucatán and is still practiced in the region today (Masson and Peraza Lope 2014c).

Many of the residents of Mayapán would have worked primarily as farmers. Local agricultural systems were essential for sustaining the urban residential population that included crafters, officials, and elites, who likely did not produce all of their own food. The relatively flat and forested terrain surrounding Mayapán is well suited for slash-and-burn cultivation during wet season months (May–September) with seed storage through the dry season for food and seed stock. This type of extensive fallow-based agricultural system supports Maya communities throughout the Maya lowlands today (Whitmore and Turner 1992), including villages in the vicinity of Mayapán (Masson and Peraza Lope 2014c). Families clear small fields (*milpas*; 2–3 hectare in size) in the forest and burn the vegetation during the dry season to introduce nutrients into the soil. Maize and other cultivars are planted at the end of the dry season in anticipation of the wet season rains. *Milpas* are tended and weeded through the wet season and harvested during the fall. Maize is often broken and left to dry on the stalk, and then, the dried ears are transported and stored in houses or other more specialized structures within a household compound. *Milpas* are cultivated for 2–3 years and are left fallow 7–15 years for forest regeneration prior to reuse. This means that more land is in fallow (2–7 times) than cultivated at any given time (Reina 1967; Reina and Hill 1980). These types of extensive cultivation systems have supported between 19 and 23 people per km^2 in the Yucatán historically (Cook 1921; Hester 1954; Wagner 1968), suggesting that large amounts of land surrounding Mayapán must have been cultivated to support peak populations of 15,000–20,000 in the fourteenth century. The closest paleoecological record to the site (Cenote San José Chulchaca; see Fig. 9.1 for location) indicates forest disturbance, burning, and maize pollen consistent with slash-and-burn farming in the region between 1250 and 1500 C.E. that continued in the Colonial Period (Leyden 2002, p. 96). Wetland cultivation during the dry season occurred elsewhere in the Yucatán (Fedick 2003), but this type of food production system is not viable in the vicinity of Mayapán due to the general lack of permanent wetlands.

Other food supply systems were also important, and the city's subsistence resources were augmented by exchange (Masson and Peraza Lope 2014c). Food trade was essential as a risk management policy due to the regularity of locally experienced effects of droughts, hurricanes, or other disasters that are not uniform in their impacts to particular localities on the peninsula (Freidel and Shaw 2000). Like most agrarian states, Mayapán would have endeavored to grow as much of its own food as possible, but also like many other pre-modern states, this option was vulnerable and would have been supplemented by trade. Indeed, Mayapán received maize, game, and fowl as tribute from its subject towns. Game and fruit, products of the city, were exchanged to coastal towns for dried fish and salt (Landa 1941, p. 40).

Earlier Classic Period occupants of Mayapán were initially drawn to the two largest cenotes in the area [Itzmal Chen and X-Coton (Fig. 9.4)], although 26 cenotes are now documented within the city wall. These openings in the caprock provide sources of water that are significant, given the absence of lakes, rivers, or perennial streams in the vicinity. Cenotes were treated as public spaces; they were not contained within private houselot enclosures (Smith 1962). Popular cenotes were located at junctures of stone lanes and other pedestrian pathways (Hare et al. 2014).

Houselot gardens at Mayapán were likely present within houselot wall enclosures that are common across the city. In addition to these domestic enclosures, non-residential walled fields are also present, located in between or adjacent to domestic enclosures (Hare et al. 2014). These spaces are analogous to inter-dwelling cultivation areas at other sites (e.g., Fedick 2010; Killion 1992; Killion et al. 1989), as well as to modern Maya houselot gardens that are contained within walls. Such spaces could be easily fertilized with organic waste, charcoal, and feces (human and animal). An organic-rich dark soil horizon commonly occurs

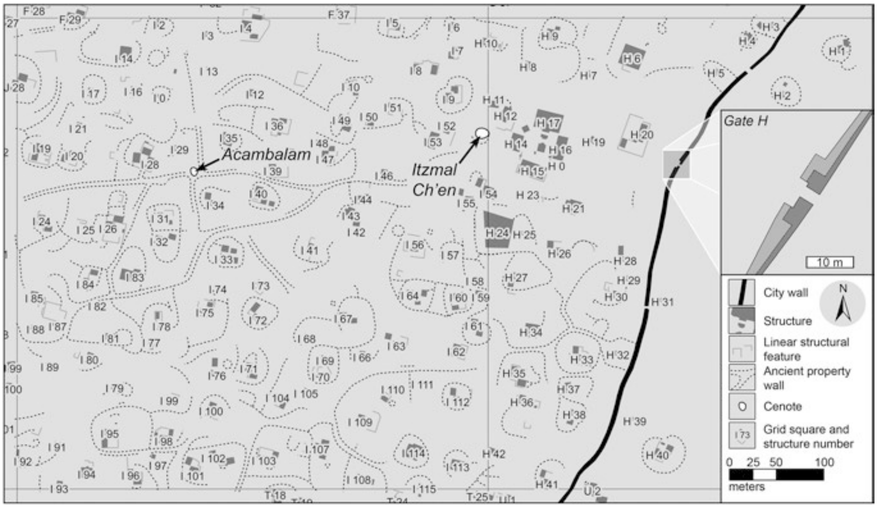

Fig. 9.4 Map showing walled house compounds in the eastern part of Mayapán. Digitized structures and defensive wall provided by T. Hare. House compounds digitized from original map in Smith (1962). Wall profile from Russell (2013) and plan of Gate H is from Shook (1952). Graphical assistance from T. Harper

within house compounds in the densely inhabited downtown area of the site and reflects pre-Hispanic alteration and augmentation of the soil (Brown 1999). House gardens played an important role in Maya society more generally (Killion 1992; Turner and Miksicek 1984; Whitmore and Turner 2001), and small-scale agroforestry is well documented historically in the Yucatán (Landa 1941).

In particular, cacao (*Theobroma cacao*) plantations are noted, with the seeds of this plant serving as a medium of exchange at historic contact (Landa 1941, p. 94). Cacao would not have flourished in the surface soils of arid northwest Yucatán, but it might have been grown in moisture traps such as rejolladas or cenotes (Kepecs and Boucher 1996). Mayapán oversaw distant cacao plantations in its hinterlands, most likely due to the importance of currency beans to the city's economy (Roys 1962, pp. 50, 55–60). A wider range of other valuable trees were likely managed in forest or houselot gardens or orchards (Fedick 2010; Gómez-Pampa 1987).

Small non-residential walled enclosures encompass spaces of 10–70 m^2 (Masson et al. 2014, pp. 247–252). These minor non-residential enclosures have been labeled as pens that may have been used for the storage of agricultural produce (e.g., dried maize ears) or used as pens for turkey, dogs, or peccary (*Pecari tajacu* and *Tayassu pecari*) (Smith 1962; Thompson and Thompson 1955). They are often located alongside houselot walls and use this wall for one of their sides. In other cases, they are freestanding. More freestanding, circular pens are found with houses outside of the city wall, which may point to their function as maize storage bins.

Larger walled fields (77.2–3275 m^2) are widely distributed within the city limits. Houses do not occur within these enclosures, and artifact densities are low. Masson et al. (2014) hypothesize that they were used for maize cultivation or animal husbandry (e.g., tethering of white-tailed deer [*Odocoileus virginianus*] or free-ranging wild turkeys). In some cases, oval walled fields extend outward from similar walled enclosures that encircle domestic space. In other cases, walled fields are enclosed in a de facto fashion by the adjoining walls of surrounding domestic enclosures (see Fig. 9.4).

Other open spaces that are not demarcated by walls are found across the city and would have presented additional options for infield cultivation. Farming families living within the city wall would have diversified their strategies by also engaging in infield cultivation and commuting to more distant *milpas*. Other families lived and worked permanently outside of the city wall as suggested by permanent commoner dwellings associated with storage buildings, cenotes, and ample land. However, there were no simple rules regarding normative domestic economies (Masson and Peraza Lope 2014c). Some residents would not have grown all of their own food, instead dedicating a portion of their time to a variety of craft production pursuits.

9.5 A Case of Animal Husbandry

The use of local and non-local animals for domestic and ritual purposes has been well studied at Mayapán (Masson and Peraza Lope 2008, 2013). A sample of nearly 100,000 faunal bones has been analyzed that provides a glimpse of the city's animal food production system. This sample comes from monumental center edifices that were cleared and restored by Carlos Peraza Lope as part of INAH's Mayapán Project. A portion of the sample also derives from settlement zone investigations of the Proyecto Económico de Mayapán (PEMY). A total of 67,107 animal bones from 94 buildings was analyzed from the monumental center, and 30,309 from 86 contexts associated with outlying houses (97,416 total). Methods of recovery are described in Masson and Peraza Lope (2008).

A wide variety of mammals, birds, reptiles, amphibians, and fish were identified in the faunal assemblage with some notable differences between the monumental center and the settlement zone. The dominant taxa from both areas of the city included white-tailed deer (23 %), dog (4.4 %), turkey (12.9 %), and iguana [*Iguana iguana*] (10.2 %) (based on the number of identified specimens [NISP]; Masson and Peraza Lope 2008). The settlement zone sample had more small mammal, iguana, and fish than the monumental zone, whereas the latter had more dog remains. Taxonomic diversity is also greatest in the monumental core, especially for rare animals such as tapir (*Tapirus* spp.), manatee (*Trichechus* spp.), felines (Felidae), and crocodile (*Crocodylus* spp.). The regular recovery of marine fish and a ubiquitous marine shell craft industry at the city reflect important coastal trading ties.

Dog is the only clear domesticated animal species in the faunal assemblage, and dogs played an important role in both elite and public rituals (Masson and Peraza Lope 2013; Pollock and Ray 1957). The bones of this domesticated animal comprised 4.4 % of the monumental core assemblage and 1.4 % of the sample in the outlying settlement. Higher concentrations in the monumental core suggest that dogs were a significant ritual food or sacrificial item. Turkey bones are also common, probably representing those of the wild ocellated turkey (Pollock and Ray 1957). This species is also depicted in Postclassic Maya codices. The ubiquity of these bones across the city suggests that they were tended in household flocks (Masson and Peraza Lope 2013, p. 241).

The great abundance of white-tailed deer in the faunal assemblage of Mayapán points to its importance as a food staple and as a festival food for the rites of the monumental center. Irrespective of their origin, it is clear that white-tailed deer were a staple of immense importance at the city. Bones identified specifically as white-tailed deer form 23 % of the faunal sample; when large mammal long bone fragments are added, which probably represent deer but are too fragmented to identify to species, white-tailed deer and large mammal form 49 % of the sample. Plausibly, half of all of the meat, fish, and fowl consumed at Mayapán was deer. The city diet was rich with meat, as faunal bones are plentiful in middens across the site. Similarly, turkey forms 13 % of the bone assemblage, and when the long bone fragments of large birds are added to this total (almost certainly those of turkey), the turkey total is raised to 17 % of the faunal sample. Conceivably, turkey and deer formed two-thirds of the Mayapán fauna. Both animals were probably raised, at least in part, in the city's houselots.

Masson and Peraza Lope (2008) suggest that white-tailed deer were raised, and probably bred in captivity, within the houselot enclosures of Mayapán. The source for this idea is Diego de Landa's account regarding tending of tamed deer by Maya women (1941, p. 127). Over 30 % of deer long bone ends represent full-sized animals whose epiphyseal ends have yet to fuse. This age group represents a class of healthy and fit animals that should not represent such a large portion of the deer assemblage, suggesting that animals of this age were butchered upon reaching adult size. This type of culling and butchery pattern is associated with animal husbandry in other parts of the world (Ducos 1978; Rackham 1994). The white-tailed deer age-at-death profile matches that of dogs (a known domesticate) in the assemblage and contrasts with those of brocket deer (*Mazama americana*) and peccary. This suggests that dogs and white-tailed deer were managed differently than animals that were obtained primarily through other means. Brocket deer and peccary may have been hunted from the surrounding forest or acquired through trade. Masson and Peraza Lope (2013) suggest that a significant portion of white-tailed deer were bred and raised in captivity. An alternative scenario is that some type of game management program guided hunting practices in the forests surrounding Mayapán. Some older deer are represented in faunal dentition samples, and early Spanish soldiers remarked upon the tameness of deer in certain Yucatecan forests (Tozzer and Allen 1910, p. 350). These faunal data are consistent with the hypothesis that animal husbandry was an important part of the food production system and that the walled enclosures at Mayapán were periodically used as corrals for larger animals.

9.6 Stable Isotope Dietary Analysis

To examine changes in diet through time, we measured the stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratios of human bone collagen from seventy-seven individuals from Mayapán dating to between 800 and 1450 C.E. (see Figs. 9.2 and 9.5 for locations). We AMS radiocarbon dated all bone samples to track dietary changes through time within the context of increasing hostilities and warfare in the very late thirteenth and fourteenth centuries. These radiocarbon dates are presented elsewhere (Kennett et al., in preparation).

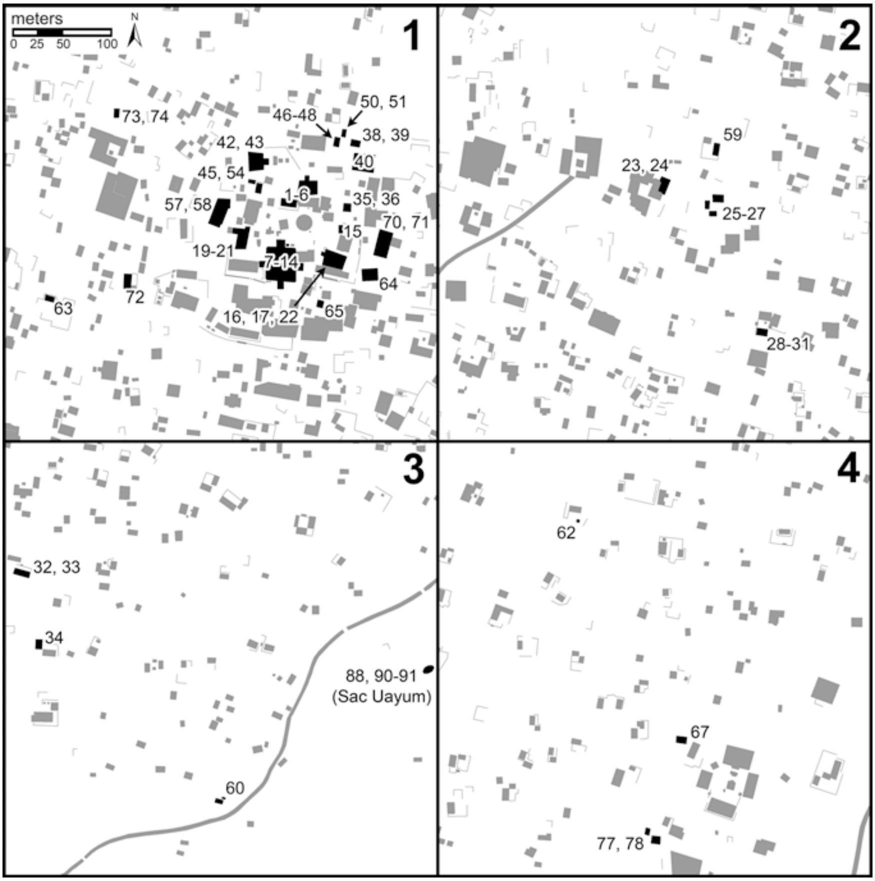

Fig. 9.5 Detail maps from Fig. 9.1 (Areas *1–4*) showing locations of burials analyzed in this study. Graphical assistance from T. Harper

Stable carbon and nitrogen isotope measurements of human bone collagen are widely used as a dietary proxy (Ambrose and Krigbaum 2003; DeNiro 1985; DeNiro and Epstein 1981; Schwarz et al. 2011). The fundamental basis for differences in bone collagen $\delta^{13}C$ is fractionation effects in plants associated with different photosynthetic pathways. Most plants (trees, shrubs, vegetables, and some grasses) metabolize carbon using the C_3 photosynthetic pathway. During photosynthesis the lighter ^{12}C isotope (as $^{12}CO_2$) is preferentially absorbed making the $\delta^{13}C$ values more negative (depleted), ranging between −25 and −27 ‰ (per mil or parts per thousand). Several grass species have evolved with the capacity to metabolize the heavier ^{13}C isotope more efficiently. These C_4 plants have less negative (enriched) isotopic compositions in the range of −13 to −11 ‰. The bone collagen of animals and humans that consume C_4 plants on a regular basis are therefore more enriched when compared with those largely eating C_3 plant foods. Maize is the most common C_4 plant consumed in Mesoamerica today, and bone collagen $\delta^{13}C$ is commonly used to track the importance of this domesticate through the Holocene as an important staple (Blake et al. 1992) or fermented beverage (Smalley and Blake 2003). There are also some plants that fluctuate between C_3 and C_4 photosynthetic pathways seasonally or diurnally (Crassulacean Acid Metabolism, CAM). Most of these have more isotopic overlap with C_4 plants, and the most common edible plant species in the environment surrounding Mayapán are cacti.

Nitrogen isotope ratios in human bone collagen derive from the protein of animals and plants in the diet and reflect the trophic level of the organism. $\delta^{15}N$ in most terrestrial plants is enriched 3–7 ‰ relative to atmospheric nitrogen ($N_2 = 0$ ‰). A stepwise enrichment of 3–5 ‰ occurs in herbivores and again in carnivores (Hedges and Reynard 2007; Schoeninger and DeNiro 1984). Marine vertebrates are generally enriched relative to terrestrial vertebrates and stepwise trophic-level effects occur up the food chain from plankton to marine mammals. This observation has been used in some geographic contexts to identify individuals more reliant upon marine foods (Walker and DeNiro 1986). Some reef fish are $\delta^{15}N$ depleted due to algal colonies in these habitats and consumption can be masked in Mesoamerica by the consumption of maize. Reef fish occur in the faunal assemblage at Mayapán, but only in small numbers compared with terrestrial vertebrates.

The isotopic composition of human bone collagen therefore reflects the relative proportion of isotopically distinct plants and animals in an individual's diet. These values reflect an average diet prior to death (turnover rate for collagen is about seven years, DeNiro 1985), and they are biased toward the protein portion of various diet sources (e.g., maize, meat). At Mayapán, we would expect most individuals to be enriched in $\delta^{13}C$ due to the historical importance of maize-based food production. Classic Period Maya populations known to cultivate maize range between −12 and −8 ‰. Based on the faunal records, we would expect the consumption of terrestrial herbivores (white-tailed deer and brocket deer) and the associated enrichment in $\delta^{15}N$ (in the 5–10 ‰ range). Some of the animals in the faunal assemblage (turkeys, dogs, and possibly deer) were likely foddered to a certain degree with maize stalks, leaves, and ears, and this would contribute a C_4 signature. $\delta^{15}N$ in the Mayapán population should largely reflect differences in local access to meat (terrestrial herbivores) or marine foods via exchange. One of our primary interests here is to determine whether there were major dietary changes associated with increasing conflict at Mayapán between 1300 and 1450 C.E., or whether the major investment in the defensive wall served to protect stored foods and enclosed gardens/corrals to provide a dietary buffer during times of hardship.

To examine the dietary change/stability at Mayapán, bone samples were processed in the Human Paleoecology and Isotope Geochemistry Laboratory at the Pennsylvania State University (Department of Anthropology). Collagen was extracted and purified using the modified Longin method with ultrafiltration (Brown et al. 1988). Bone samples were initially cleaned of adhering sediment and the exposed surfaces were removed with an X-acto® blade. Samples (200–400 mg) were demineralized for 24–36 h in 0.5 N HCl at 5 °C followed by a brief (<1 h) alkali bath in 0.1 N NaOH at room temperature to remove humates. The pseudomorph was rinsed to neutrality in multiple changes of Nanopure H_2O and then gelatinized for 12 h at 60 °C in 0.01 N HCl. Gelatin solution was pipetted into precleaned Centriprep® 30 ultrafilters (retaining > 30 kDa molecular weight gelatin) and centrifuged 3 times for 30 min, and diluted with Nanopure H_2O and centrifuged 3 more times for 30 min to desalt the solution (ultrafilter cleaning methods are described in McClure et al. 2011, pp. 28–29). Ultrafiltered collagen was lyophilized and weighed to determine percent yield as a first evaluation of the degree of bone collagen preservation. Carbon and nitrogen concentrations and stable isotope ratios were measured at the Pennsylvania State University, Light Isotope Laboratory with a Costech EA (ECS 4010), Thermo Finnigan Conflo IV gas handling device, and a Thermo Finnigan Delta V analyzer. Sample quality was evaluated by % crude gelatin yield, %C, %N, and C:N ratios. C:N ratios for all samples reported fell between 3.10 and 3.34, indicating good collagen preservation (DeNiro 1985; van Klinken 1999).

Stable carbon and nitrogen isotope values for all individuals are presented in Table 9.1 and plotted in Fig. 9.6. We provide age and sex data when determined for each individual along with a measure of sociopolitical status (Elite, Commoner, Sacrificial victim) based on the archaeological context of the skeletal material. Figure 9.6 shows that there is a great deal of overlap in isotope values through time. Most of the variability is in $\delta^{13}C$ with much less in $\delta^{15}N$. There are a few higher-$\delta^{15}N$ outliers (>9.6 ‰) in the sample. Where the age of these ^{15}N-enriched individuals can be determined they are infants or subadults, which is consistent with the well-known trophic-level enrichment associated with breast-feeding (Katzenberg and Pfeiffer 1995; Richards et al. 2002). Higher-$\delta^{15}N$ in subadults indicates that weaning had taken place within the collagen turnover time and that the enrichment from breastfeeding was still in the process of being averaged out of the individual at the time of death. Therefore, we assume that $\delta^{15}N$ values higher than ~9.6 ‰ in the larger sample ($n = 77$) reflect some enrichment from breast-feeding, rather than greater consumption of marine or higher

Table 9.1 Isotope results and burial attributes for Mayapán

ID	PSU #	Provenience	Pre-treat[a]	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C:N	Loc.[b]	Burial status[c]	Burial type[d]	Age class[e]	Sex
Terminal Classic (AD 750–1000)											
MP62	6085	Milpa 17, 1573, N7, E03-4	XAD	−10.9	8.4	3.18	4	C	B	3	U
MP61	5916	L-28, E-9, Nivel 2, Capa II, Ent 03-3	XAD	−11.0	8.8	3.23	6	C	B	2	U
Early Postclassic (AD 1000–1200)											
MP17	6132	33-V, 5083-4, Capa IV, Ent 28	UF	−9.1	8.9	3.18	1	U	B	4	F
MP40	6159	27-J, 8797, Ent 35	UF	−10.0	8.0	3.11	1	U	U	4	M
MP48	6164	1-E, 0441-1, Ent 43	UF	−8.6	9.0	3.12	1	C	B	4	M
MP23	5893	R.106, 8-M, 0668, Ent 3	UF	−10.3	8.7	3.28	2	E	B	3	U
MP67	6130	6 J-6 K, 5046, Nivel 3, Capa II, Ent 08-02	UF	−7.6	10.9	3.13	4	C	B	3	U
Early Mayapán (AD 1200–1250)											
MP15	6148	Q.88c, 9-H, 4359, Ent 26	UF	−10.9	11.1	3.19	1	E	B	U	U
MP21	6150	Q.72, 13-R, 6693, Ent 32	UF	−9.3	9.0	3.18	1	E	B	3	U
MP34	6082	Y.44, 2827-2, Capa II, Ent 11 & 12	XAD	−9.8	9.2	3.18	1	C	B	3	U
MP35	6158	Q.89, 10-H, 8150, Capa II, Ent 37	UF	−9.9	8.6	3.17	1	S	S	U	U
MP36	5914	Q.89, 10-F, 8110-III, Capa III, Ent 39	XAD	−9.3	6.9	3.24	1	S	S	3	U
MP38	5915	Q.94, 17-Y, 9237-1, Capa I, Ent 34	XAD	−9.5	7.3	3.21	1	C	B	3	M
MP44	5894	Q.67, 2-H, 1212, Ent 50	UF	−9.2	8.5	3.27	1	C	B	4	M
MP45	6162	Q.68, 7-R, 1517, Ent 51	UF	−9.6	8.8	3.13	1	C	B	3	F

(continued)

Table 9.1 (continued)

ID	PSU #	Provenience	Pre-treat[a]	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C:N	Loc.[b]	Burial status[c]	Burial type[d]	Age class[e]	Sex
MP46	5895	Q.92, 1-E, 0441-1, Capa I, Ent 40	UF	−9.6	9.4	3.25	1	C	B	2	U
MP71	6137	Q.99, 21-G, 4201-1, Capa I, Ent 63	UF	−9.8	8.5	3.21	1	E	B	3	F
MP72	5900	Q.176a, Pozo 1, 8553, Nivel 3, Ent 09-06	UF	−6.9	11.3	3.29	1	E	B	1	U
MP74	6086	Q.39, 6,7-E, 8096, Nivel 3, Capa II, Ent 09-05	XAD	−10.0	10.1	3.22	1	E	B	U	U
MP25	6134	R.112, 10-G, 1330-1, Ent 1	UF	−9.8	8.0	3.21	2	C	B	3	M
MP26	6153	R.112, 8-P, 1508-3, Ent 2	UF	−10.4	8.5	3.19	2	C	B	4	F
MP29	6155	R.183b, 5-E, 2045-5, Ent 6 & 7	UF	−10.8	8.7	3.12	2	E	B	U	U
MP30	6156	R.183b, 5-E, 2045-6, Ent 8 & 9	UF	−10.5	9.4	3.14	2	E	B	U	U
MP31	6157	R.183b, 7-E, 2047-2, Ent 10	UF	−10.5	8.9	3.18	2	E	B	2	U
MP32	5913	Y.43b, 10-K, 9-K, 2430-3, Ent 13	XAD	−10.6	8.0	3.34	3	E	B	3	F
MP33	6081	Y.43b, 6-J, 2386-3, Ent 14	XAD	−9.7	9.4	3.20	3	E	B	U	U
MP59	5898	RS-29, Milpa 11, 2310, Nivel 8, Ent 03-7	UF	−10.6	8.9	3.29	4	C	B	4	F
MP77	6138	I-55, 23-D, 6149, Nivel 1, Capa I, Ent 09-01	UF	−9.3	8.0	3.21	4	C	B	3	F
MP78	6087	I-55, 22-Da, 6160, Nivel 2, Capa I, Ent 09-02	XAD	−9.8	8.6	3.17	4	C	B	3	M
MP82	6057	Cenote San Jose, CR7	UF	−11.1	8.9	3.13	5	U	C	3	M

(continued)

Table 9.1 (continued)

ID	PSU #	Provenience	Pre-treat[a]	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C:N	Loc.[b]	Burial status[c]	Burial type[d]	Age class[e]	Sex
MP55	6167	L.28, Pozo 4, Nivel 5, Capa 5, Ent 03-5	UF	−10.0	8.2	3.15	6	C	B	U	U
Middle Mayapán (AD 1250–1400)											
MP01	5889	Q.79, 19-N, 3409, Ent 15	UF	−10.2	8.2	3.24	1	S	S	4	F
MP02	6050	Q.79, 21-O, 3441-1, Capa I, Ent 18	UF	−10.7	9.7	3.29	1	S	S	2	U
MP03	6051	Q.79, 22-O, 3442-1, Ent 19	UF	−9.6	8.9	3.15	1	S	S	3	U
MP04	6052	Q.79, 25-Q, 3505, Ent 20	UF	−9.7	8.4	3.21	1	S	S	3	U
MP05	6053	Q.80, 16-H, 3226, Ent 12	UF	−10.1	8.2	3.13	1	S	S	U	U
MP06	6054	Q.80, 19-N, 3409, Ent 16	UF	−10.3	8.7	3.16	1	S	S	2	U
MP16	6149	Q.152, 26-P, 4776, Ent 27	UF	−9.4	8.6	3.15	1	S	S	U	U
MP19	6133	Q.72, 5-Z, 7005-1, Ent 30	UF	−9.8	9.1	3.21	1	E	B	3	U
MP20	5892	Q.72, 5-Z, 7005-1, Ent 31	UF	−10.1	8.6	3.27	1	E	B	4	F
MP22	6151	Q.152, 28-O, 4728-1, Capa I, Ent 29	UF	−9.6	8.3	3.17	1	S	S	3	U
MP39	6083	Q.94, 11-X, 9201-1, Capa I, Ent 36	XAD	−9.4	9.1	3.20	1	C	B	U	U
MP42	6160	Q.58, 11-T, 1581, Ent 48	UF	−9.9	9.3	3.14	1	U	U	4	M
MP43	6161	Q.58, 11-K, 1311-1, Capa I, Ent 49	UF	−9.5	8.9	3.13	1	U	U	4	F
MP47	6163	Q.92, 1-E, 0441-1, Ent 41	UF	−10.4	8.6	3.13	1	C	B	3	F
MP50	5896	Q.93, 8-M, 0528-1, Capa I, Ent 46	UF	−9.5	8.6	3.26	1	C	B	3	F
MP51	6135	Q.58, 11-K, 1311-1, Capa I, Ent 47	UF	−11.3	8.6	3.23	1	U	U	4	F

(continued)

Table 9.1 (continued)

ID	PSU #	Provenience	Pre-treat[a]	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C:N	Loc.[b]	Burial status[c]	Burial type[d]	Age class[e]	Sex
MP52	6084	Q.67, 8-J, 1278-1, Capa I, Ent 53	XAD	−9.1	8.6	3.26	1	C	B	3	M
MP53	6165	Q.67, 4-J, 1274-2, Capa II, Cala 121, Ent 54	UF	−10.4	10.0	3.14	1	C	B	2	U
MP54	6166	Q.68, 8-P, 1458-1, Capa I, Ent 52	UF	−9.4	12.0	3.18	1	C	B	2	U
MP57	5897	Q.54, 12-L, 2232, Ent 56	UF	−12.1	7.2	3.13	1	E	B	3	F
MP58	6136	Q.54, 10-J, Pozo 68, 2190-2, Capa II, Ent 57	UF	−9.6	9.1	3.26	1	E	B	4	F
MP63	5917	P-114, Milpa 1A, 2017, Pozo 43, Nivel 6, Ent 03-2	XAD	−7.1	11.3	3.23	1	C	B	1	U
MP64	5899	Q.141, 5-M, 3765-1, Capa I, Ent 58	UF	−10.7	8.2	3.26	1	E	B	4	M
MP65	5918	Q.149, 10-K, 3210-1, Capa I, Ent 59	XAD	−9.1	9.1	3.25	1	C	B	3	U
MP70	6131	Q-99, 19-C, 4079-1, Capa I, Ent 62	UF	−10.3	8.6	3.15	1	E	B	2	U
MP73	5919	Q.39, 6,7-E, 8095, Nivel 3, Capa II, Ent 09-04	XAD	−9.4	9.4	3.29	1	E	B	U	U
MP24	6152	R.106, 15-L, Pozo 3, 0645-1, Ent 4	UF	−11.6	8.3	3.15	2	E	B	U	U
MP27	6154	R.112, 8-O, 1608-2, Ent 2	UF	−9.6	9.2	3.16	2	C	B	4	F
MP88	5902	Sac Uayum, Diente	UF	−9.5	9.3	3.30	3	U	C	U	U
MP90	6060	Sac Uayum, Fem #2	UF	−9.8	7.7	3.13	3	U	C	U	U
MP91	6061	Sac Uayum, Tibia	UF	−10.3	8.4	3.10	3	U	C	U	U

(continued)

Table 9.1 (continued)

ID	PSU #	Provenience	Pre-treat[a]	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C:N	Loc.[b]	Burial status[c]	Burial type[d]	Age class[e]	Sex
MP60	6129	X.64, Milpa 7, 2207, Nivel 6, Ent 03-6, adult & juvenile	UF	−9.1	8.0	3.15	4	C	B	4	F
MP80	5901	Cenote San Jose, CR10	UF	−10.5	9.0	3.28	5	U	C	3	M
MP81	6056	Cenote San Jose, CR11	UF	−9.4	9.1	3.14	5	U	C	3	F
MP83	6058	Cenote San Jose, CR8	UF	−10.7	8.5	3.13	5	U	C	3	F
MP84	6059	Cenote San Jose, 1-C, 1-F, L.041-3	UF	−9.7	8.5	3.13	5	U	C	U	U
MP86	6088	Cenote San Jose, 4-F, L.104-3	XAD	−8.4	9.0	3.15	5	U	C	U	U
Late Mayapán (post-AD 1400)											
MP07	5890	Q.162, 16-D, Ent 2	UF	−8.4	9.5	3.14	1	S	S	2	U
MP08	6055	Q.162, 16-E, 0136, Ent 3	UF	−8.8	9.6	3.16	1	S	S	2	U
MP09	6143	Q.162, 16-E, 0136, Ent 4 & 5	UF	−9.6	7.8	3.17	1	S	S	U	U
MP10	6144	Q.162, 16-E, 0136, Ent 7	UF	−10.2	8.7	3.17	1	S	S	3	M
MP11	6145	Q.162, 16-E, 0136, Ent 17	UF	−8.9	10.2	3.19	1	S	S	2	U
MP12	6146	Q.162, 16-E, 0136-1, Capa I, Ent 8 & 9	UF	−8.7	8.6	3.22	1	S	S	2	U
MP13	6080	Q.162, 16-E, 0136-1, Capa I, Ent 10	XAD	−8.4	9.4	3.21	1	S	S	2	U
MP14	6147	Q.162, 16-E, 0136-1, Capa I, Ent 11	UF	−9.5	8.5	3.12	1	S	S	3	M
MP18	5891	Q.162, 21-D, 0171-2, Capa II, Ent 25	UF	−8.6	9.5	3.28	1	S	S	4	F

[a]UF: >30 kDa ultrafiltered gelatin; XAD: XAD-purified amino acids
[b]Burial locations are keyed to Figs. 9.2 and 9.5
[c]C: commoner; E: elite; S: sacrifice; U: unknown
[d]B: burial; C: cenote; S: sacrifice; U: unknown
[e]1: infant, 0–2 yrs; 2: subadult, 2–18 yrs; 3: adult, 18–50 yrs; 4: elderly, 50+ yrs

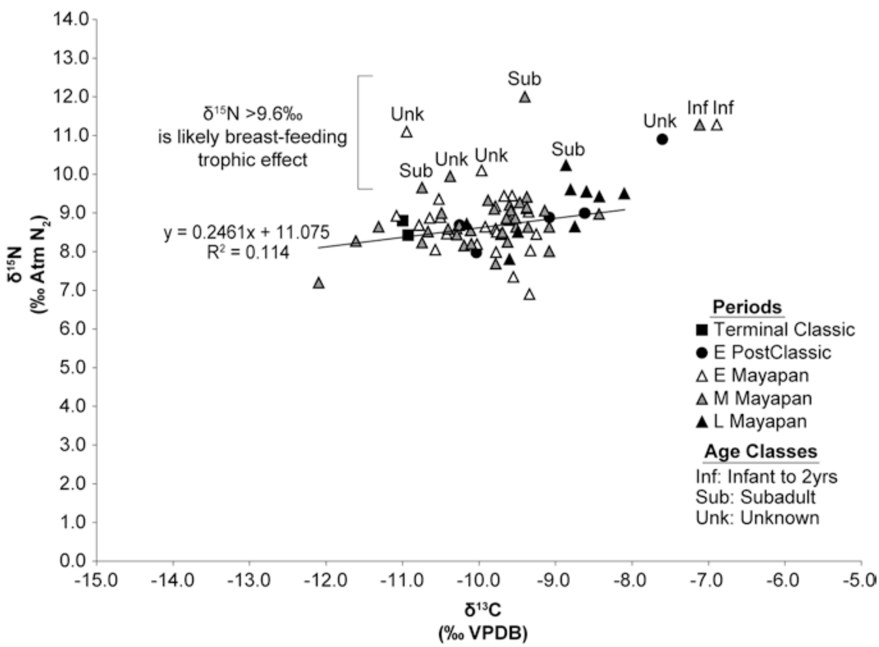

Fig. 9.6 Carbon and nitrogen isotope values for the Mayapán sample ($N = 77$)

trophic-level foods (e.g., terrestrial carnivores). These samples ($n = 9$) were excluded from statistical analyses.

After removal of these individuals, $\delta^{13}C$ ranges between −12.1 and −8.1 ‰ and $\delta^{15}N$ between 6.9 and 9.6 ‰. This is consistent with Classic Period Maya populations heavily reliant upon maize as a staple crop combined with the primary consumption of terrestrial meat sources (Somerville et al. 2013). Taking the data across all time periods ($n = 68$), there is a significant but weak positive correlation between $\delta^{13}C$ and $\delta^{15}N$ ($y = 0.246x + 11.08$; $R^2 = 0.11$; $p = 0.005$) suggesting that a relatively small portion (i.e., 11 %) of the variation in $\delta^{15}N$ is due to trophic-level differences in the diets of the population. However, most of the population is within a narrow 2.5 ‰ envelope, less than the shift between trophic levels. This indicates relatively little variation in the sources of meat protein among individuals. This is consistent with the faunal data from the site indicating the abundance of white-tailed deer and other terrestrial mammal bones in all sectors of the city.

We assigned samples to five temporal categories based on calibrated age ranges: Terminal Classic (TC, 750–1000 C.E.; $n = 2$); Early Postclassic (EP, 1000–1200 C.E.; $n = 4$); Early Mapayán (EMP, 1200–1250 C.E.; $n = 21$); Middle Mapayán (MMP, 1250–1400 C.E.; $n = 33$); and Late Mapayán (LMP, 1400–1500 C.E.; $n = 8$). The small Terminal Classic and Early Postclassic samples are not considered here. Comparing $\delta^{13}C$ and $\delta^{15}N$ of the three Mapayán periods indicates that there are no significant differences through time in $\delta^{15}N$. There are also no significant changes in $\delta^{13}C$ throughout much of the occupation of the city. No statistically significant differences were identified in the sample between the EMP and MMP populations (1200–1400 C.E.; mean $\delta^{13}C$ is −10.0 ‰). There are also no significant differences between mean $\delta^{13}C$ or $\delta^{15}N$ in identified females ($n = 19$) and males ($n = 14$) within or between these time periods (t test assuming unequal variances; Ruxton 2006). The $\delta^{13}C$ of the very latest population in our sample (LMP; 1400–1500 C.E.) is significantly different from the preceding 200 years. The mean $\delta^{13}C$ for LMP is somewhat enriched (−9.0 ‰), or roughly a +1.0 ‰ shift in that period (vs EMP: $t = -3.58$, df = 11, $p = 0.004$; vs MMP: $t = -3.38$, df = 11, $p = 0.006$). We note here that the sample size for this interval is small.

Status differences may be connected to this slightly enriched $\delta^{13}C$ signal in the LMP group (Fig. 9.7). Individuals were assigned to status categories of elite, commoner, sacrificial victim, and undetermined, based on archaeological context, and it is notable that all 9 LMP individuals were identified as sacrifices. Comparing each status group within and between the three Mayapán periods, there are significant differences in means between the elites of EMP (−10.2 ‰) and MMP (−10.5 ‰) and the sacrificed individuals from the LMP (−9.3 ‰) (vs EMP elites: $t = -2.48$, df = 11, $p = 0.031$; vs MMP elites: $t = -2.67$, df = 13, $p = 0.019$). Within the MMP period, elites (−10.5 %) are significantly (but slightly) depleted by 1 ‰ compared with commoners (−9.5 ‰; $t = 2.57$, df = 10, $p = 0.03$). The carbon isotopic compositionof EMP elites are, on average, slightly less enriched than commoners, though not significantly so, suggesting more varied diets less reliant

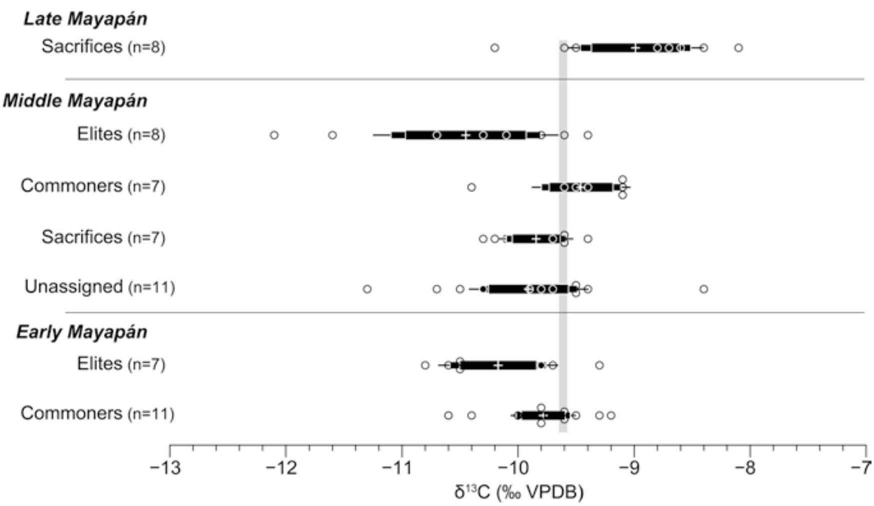

Fig. 9.7 Mean carbon isotope values for elites, commoners, and sacrifices at Mayapán for the Early (EMP), Middle (MMP) and Late (LMP) datasets. Data points are shown as open circles with the mean indicated by a cross. The bullet plot shows the 95, 90, and 83 % confidence intervals (CI) (thinnest to thickest bullets) around the mean. Gray line highlights the statistical differences at the 95 % CI between the EMP and MMP elites relative to the LMP sacrifices

upon maize. Sacrificed individuals are indistinguishable from commoners during the thirteenth and fourteenth centuries. The LMP sacrifices are even more enriched, and this is enough to be statistically distinct from EMP and LMP elites, as shown in Fig. 9.7. Individual data points, means, and confidence intervals (CI) around those means are plotted by period and status, with the bars of varying thickness indicating 83, 90, and 95 % confidence intervals. The EMP and MMP elite means are significantly different at the 95 % CI from the LMP sacrifice mean for $\delta^{13}C$.

9.7 Summary and Conclusion

Our stable isotope study of well-dated human skeletal material indicates dietary stability in the Mayapán population between 1200 and 1400 C.E. The importance of maize as a staple food is confirmed as part of a diet rich in terrestrial meats, an observation consistent with existing faunal records from the city. There were no detectable dietary differences between men and women and only subtle differences between elite and non-elite individuals. Carbon isotopic enrichment in commoners is indicative of more narrow maize-focused diets. Sacrificed individuals are indistinguishable from commoners during the thirteenth and fourteenth centuries. More negative carbon isotopes in higher-status individuals suggest more varied diets consistent with the greater diversity of animal species represented in the elite sectors of the city. The relatively small magnitude of the differences in isotope ratios between commoners and elites, however, stands in contrast to the large differences reported for a number of Classic period sites, including Altar de Sacrificios (Wright 1997), Altun Ha (White, Pendergast et al. 2001), Caracol (Chase et al. 2001), Chau Hiix (Metcalfe et al. 2009), Colha (White et al. 2001, Dos Pilas (Wright 1997), Lamanai (White and Schwarcz 1989), and Pacbitun (White et al. 1993), and corroborates the lack of marked status-based dietary differences in other Postclassic samples (Metcalfe et al. 2009; Williams et al. 2009).

These results are interesting in light of documentary accounts and archaeological findings with respect to the evidence for increasing fourteenth and fifteenth century violence at the city (Masson and Peraza Lope 2014b), particularly due to the possibility that such unrest unfolded following resource shortages. How might this interpretive discrepancy be explained? It is possible that violence and warfare were episodic and short in duration, and were not of a scale that impacted the stability of the food supply. Quick resolutions, however violent, might not have affected the bone chemistry of the skeletal population. It is worth considering that the security of staple crops and animal foods was a cause worth fighting for, either by successfully protecting local resources or by guaranteeing food exchange (via tribute or market systems), or by raiding other towns in the Yucatán. It is known that the Mayapán confederacy had military forces capable of acting quickly and often (Roys 1962, pp. 47–50). Perhaps, this institution served the city well with respect to staple resources and the stability of market exchange options in the fourteenth century.

It is also true that the Mayapán diet was considerably diversified, particularly due to the abundance of white-tailed deer and turkey, animals that could be fed from forest forage in lieu of maize, should the maize crop fail in a given year. White-tailed deer has been a preferred Maya food source since the establishment of the first Preclassic villages to the present day (Masson 2004). The post-Mayapán, Contact-era Cocom family of the Sotuta polity, who were descended from Mayapán's most influential governors, were known exporters of game and fruit to coastal towns, such as Ah Kin Chel. In return, they imported salt and fish to inland localities (Landa 1941, p. 40). Given the abundance of deer at Mayapán itself, it is reasonable to infer that the city engaged in similar types of faunal exchange. Coastal sites such as Cozumel have scarce quantities of deer, which would have been a luxury (e.g., Carr 1996; Hamblin 1984). Meat and fowl surpluses provided an extra measure of staple food security that was useful as stored (alive) resources for consumption or exchange. It is interesting to note that sacrificial victims were relatively indistinguishable from the city's commoner residents. This pattern suggests a shared foundation of staple foods within the confederacy and throughout non-allied polities that it raided. Dietary stability may thus be attributed to regular food exchange between communities as well as the diverse array of food production systems within communities. The cenotes, houselot yards, fields, and pens within and beyond Mayapán's city wall provide one example of diverse spaces for cultivation or animal tending. The isotopic shift evident in the post-1400 C.E. sample, which is small and comprised almost exclusively of sacrificed individuals, may reflect greater reliance upon maize that occurred within the context of increased societal instability as the Mayapán state was in decline (see VanDerwarker and Wilson, this volume for similar findings elsewhere). Additional work will be required to make this determination.

It is not known whether warfare had a significant impact on diet at other Postclassic Maya sites. Paleodietary reconstruction through isotope analysis has been conducted on Postclassic samples from Altun Ha (White et al. 2001a), Chau Hiix (Metcalfe et al. 2009), Lamanai (White and Schwarcz 1989), Marco Gonzalez, San Pedro (Williams et al. 2009), and Iximche (Nance et al. 2003). With the exception of Iximche, the evidence for warfare is elusive in the archaeological record of these sites. No prior studies have tracked chronological changes in bone chemistry and diet within the Postclassic, as we have done here.

The relative dietary stability at Mayapán in the face of escalating warfare and known sociopolitical stresses in the late thirteenth and fourteenth centuries C.E. was unexpected and rather remarkable given the other case studies in this volume. In smaller-scale societies, dietary stress can result in conflict and war for resources (Kennett 2005; Kennett and Kennett 2000; Lambert 1997). Dietary stress is one obvious factor in the collapse of societies, including some portions of the Classic Maya southern lowlands (e.g., Gill 2001), and it has been proposed as a mechanism for triggering increasing sociopolitical complexity associated with the formation of state institutions (Carneiro 1970). The result of our isotope work suggests that dietary stress was not a significant factor during the rise of the Mayapán state. Nor did it represent a major outcome of societal turmoil of the fourteenth and fifteenth centuries at Mayapán, although our post-1400 C.E. sample is currently small. These patterns are striking, given that some sources suggest periodic drought and food shortages in the region, and the city collapsed violently by 1461 C.E. (Masson and Peraza Lope 2014b). It is possible that dietary stress may have destabilized the Mayapán state and society in abrupt, periodic intervals that have yet to be detected in our sample. Overall, our work at Mayapán thus far demonstrates the complex linkages between food and war in ancient societies more generally. More specifically, these patterns attest to the resiliency of this political capital as a probable consequence of food production diversification, a thriving commercial economy and perhaps military strength that could protect the city's interests.

Acknowledgements We thank Amber VanDerwarker and Greg Wilson for inviting us to participate in this book project. Thanks also to Thomas Harper and Timothy Hare for graphical assistance and Julie Hoggarth for assistance with the references. This manuscript was improved with comments from the anonymous reviewers. Funding for this work was provided by the National Science Foundation (BCS-0940744; HSD-0827205 [Kennett]) and Penn State. Mayapán field research has been funded by the National Science Foundation (BCS-0109426, BCS-0742128, BCS-1406233 [Masson], BCS-1144511 [Hare]), NGS's Committee for Research and Exploration (to Masson and to Bradley W. Russell), and the Foundation for the Advancement of Mesoamerican Studies (Masson); Carlos Peraza Lope's INAH project has been funded by the government of the state of Yucatán, as well as CULTUR (Patronato de las Unidades de Servicios Culturales y Turísticos and SEDESOL (Secretaria de Desarollo Social).

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Chapter 10
Patterns of Violence and Diet Among Children During a Time of Imperial Decline and Climate Change in the Ancient Peruvian Andes

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The Late Intermediate Period (LIP, 1000–1400 C.E.) in the Peruvian Andes was characterized by dramatically different cultural and climatological contexts compared to the preceding Middle Horizon (600–1000/1100 C.E.) when the Wari empire exerted great influence over a vast region now known as Peru (Fig. 10.1). Given the dramatic differences between the two cultural eras, we examine how cultural and climatic conditions shaped human activities, particularly as they relate to violence against children, childhood diet, and residential mobility. Did the decline of Wari state infrastructure and the severe drought of the twelfth to fourteenth centuries contribute to poor morbidity among subadults, particularly as it related to violence-related trauma and changes in food access?

The Wari empire was the first expansive empire in South America, and it maintained a mosaic of control from the northern Andes of Peru, to the central Peruvian coast, to the Moquegua Valley in the far south (Schreiber 1992). After

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_10

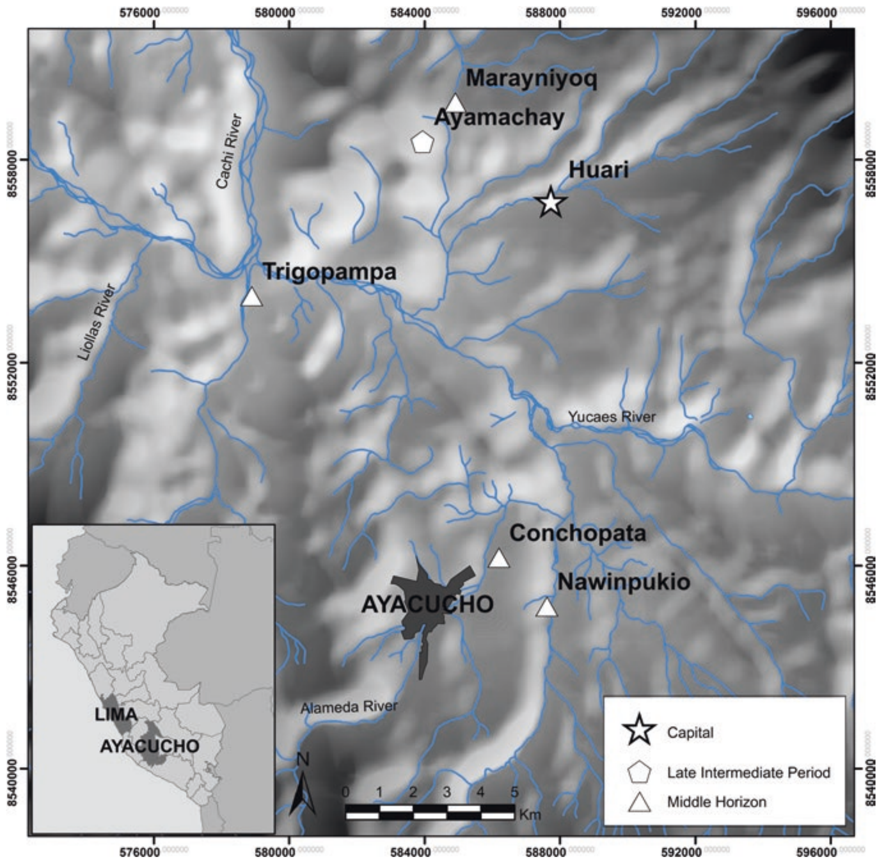

Fig. 10.1 Map of Peru showing the Wari-era (Middle Horizon) and post-Wari era (Late Intermediate Period) sites discussed in the text. Monqachayoq and Vegachayoq Moqo are sectors at Huari that have LIP skeletal remains (Map by Carla Hernandez, Spatial Analysis Research Laboratory, Department of Anthropology, Vanderbilt University)

four centuries of rule, the Wari empire "collapsed" for reasons that are still not fully understood, though it could be related to internal competition at the end of the Middle Horizon (Tung 2014) combined with a severe drought that may have began as early as 900 C.E. (Bird et al. 2011) and continued until about 1350 C.E. (Thompson et al. 1985, 2013).

While the factors that contributed to Wari decline are beyond the scope of this chapter, we can evaluate the impacts of Wari decline and the extended drought. Other studies have documented some of those effects, noting for example that the LIP was characterized by dramatic changes in material culture; polychrome ceramics and textiles greatly diminish in numbers, hinting at the loss, or at least the decline, of production infrastructure (Bauer et al. 2010; Covey 2008; Kurin 2012).

Social unrest and conflict were also on the rise, as evidenced by the increase in fortifications (Arkush 2008, 2010; Arkush and Tung 2013; Bauer et al. 2010; Conlee 2006; Covey 2008; Stanish 2003; Wernke 2011) and significant increases in cranial trauma, an excellent proxy for violent interactions (Andrushko and Torres 2011; Kurin 2012; Torres-Rouff and Costa Junqueira 2005; Tung 2008). While these studies have provided an important foundation for understanding LIP lifeways more generally, there is scant evidence documenting how this period of social unrest affected childhood violence and altered food access among children and their breastfeeding mothers. The stable isotope studies presented here provide direct evidence for certain aspects of food consumption, but they also provide indirect insights into food production and distribution, allowing us to investigate whether all segments of society had equal access to dietary resources. Variation in diet within a population may be a reflection of greater social inequities, gender-based differences in food access or food choice, and/or food taboos, among other possible explanations. These and related issues are examined through an analysis of skeletal samples that date primarily to the second half of the LIP (1200–1400 C.E.). In particular, the study of violence is achieved through an analysis of cranial trauma among children from post-Wari sites; dietary practices among children are examined through a study of carbon isotopes from dental apatite carbonates and of carbon and nitrogen isotopes from collagen in the dentin; residential mobility is explored through analysis of oxygen isotopes from the carbonates in the dental apatite.

10.1 Physical Violence, Structural Violence, and Warfare

Warfare entails violence, but evidence for violence does not mean that warfare occurred. Thus, a study of juvenile cranial trauma must attempt to discern the context in which children suffered physical trauma, whether it was intra-community violence (e.g., child abuse), ritual killings, or warfare. We define warfare as armed, physical conflict that is carried out collectively between opposing groups of people and in which the attack was planned by at least one of the parties; war is not a random outbreak of violence as seen with riots or brawls (Kelly 2000). The attacks usually entail lethal intent, though captives may also be taken alive and incorporated into communities as slaves, servants, wives, adopted children, or community members, or the captives may be ritually killed at a later time (Tung 2012). Although young children rarely, if ever, engage in warfare as trained, active participants, they can be victims of war (for a discussion of child soldiers forced into warfare, see Betancourt et al. 2011; Derluyn et al. 2004). In the pre-Hispanic Andes, violence-related trauma against children is rare, though more recent studies are showing that juveniles do suffer serious physical trauma and death, particularly in ritual contexts that may follow after warfare (Klaus 2010; Toyne 2011; Tung and Knudson 2010; Turner et al. 2013).

A study of violence against children—in conjunction with other data—permits a more complete evaluation of whether warfare occurred, how lethal it was, and who the primary (or incidental) victims may have been. Further, because warfare is also a part of, and contributor to, structural violence, we can more deeply examine how other aspects of morbidity—diet and malnutrition, for example—are shaped by war. Structural violence is a systematic application of violence or harm, in its various manifestations, that affects a particular subgroup, either structured by class, age, gender, ethnicity, sexual orientation, or some other social identity marker (Farmer 1996; Galtung 1969). In one regard, who goes to war is often determined by one's association with a particular social grouping and can thus be seen as a form of structural violence leading to particular individuals experiencing a higher likelihood for trauma and death. Another less obvious example of structural violence is how malnutrition among a marked subgroup (e.g., rural commoners, children, or women) may result from chronic intergroup violence. The systematic, unequal access to foods could result from a pointed political decision to redistribute foods in a particular way or from long-standing and unquestioned social inequalities that indirectly lead to certain subgroups having less access to nutritious calories. A volume on food and warfare explicitly acknowledges the strong linkages between conflict and how it can contribute to, or be caused by, insufficient or unequal access to dietary resources. The intellectual unification of food and warfare also implicitly acknowledges that structural violence involves direct physical violence as well as more subtle—though substantial—forms of violence that can have devastating effects on one's health and well-being, and whether a person lives or dies.

10.2 Bioarchaeological Studies of Childhood

The focus on childhood morbidity not only addresses the more subtle effects of warfare and structural violence (Korbin 2003), but it also provides a more textured understanding of past societies, particularly when we consider how important the juvenile years are for socializing members into society. It is a "training ground… for when skills and belief systems are learned, personalities formed, and attitudes and values inculcated" (Kamp 2001, p. 2). The invisibility of the child in archaeological studies may have resulted from notions that they are unimportant, or because they (and their activities) seem too intangible (Kamp 2001). However, with advances in isotopic studies, many aspects of childhood can be reconstructed even when there are no child skeletons to analyze; the dentition provides a retrospective view of childhood health, diet, water consumption, timing of weaning, and childhood residence. Thus, the focus on children in this study can provide a much needed view of how dramatic social and environmental changes in the Andes particularly impacted the youngest members of society, which, in broader comparison with adult men and women, allows detection of the differential impact—or homogeneous effect—of a long-term drought. For example, Sultana (2014) has argued that modern climate change in South Asia and the concomitant increase in climate instability (e.g., floods, tsunamis, and water scarcity) have been much more harmful to women's health and well-being. This finding implies that children also particularly suffer during these periods of climate stress and unpredictability in food production (see below for further discussion). Whether or not this was the case in the ancient Andes is an important question to explore, because not only do the skeletal and isotopic analyses reveal the actual health status of juveniles, but these data also provide insight into how children were integrated into post-Wari society and whether they may have been buffered against the potentially negative effects of climate stress.

10.3 Climate Stress, Violence, and Diet

There have been a number of important archaeological studies on climate stress and its impact on cultural practices (Benson et al. 2009; Binford et al. 1997; deMenocal 2001; Dillehay and Kolata 2004; Erickson 1999; Kolata et al. 2000; Shimada et al. 1991; Zhang et al. 2007), and recent bioarchaeology studies have also been exploring how climate stress can affect morphology, development, health, and violence (Billman et al. 2000; Harrod and Martin 2014; Lambert 2002; Schug 2011). And while this study examines how a severe drought correlates with rates of violence and childhood diet, we also critically examine the oft-cited causal relationship between environmental stress, resource competition, and war (Carneiro 1970). That is, because we often view malnutrition, illness, and trauma as an inevitable component of a poor natural environment, we often overlook how these health outcomes can also result from social relations (Goodman and Leatherman 2003) and human decisions about how to manage and transform the natural environment (Fisher 2005). While climate stress can contribute to serious deleterious effects on human health and livelihood, these effects are mediated through historical precedence, political decision-making, social networks, and social norms that may dictate or encourage certain behaviors. For example, the rise of Wari ca. 600 C.E. coincided with a drought, and this environmental crisis provided a context for Wari leaders to develop and enhance agricultural infrastructure, essentially cementing their authority (Williams 2002). Clearly, some mechanisms may mitigate the deleterious effects of climate stress, whether it be the construction of new irrigation canals (Schreiber and Lancho Rojas 2003), the development of raised field agriculture to reclaim waterlogged land in the aftermath of an El Niño event (Moore 1991), or the construction of levees intended to protect habitation areas from floods. Conversely, climate stress and ineffective responses may lead to crop failure and severe food shortages, in which choices about food distribution become paramount; will dietary resources be equitably distributed, or will some groups, whether structured by age, gender, or social class, have less access to certain foods? These decisions then have downstream effects on growth and development, fertility, and ability to fight infection or heal from injury, among others.

Studies of modern climate change have also shown the unequal ways that distinct segments of a population respond to and are affected by it, revealing the gendered and class-based outcomes. For example, dependence on natural resources and divisions of labor are often structured by gender, and an extended drought can thus variably affect men and women. In South Asia, for example, females are disproportionately negatively affected by drought (e.g., displacement and thus a loss of social networks, physical and sexual violence, extended workload fetching water, and preferential saving of boys over girls), particularly in agrarian societies where the most productive tasks are water-related (Sultana 2014). Thus, our study recognizes the profound ways that environmental stress can negatively impact community health, while also acknowledging that social relations shape a large part of those health outcomes. That is, not all aspects of health and diet can be explained by rain shortfalls. The absence of Wari state infrastructure and the likely tensions that emerged when new social and political power structures were being forged also could have shaped community lifeways and morbidity patterns in the LIP. Moreover, changes in sociopolitical structures also could have affected how LIP populations reacted to the ongoing drought, showing that political structures, decision-making processes, and other non-ecological factors structured the community health profiles of LIP peoples.

10.4 The Late Intermediate Period Sites

The former capital city of the Wari empire—the site of Huari—was reoccupied, or at least reused for burials, in the LIP. Two sectors in particular were used to deposit those LIP bodies: Monqachayoq and Vegachayoq Moqo (Fig. 10.2). At Monqachayoq during the Wari era, the highest elite stratum, perhaps even a royal class, was buried deep within the stone-lined tombs of this sector (Solano Ramos and Guerrero Anaya 1981), but only small bone fragments from that Wari-era burial group remain, owing in large part to the intense looting in colonial and modern times. In one of the side stone-lined galleries to the north of the royal tombs, archaeologists working there in the 1970s uncovered thousands of complete human bones (Solano Ramos and Guerrero Anaya 1981), representing approximately 130 individuals. Those remains were commingled, so complete skeletal individuals could not be reconstructed, but bone preservation was excellent allowing clear observations for trauma. Radiocarbon dates from those Monqachayoq remains show that they correspond to the LIP and that they suffered high rates of cranial trauma: Antemortem trauma affected 71 % of adults and perimortem trauma affected 42 % of adults ($N = 31$) and 30 % of children ($N = 10$) (Tung 2008). The cranial trauma rates from the new skeletal samples (discussed below) are compared to this previously studied sample, and new isotope data from LIP Monqachayoq dentition are presented.

At the Vegachayoq Moqo sector, 150 m north of Monqachayoq, elites from the Wari era were buried in niches within a long stone wall that surrounded a ritual D-shaped structure (see Fig. 10.2), and those too were looted in colonial and modern times. On the other side of that niched wall, however, archaeologists excavating

Fig. 10.2 The Monqachayoq and Vegachayoq sectors at Huari. *Top photograph* Monqachayoq. *Middle and bottom photographs* Different views of Vegachayoq Moqo

in the 1980s uncovered thousands of commingled human remains from over 100 individuals (Bragayrac 1991). Cut marks on approximately 80 % of the long bones suggest that the bodies had been dismembered; the body parts were then thrown in a large, long trench that ran the length of the stone wall. Radiocarbon dates from the bones indicate that they also date to the LIP (see below).

In the hills to the north/northwest of Huari, there are cave sites (*machays*) visible from the northern end of the site. These caves are approximately 3.3 linear km from Vegachayoq Moqo, and two of the *machays* had LIP human burials. The two sites—Ayamachay and Rosamachay—were excavated by Richard MacNeish and colleagues in 1969, and they uncovered a total of ten partially complete burials (three from Ayamachay and seven from Rosamachay); ceramic associations and analyses of stratigraphic levels led these researchers to suggest that the interments date to the LIP (Veierra and MacNeish 1981). A new AMS date confirms this temporal association (see below). In the archaeology laboratory at the local university in Ayacucho, we relocated seven of the individuals from the caves that MacNeish and colleagues excavated.

All of the human remains from these sites and sectors were stored in the Archaeology Laboratory at the Universidad de San Cristobal de Huamanga (UNSCH) and at the Ministry of Culture in Ayacucho. The human remains from Huari were relocated in 2007 and the remains from the cave sites were found at UNSCH in 2010. Analysis is ongoing, and here we present the trauma data on child crania from the cave sites and carbon and oxygen isotope ratios from the hydroxyapatite from deciduous (juvenile) and permanent (adult) teeth from the caves and from the LIP-Huari sectors (Vegachayoq Moqo and Monqachayoq). The stable isotope data from deciduous teeth provide a retrospective view of diet in early infancy (when those teeth were forming), while permanent dentition provides a retrospective view of later infancy and early/late childhood diet (depending on which tooth is sampled). These data on juvenile diet are complementary to the data on child cranial trauma, providing a more textured view of children's lifeways during a time after imperial decline and an ongoing severe drought.

10.5 Background on Stable Isotope Analyses

Archaeologists use biogeochemical methods to shed light on ancient diets, food distribution practices, and resource production. Stable isotopic studies devoted to paleodietary reconstructions in the Andes have investigated a range of issues including food acquisition activities (Webb et al. 2013a), seasonality in death and food storage (Williams and Katzenberg 2012), economic and resource exchange practices (Coutts et al. 2011; Slovak and Paytan 2011; Tomczak 2003), labor networks (Turner et al. 2010), dietary profiles of sacrificial victims (Turner et al. 2013), and most predominately, maize consumption and cultivation (Burger and van der Merwe 1990; Cadwallader et al. 2012; Finucane 2009; Finucane et al. 2006; Hastorf and Johannessen 1994; Kellner and Schoeninger 2008; Knudson et al. 2007; Lambert et al. 2012). In this study, we use stable isotope analyses to understand changes in foodways during a time of sociopolitical decline and climate change.

Stable isotope analyses provide insights into ancient subsistence practices because the isotopic signature in human bone and teeth reflects the signature of consumed food (Price et al. 2002; Schwarcz 1991; Schwarcz and Schoeninger 1991). Carbon is present in teeth in the carbonate portion of enamel and the organic component of dentin collagen (Price and Burton 2011). In the same individual, the ratios of stable carbon isotopes in the carbonate and the collagen can vary (Price and Burton 2011). Carbon isotope values are influenced by the type of plants consumed as well as marine and terrestrial fauna eaten. Importantly, $\delta^{13}C$ values allow distinctions between the proportions of plants consumed using primarily a C_3 or C_4 photosynthetic pathway (Tieszen and Chapman 1992). The only C_4 plants ancient Andeans consumed were amaranth (*Amaranthus caudatus*) and maize (*Zea mays*), and most Andean research has focused on the consumption of maize, a socially valued crop that was commonly used in feasts and rituals, and that formed an important part of reciprocal exchange networks; C_3 plant foods in the Andes include a variety of tubers, quinoa (*Chenopodium quinoa*), and peppers (*Capsicum* spp.), among others (Turner et al. 2010). Based on the controlled feeding studies of rodents, researchers determined that carbon isotope ratios from the mineral portion of enamel apatite $\delta^{13}C$ ($\delta^{13}C_{ap}$), represent isotopic composition of the entire diet (Ambrose and Norr 1993; Kellner and Schoeninger 2007). Carbon isotope ratios from collagen ($\delta^{13}C_{col}$) in dentin and bone denote the portion of carbon in dietary protein consumed (Ambrose 1993; Ambrose and Norr 1993).

Nitrogen isotope ratios ($\delta^{15}N$) from collagen in dentin and bone can detect the sources of dietary protein (e.g., terrestrial meat vs. freshwater fish) and the trophic-level effects of protein intake (Ambrose and Norr 1993; Schoeninger et al. 1983). Climate can also alter nitrogen isotope values, particularly in arid environments, when nitrogen isotope ratios can rise (Ambrose 1991; Ambrose and DeNiro 1987). When carbon isotope values are analyzed in conjunction with nitrogen isotope values, we can better distinguish between the consumption of marine and terrestrial foods. In humans, nitrogen isotope values are heavily influenced by the trophic level of the consumed organism and the importance of leguminous plants in the diet (Ambrose et al. 1997; Ambrose and Norr 1993; Lee-Thorp et al. 1989). Through trophic webs, nitrogen enrichment occurs in a step-like manner of 3 ‰ between food source and consumer (Schoeninger and DeNiro 1984). As a result, breastfeeding can also affect nitrogen enrichment, making the $\delta^{15}N$ in breastfeeding infants higher than the mother (Fogel et al. 1989). Thus, dentin in teeth that form during the breastfeeding years tends to be more enriched in nitrogen (higher values) than the teeth that formed after weaning (Wright and Schwarcz 1999). This is because the isotopic composition of dentin is not greatly altered throughout life, though the secondary dentin near the pulp chamber undergoes change (Wright and Schwarcz 1999, p. 1160).

In addition to dietary and weaning practices, stable isotope analyses can help archaeologists assess prehistoric migration and climatic events. Recently, in the Andes, oxygen isotope analyses ($\delta^{18}O$) have been used to interpret weaning practices, document potential water sources, and reconstruct patterns of population movement (Andrushko et al. 2011; Buzon et al. 2011; Hewitt 2013; Knudson 2009; Knudson and Price 2007; Toyne et al. 2014; Turner et al. 2009; Webb 2010; Webb et al. 2013b). Oxygen isotope analyses can also assist in paleoclimatic reconstructions and act as a proxy for local surface temperature (Fricke et al. 1995). These types of analyses work because the oxygen isotope composition in enamel reflects the signatures of ingested meteoric water (Longinelli 1984; Luz et al. 1984). Oxygen isotope signatures vary depending on a host of factors including climate, altitude, latitude, precipitation, proximity to the coast, water storage and preparation practices, and breastfeeding (Dansgaard 1964; Koch 1998; Roberts et al. 1988; Wilson et al. 2007; Wright and Schwarcz 1998). We use oxygen isotope values from enamel carbonate to interpret geographic residence during infancy and early childhood when enamel formation occurred, and we interpret these results in light of large-scale climatic changes that occurred in the LIP. By using a multi-isotopic approach, we address shifts in diet and migration at a time of significant political, social, and environmental change.

10.6 Materials and Methods

10.6.1 Cranial Trauma

Skeletal trauma plays an important role in assessing claims of ancient warfare and violence; cranial trauma, in particular, is an excellent proxy for violent conflict and likely does not reflect accidental injuries (Lovell 1997; Walker 1997, 2001). In this study, we report cranial trauma frequencies for eight juveniles: Huari-Vegachayoq Moqo (six juveniles) and the cave sites of Ayamachay and Rosamachay (two juveniles). These data are then compared to and combined with cranial trauma data from ten LIP children from the Monqachayoq sector at Huari (Tung 2008). All LIP child crania were compared to trauma frequencies from children at Middle Horizon Wari sites in the heartland to determine whether there was a significant difference in violence toward juveniles through time.

For crania that were more than half complete, we recorded age-at-death, type of trauma (antemortem and perimortem), and wound location according to established protocols (Buikstra and Ubelaker 1994). As with most juvenile skeletal remains, sex could not be determined because sexually dimorphic skeletal traits had not yet developed in these prepubescent individuals. Among the adults from whom dental samples were selected for a retrospective view of childhood diet, sex was estimated based on cranial characteristics. The main diagnostic criteria for distinguishing antemortem from perimortem injuries require identifying new bone formation and reactions stemming from wound healing and repair (Galloway 1999b; Ortner 2003). Perimortem fractures do not show any evidence of new bone growth (Berryman and Jones Haun 1996; Merbs 1989), and they often have concentric and radiating lines emanating from the impact point (Sauer 1998). Additional characteristics used to distinguish perimortem trauma from postmortem breakage included assessing color and shape of the fracture margin (beveled vs. smooth edges, respectively) and the presence of adhering (or “hinging”) bone along the fracture margin (Galloway 1999a). We examined wound shapes to distinguish blunt force trauma from sharp force trauma. Blows from blunt objects, such as stones, can leave diagnostic depression fractures that are typically round or oval (Walker 2001), while projectile or sharp force trauma tend to leave healed linear fractures or embedded points (Lambert 1997).

10.6.2 Stable Isotope Analyses

Stable carbon and oxygen isotope analysis was conducted on 26 dental apatite samples representing 25 individuals from Vegachayoq Moqo ($n = 20$) and the *machays* ($n = 6$), and dentin from six individuals from the *machays* was examined for stable carbon and nitrogen isotope ratios.

10.6.2.1 Carbon and Nitrogen Isotope Analyses from Dentin Collagen

The six Ayamachay/Rosamachay individuals were opportunistically sampled such that loose teeth were preferentially chosen for isotopic analysis.[1] Consequently, three samples are first molars, two samples are second molars, and one sample is a deciduous incisor. Dentin from teeth was sampled in two places: the

[1]Tooth dentin samples were cleaned and ground to a fine powder using a Foredom handheld motor tool on low speed. All powdered samples had 0.5 N HCl applied and then refrigerated at 9 °C for 24 h. The acid was removed, samples were rinsed five times in pure water, and a solution of 0.1 N NaOH was applied to each sample for 20 h to remove humic contaminants and lipids. After another five water rinses, samples were freeze-dried before isotopic analysis. The result of this method produces a collagen pseudomorph containing mostly collagen but potentially also retaining small amounts of other biological proteins, such as osteocalcin. Steps were taken to ensure that collagen samples included in this study were not compromised due to diagenesis or contamination. Percent collagen yield, percent carbon and nitrogen, and atomic C/N ratios are all reported. Collagen yield for samples ranged from 7 to 50 % (with tooth samples typically having smaller collagen yields than bone samples, potentially related to sample size and loss with chemical preparation steps). C:N ratios are commonly used to assess collagen preservation, with values between 2.9 and 3.6 accepted as “good” samples (DeNiro 1985). All dentin samples have C:N values within this range. Collagen samples were analyzed at the Center for Stable Isotope Biogeochemistry (CSIB) in the Department of Integrative Biology at the University of California, Berkeley. Samples were analyzed using a CHNOS Elemental Analyzer (varioIsotope cube, Elementar, Germany) coupled with an IsoPrime Isotope Ratio Mass Spectrometer (IsoPrime, UK). Internal standards including NIST SRM 1547 peach leaves and NIST SRM 1577c bovine liver, MJM1 dentin, and ABS 180 bone were also analyzed.

cemento-enamel junction (CEJ) and the root tip. Sampling in these two areas of the tooth captures dietary information recorded during different periods of tooth development, and both values are reported below. However, because these post-Wari samples are compared to previously published Wari samples, which sampled from only one part of the dentin (Finucane 2009; Finucane et al. 2006), we calculated the average from the crown and root from the Ayamachay/Rosmachay samples and compared that average value to the Wari-era dentin. Dentin collagen samples were prepared following standardized protocols (Sealy et al. 1995; Waters-Rist et al. 2011).

10.6.2.2 Carbon and Oxygen Isotope Analyses from Enamel Apatite

Apatite carbonate samples were extracted from the teeth from the burials in the *machays* (cave sites) following a standardized protocol[2] (Koch et al. 1997). The Vegachayoq Moqo and Monqachayoq apatite carbonate samples were processed at the Vanderbilt Isotope Laboratory in the Department of Earth and Environmental Sciences, following protocol by Koch et al. (1997) and DeSantis et al. (2009).[3]

All stable isotope data were normalized to NBS-19 and are reported in conventional delta (δ) notation for carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$), where $\delta^{13}C$ (parts per mil, ‰) = ((Rsample/Rstandard) − 1) * 1000, and R = $^{13}C/^{12}C$; and, $\delta^{18}O$ (parts per mil, ‰) = ((Rsample/Rstandard) − 1) * 1000, and R = $^{18}O/^{16}O$; and the standard is VPDB (Pee Dee Belemnite, Vienna Convention) (Coplen 1994). All oxygen isotope values initially analyzed and reported in reference to VPDB were converted to VSMOW by using the following equation, $\delta_{SMOW} = 1.03091\ \delta_{PDB} + 30.91$ (Coplen 1994).

[2]Powdered samples had a solution of 2–3 % NaOCl (bleach) added to each. Samples were periodically agitated and after 24 h, the bleach solution was removed and samples were rinsed five times with pure water. A solution of 1 M acetic acid buffered with calcium-acetate was added to each sample for 12 h. The acid solution was removed and samples were rinsed five times in pure water. Carbonate samples were freeze-dried and then analyzed on a GV IsoPrime mass spectrometer with Dual-Inlet and MultiCarb systems in the Laboratory for Environmental and Sedimentary Isotope Geochemistry (LESIG) at the Department of Earth and Planetary Science, University of California, Berkeley. Replicates of an international standard, NBS19, and internal laboratory standards were measured in addition to samples for each run. Samples are compared to the VPDB standard for both $\delta^{13}C$ and $\delta^{18}O$. The external analytical precision is reported as ±0.04 ‰ for $\delta^{13}C$ and ±0.07 ‰ for $\delta^{18}O$.

[3]Teeth were drilled perpendicular to the growth axis with a low-speed dental-style drill and carbide dental burrs. Following standardized protocols (DeSantis et al. 2009; Koch et al. 1997), approximately 2–3 mg of enamel powder soaked in 30 % hydrogen peroxide for a minimum of 24 h to ensure all organics were removed. Enamel powder was subsequently rinsed in pure water three times. Acetic acid (0.1 N) was then added to the samples, and they soaked for exactly 18 h, after which samples were rinsed with pure water an additional three times before left to dry in desiccators. Approximately 1 mg sample from the carbonate portion of tooth enamel hydroxyapatite was run on a Finnigan Delta Plus XP mass spectrometer at the Stable Isotope Facility at the University of Wyoming for carbon and oxygen.

Normality tests were performed on all sets of isotopic data. When isotopic data were normally distributed, Student's t-tests were used to compare between sites and periods. Non-normally distributed data were compared using Mann-Whitney tests when making comparisons between two sites. All statistics were run using XLStat and/or IBM-SPSS 22.

10.7 Results

10.7.1 Radiocarbon Dates

Four AMS dates from the Monqachayoq sector at Huari were previously published, and they show that those human remains date to the LIP: ca. 1300 C.E. (Tung 2008) (Table 10.1). Additional radiocarbon dates from crania and a maize

Table 10.1 Radiocarbon dates from Monqachayoq and Vegachayoq Moqo sectors at Huari and Ayamachay

Laboratory code	Bone code	^{14}C age (years BP)	Sigma	Range (CE)	Relative prob.	Range (CE)	Relative prob.
Beta-229247	MC-Cran44	940 ± 40	1	1048–1083	0.314	1140–1208	0.686
Beta-229247	MC-Cran44		2	1038–1216	1		
Beta-229245	MC-Rad-AY	780 ± 40	1	1229–1251	0.32	1260–1294	0.68
Beta-229245	MC-Rad-AY		2	1217–1313	0.92	1358–1380	0.08
Beta-229246	MC-Cran43	600 ± 40	1	1324–1344	0.29	1389–1422	0.71
Beta-229246	MC-Cran43		2	1312–1359	0.35	1379–1441	0.65
Beta-229244	MC-RibII-2-5	560 ± 40	1	1402–1436	1		
Beta-229244	MC-RibII-2-5		2	1324–1343	0.06	1389–1451	0.94
Beta-229249	VM-Cran17	650 ± 40	1	1313–1358	0.73	1380–1398	0.28
Beta-229249	VM-Cran17		2	1296–1407	1		
Beta-229250	VM-Cran56	580 ± 40	1	1393–1434	1		
Beta-229250	VM-Cran56		2	1319–1351	0.18	1385–1446	0.82
Beta-229252	VM-Maize	790 ± 40	1	1229–1252	0.4	1259–1288	0.6
Beta-229252	VM-Maize		2	1212–1308	0.96	1361–1378	0.04
120942	Machay Thread	925 ± 15	1	1155–1190	1		
120942	Machay Thread		2	1069–1076	0.019	1148–1214	0.981

All samples calibrated Calib 7.0 and showing calibration at both 1 and 2 sigma with relative probabilities. Southern hemisphere correction was applied (SHcal 13)

Beta= Beta Analytic. Ayamachay samples processed at Earth System Science Department at UC-Irvine

Monqachayoq (MC) samples originally published in Tung (2008), but recalibrated here with Calib 7.0

fragment at Vegachayoq Moqo, as well as an AMS date from Ayamachay, confirm that temporal association, though the textile thread from Ayamachay is slightly earlier: ca. 1200 C.E. (see Table 10.1 for details).

10.7.1.1 Child Cranial Trauma

None of the eight juveniles (two at the *machays* and six at Vegachayoq Moqo) exhibit antemortem cranial trauma. The total absence of antemortem trauma is consistent with the preceding Wari era when none of the 39 children exhibited healed head wounds (Tung 2012). This finding suggests that children in both eras were not victims of child abuse, nor were they engaged in physically risky activities in which they could suffer sub-lethal head injuries.

In contrast, lethal (perimortem) trauma was very common during the LIP. Two-thirds of the children (4/6 = 66 %) from Vegachayoq Moqo exhibit perimortem cranial fractures (one of which is a possible perimortem fracture) (Figs. 10.3 and 10.4); none of the children from the *machays* have perimortem cranial trauma (but see the description of trepanation below). This combined LIP frequency (4/8 = 50 %) of perimortem trauma is significantly greater than the earlier Wari era, when none of the Wari-era juveniles ($N = 39$) exhibit perimortem head wounds (Fisher's exact, $p = 0.0004$; $N = 47$). This significantly higher frequency of perimortem cranial fractures among LIP children suggests a dramatic change in how children were treated in post-Wari society. And although there is no significant difference in the perimortem trauma rate between Vegachayoq Moqo and the *machays* (likely owing to small sample size), 66 versus 0 % is quite remarkable and hints at starkly different childhoods between children who lived at the former urban center versus those inhabiting more rural settlements.

Among the three (possibly four) children with perimortem cranial trauma, there are a total of six (possibly seven) cranial fractures, and all of them appear to be from blunt force trauma; there are no sharp force traumas or embedded points. Cranium 20 has three head wounds, Cranium 3 has two head wounds, and Crania 6(?) and 68 have one cranial fracture each. The locations of the perimortem wounds are remarkably similar: There are four fractures on the posterior of the head and three fractures on the left lateral side (see Fig. 10.3). This posterior and left-side patterning might suggest a standardized way of killing children during the LIP. For example, a blow from a right-handed attacker facing the child would result in these kinds of left-side injuries; a strike against a child who is ducking his head, fleeing an attack, or in a prone position could result in posterior head wounds. More specifically, among the four posterior cranial fractures, it appears that two of them were sustained while the child had a slightly bowed head. That is, two fractures are on the inferior portion of the cranium's posterior, thus bowing (or ducking) the head would expose this part of the skull. These wounds are nearly identical to the basal ring fractures observed among victims of the Khmer Rouge in Cambodia, in which attackers systematically hit the back of the victim's head while they were kneeling, heads bowed, and hands tied behind their backs (Ta'ala et al. 2006).

Fig. 10.3 *Top row*, Cranium 20: Perimortem trauma on the left side (*left photograph*) and two perimortem fractures on the posterior (*right photograph*). *Bottom row* Cranium 68: perimortem trauma on the left side (*bottom left photograph* is posterior view, *bottom right photograph* is posterior-lateral view). Both are from the LIP component at the Vegachayoq Moqo sector at Huari

10.7.2 Trepanation

In addition to cranial trauma, trepanation, a practice often related to head injuries in the Andes (Andrushko and Verano 2008; Kurin 2013), was observed on one child cranium from the cave site, Ayamachay. This individual, aged 7–8 years at the time of death, exhibited an oval-shaped trepanation on the posterior portion of the skull; there were cut marks surrounding the aperture. The cut marks are consistent with a circular cutting or grooving technique, and they indicate that there was removal of soft tissue during trepanning. There was no evidence for bone healing or remodeling at the margins—an observation that suggests the individual likely died during or shortly after the surgical procedure. Given that two-thirds

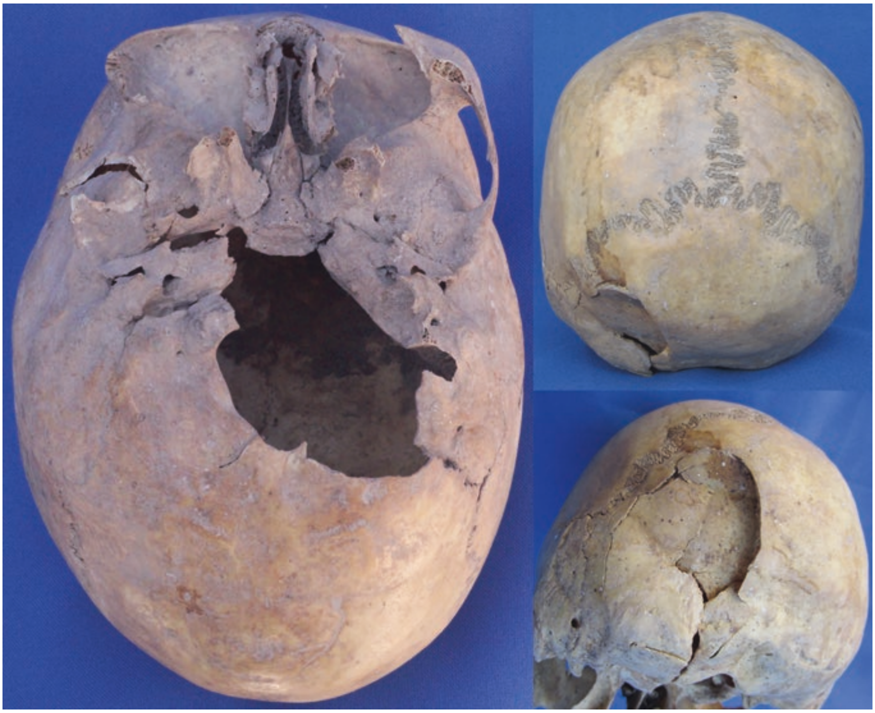

Fig. 10.4 *Left photograph* Cranium 6: possible perimortem trauma on the inferior, basal portion of the child's cranium. *Right photographs* Cranium 3: perimortem trauma on the left posterior of a child's cranium. Both are from the LIP component at the Vegachayoq Moqo sector at Huari

of the children from Vegachayoq Moqo exhibit perimortem cranial trauma, it is possible that this trepanned child suffered a head injury too, and the surgical procedure was an (unsuccessful) attempt to treat the injury. If there was a cranial fracture, the trepanation completely removed it, obscuring our ability to evaluate whether there was a fracture at that location. Nonetheless, given the lack of visible trauma, we must also consider reasons aside from cranial injuries that may have led to the trepanning, such the desire to ease symptoms of mastoiditis or epilepsy (Andrushko and Verano 2008).

There may be evidence of cranioplasty on this trepanned child cranium. A piece of bottle gourd (*Lagenaria siceraria*) rind (9.78 cm × 5.27 cm) was found inside the cranium, and the gourd's external surface had five holes near the edge, and two of those holes had thread remnants in them. Those two thread-filled holes correspond to two small, darkened areas located on the posterior right parietal near the trepanation hole. When the holes from the gourd are aligned with the spots on the skull, the gourd covers the trepanation almost entirely (Fig. 10.5). The presence of the gourd rind suggests that this may be an attempt at cranioplasty—a procedure performed to repair a defect of the skull. Ethnographic (Bandelier 1904) and archaeological evidence (Kurin 2013) for the practice is scarce; however, the

Fig. 10.5 Trepanation and the gourd piece that may be evidence of cranioplasty on the juvenile from one of the *machays*

few examples that do exist depict metal plaques, gourd rinds, or excised bones as the preferred materials to place over the hole and protect the brain (Verano and Andrushko 2010). It is also possible that the gourd piece was added after death as part of the process of preparing the child for burial, so that the body would be made whole.

10.7.3 Stable Isotope Analysis to Reconstruct Childhood Diets

10.7.3.1 Carbon Isotope Ratios

Stable carbon isotope analysis of dental apatite carbonate from a subsample of individuals from Monqachayoq, Vegachayoq Moqo, and the cave sites was done to evaluate whether certain aspects of diet—maize consumption in particular—were significantly different in the Wari versus post-Wari eras. The dental enamel that was sampled formed during different periods of childhood, so the first set of values presented are from all dental samples, while the subsequent reporting divides them up by different juvenile periods. Among all 26 dental carbonate samples from 25 post-Wari individuals (Huari and the cave sites), the $\delta^{13}C$ ranges from -12.57 to -2.29 and the mean $\delta^{13}C = -6.1028$ (s.d. = 2.664) (Table 10.2, Fig. 10.6). Previous studies of 25 Wari-era dental samples show a range of -6 to -1.2 and the mean $\delta^{13}C = -3.716$ (s.d = 0.996) (Finucane 2009; Finucane et al. 2006) (see Table 10.2, Fig. 10.6). The Wari-era carbon isotope ratios are significantly higher than the post-Wari values ($t = 4.2$; $p < 0.0001$, 2-tailed), indicating a significant shift in childhood diet from the MH to the LIP.[4]

Breastfeeding babies can have quite distinct stable isotope values relative to older children, owing to either the trophic-level effect of breastfeeding infants or to a dramatic shift in diet as they start to consume solid foods. Thus, we report the range and means for teeth that formed during infancy/early childhood (IEC), when the individual was likely breastfeeding, and we report values for the middle childhood/adolescent (MC/AD) forming teeth, which likely pertain to post-weaning years. Among the post-Wari IEC teeth, the $\delta^{13}C$ range is -3.87 to -9.79 and the mean $\delta^{13}C = -6.12$ ($N = 11$), and among the MC/AD teeth, the $\delta^{13}C$ range is -2.29 to -12.57 and the mean $\delta^{13}C = -6.0936$ (s.d. = 3.287; $N = 14$).

Comparisons between Wari and post-Wari samples show that each juvenile phase (IEC and MC/AD) has significantly different $\delta^{13}C$ values. Wari-era IEC teeth (mean $\delta^{13}C = -3.81$; $N = 12$) (Finucane 2009; Finucane et al. 2006) show significantly higher values than post-Wari IEC teeth (mean $\delta^{13}C = -6.12$; $N = 11$) ($t = 3.76$, $p = 0.0012$), suggesting that breastfeeding mothers (and young children in the process of weaning) in the Wari era had greater access to carbon-enriched foods.

The Wari-era MC/AD teeth (mean $\delta^{13}C = -3.631$; s.d. = 0.828; $N = 13$) (Finucane 2009; Finucane et al. 2006) versus post-Wari MC/AD teeth (mean $\delta^{13}C = -6.0936$; $N = 14$) show that the Wari-era children had significantly higher $\delta^{13}C$ values ($t = 2.71$; $p = 0.0161$). This suggests that after weaning, the Wari-era

[4]When just the *machays* are compared to Wari samples, the difference is significant ($t = 3.68$, $p = 0.014$), and when just Huari-LIP samples are compared to Wari samples, the difference is also significant ($t = 3.05$, $p = 0.006$).

Table 10.2 The carbon, nitrogen, and oxygen isotope ratios from the samples discussed in the text

Site	Sample	Element	Age Cat. for tooth	Tooth location	d 15N (air) dentine coll	d 13C (vpdb) dentine coll	C/N (atomic)	d13C (vpdb) enam apat	d18O (SMOW) enam apat	d18O (vpdb) enam apat
Machay	Cran 1	URM2	MC	Crown/CEJ	10.1	−18.6	3.1	−12.2	27.86	−3.0
Machay	Cran 1	URM2	MC	Root	9.1	−17.7	3.1			
Machay	Cran 2	ULM2	MC	Crown/CEJ	11.6	−14.4	3.1	−6.7	21.87	−8.8
Machay	Cran 2	ULM2	MC	Root	11.3	−12.7	3.1			
Machay	Cran 3	ULM2	MC	Crown/CEJ	9.4	−18.2	3.0	−10.4	22.34	−8.3
Machay	Cran 3	ULM2	MC	Root	9.8	−16.8	3.2			
Machay	Cran 4	ULdec. i1	I	Crown/CEJ	11.5	−13.2	3.1	−7.8	20.83	−9.8
Machay	Cran 4	ULdec. i1	I	Root	10.1	−15.3	3.1			
Machay	Cran 5	ULM1	IEC	Crown/CEJ	12.4	−12.8	3.2	−5.8	22.44	−8.2
Machay	Cran 5	ULM1	IEC	Root	11.7	−11.2	3.0			
Machay	Cran 6	URM1	IEC	Crown/CEJ	12.2	−13.0	3.2	−5.2	21.93	−8.7
Machay	Cran 6	URM1	IEC	Root	11.9	−12.2	3.2			
Huari Monq.	21.01	LRI1	IEC	Mid-crown				−4.4	22.1	−8.5
Huari Monq.	Cran 50	URM1	IEC	Mid-crown				−3.9	21.7	−9.0
Huari Monq.	Cran 30	URM1	IEC	Mid-crown				−5.8	21.7	−9.0
Huari Monq.	Cran 08	ULM1	IEC	Mid-crown				−7.9	22.1	−8.6
Huari Monq.	Cran 23	URM2	MC	Mid-crown				−5.2	21.2	−9.4
Huari Monq.	Cran 15	ULM2	MC	Mid-crown				−4.3	22.3	−8.3
Huari Monq.	Cran 02	ULM2	MC	Mid-crown				−4.6	22.1	−8.6
Huari Monq.	Cran 51	URM1	IEC	Mid-crown				−6.2	21.7	−9.0
Huari Monq.	Cran 69	ULM3	AD	Mid-crown				−2.7	21.6	−9.1
Huari Monq.	Cran 70	URM1	IEC	Mid-crown				−4.9	21.8	−8.8

(continued)

Table 10.2 (continued)

Site	Sample	Element	Age Cat. for tooth	Tooth location	d 15N (air) dentine coll	d 13C (vpdb) dentine coll	C/N (atomic)	d13C (vpdb) enam apat	d18O (SMOW) enam apat	d18O (vpdb) enam apat
Huari Monq.	Cran P	ULM2	MC	Mid-crown				−2.3	21.9	−8.8
Huari Monq.	Cran M	ULM3	AD	Mid-crown				−4.5	21.3	−9.3
Huari Monq.	Cran S	URM2	MC	Mid-crown				−6.1	22.1	−8.5
Huari VM	HTM 48 Ind 1.26	URP3	IEC	Mid-crown				−9.8	21.9	−8.8
Huari VM	HTM 50 #11	LLP4	MC	Mid-crown				−12.6	21.2	−9.4
Huari VM	Cran 1001	LRM2	MC	Mid-crown				−5.5	20.9	−9.7
Huari VM	Cran 4	URM1	IEC	Mid-crown				−5.7	21.5	−9.1
Huari VM	Cran 58	ULM2	MC	Mid-crown				−4.6	21.4	−9.2
Huari VM	Cran 66	ULM2	MC	Mid-crown				−3.8	22.7	−7.9

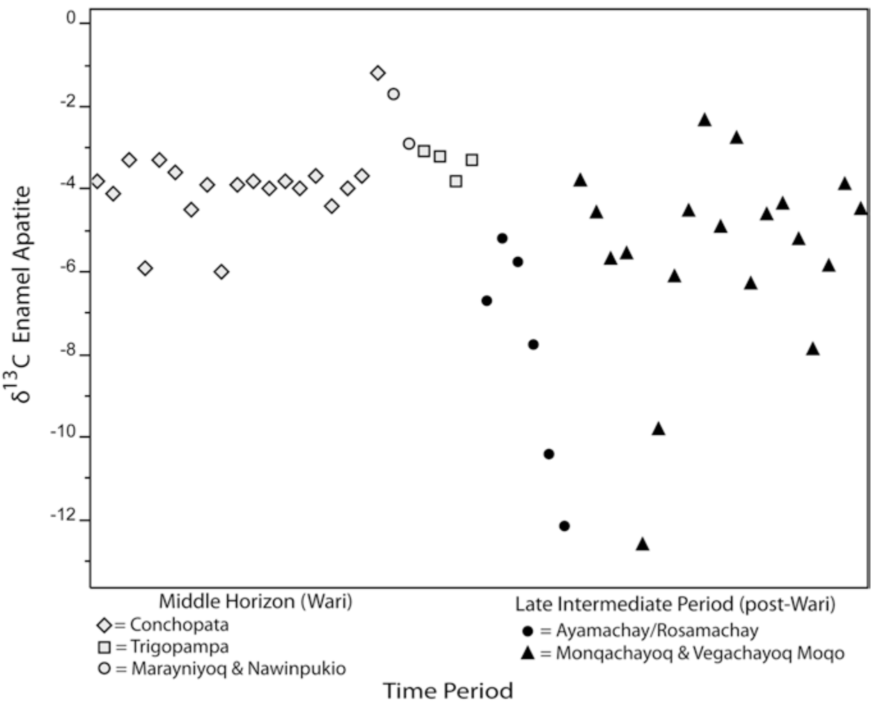

Fig. 10.6 Carbon isotope ratios from dental enamel apatite (carbonates) from the Middle Horizon (Wari era) burials and the Late Intermediate Period (post-Wari) burials. Some Middle Horizon values are from Finucane et al. (2006)

juveniles continued to have greater access to carbon-enriched food such as maize relative to children and adolescents in post-Wari times.

There are no sex-based differences in carbon isotope ratios from dental apatite among the LIP samples. For all of the LIP boys, the mean $\delta^{13}C = -5.23$ ($N = 8$) and for all of the LIP girls, the mean $\delta^{13}C = -6.27$ ($N = 5$) ($t = -0.63$; $p = 0.542$). (This also holds for internal site comparisons: boys vs. girls from the cave sites and boys vs. girls from Huari.) In all, this suggests that boys and girls consumed a similar diet, at least as it related to the consumption of carbon-enriched foods.[5]

10.7.3.2 Comparing Carbon Isotope Ratios in the LIP: LIP Sectors at Huari Versus the LIP Machays

Among the dental apatite samples from the LIP sectors at Huari ($n = 19$), the mean $\delta^{13}C = -5.505$ (s.d. = 2.409), and at Ayamachay/Rosamachay ($n = 6$), the mean $\delta^{13}C = -8.00$ (s.d. = 2.746). A Mann-Whitney test shows that the values

[5]Teeth from children could not be used in the sex comparisons because their sex cannot be estimated. But, for individuals who died in adulthood, their sex could be estimated based on adult skeletal morphology, providing a retrospective view of diet of girls versus boys.

from these sites are significantly different ($p = 0.0252$), suggesting that post-Wari individuals who were buried at Huari had a childhood diet distinct from those who were buried in the caves, at least as it related to the consumption of carbon-enriched foods (e.g., maize). This childhood dietary difference hints at temporal differences (the *machays* are earlier) or the emergence of social inequality in the post-Wari era, a topic further discussed below.

10.7.3.3 Carbon Isotope Ratios from Dentin: Distinct Values Between Wari and the Post-Wari Eras

Among the Ayamachay/Rosamachay samples, dentin collagen from teeth was examined for carbon and nitrogen isotope ratios, and those were compared to the values obtained from the dentin collagen of Wari-era dentition.[6] Of those post-Wari individuals, the dentin collagen mean $\delta^{13}C = -14.63$ ($N = 6$). In the Wari era, the dentin collagen mean $\delta^{13}C = -10.688$ ($N = 17$) (Finucane 2009; Finucane et al. 2006). These values are again significantly different ($t = 3.68$; $p = 0.0104$), suggesting that, at least in the protein component of the diet, carbon-enriched foods were significantly less common in the post-Wari era.

10.7.3.4 Nitrogen Isotope Ratios from Dentin: Similar Values Between the Wari and the Post-Wari Eras

Nitrogen isotope ratios from the Ayamachay/Rosamachay dentin collagen samples show an average $\delta^{15}N = 10.933$ ($N = 6$), and among the Wari dentin collagen samples, the average $\delta^{15}N = 10.829$ ($N = 17$) (Finucane 2009; Finucane et al. 2006). These values are statistically similar ($t = 0.14$; $p = 0.887$), suggesting that some aspects of childhood diet were unchanged from one time period to the next. In particular, there is no evidence that there was a significant shift in the consumption of foods from different trophic levels.

10.7.3.5 Oxygen Isotope Ratios

Oxygen isotope ratios from dental apatite carbonates from the LIP samples are as follows: the Huari-LIP $\delta^{18}O_{VSMOW}$ ranges from 20.914 to 22.721 and the average $\delta^{18}O_{VSMOW} = 21.7495$ (s.d. $= 0.443$; $N = 19$); the *machays* $\delta^{18}O_{VSMOW}$ ranges from 20.828 to 27.859 and average $\delta^{18}O_{VSMOW} = 23.0792$ (s.d. $= 2.74$; $N = 5$) (Table 10.2). There is no significant difference in oxygen isotope ratios between the Huari-LIP samples and the *machay* samples ($t = 2.14$; $p = 0.3413$), suggesting that both populations acquired their water sources from the same or similar sources.

[6] As of yet, there are no isotope data from dentin from the LIP Huari samples.

Among the entire LIP sample, the mean $\delta^{18}O_{VSMOW} = 22.027$ (s.d. = 1.33; $N = 24$), and one sample is more than four standard deviations above the mean: a middle-aged female from Ayamachay (Cran. 1). (No other samples are even one standard deviation from the mean.) This outlier value suggests that her childhood was spent in a location with a highly distinct water source, likely outside of the Ayacucho Basin.

Because there are currently no oxygen isotope data from the preceding Wari era, it is unclear whether the water source(s) significantly changed in the post-Wari era. Further, although previous studies have demonstrated that there was a long-term drought ca. 900–1350 C.E. (Bird et al. 2011; Thompson et al. 1985, 2013), the current oxygen isotope data cannot address the issue of declines in precipitation relative to the Wari era until more Wari-era samples (and samples from animals) are available.

10.8 Discussion: More Lethal Violence and Less Maize for Children of the Post-Wari Era

The samples from the *machays* and the former Wari imperial capital (Huari) all date to the LIP, primarily from the second half of the LIP. This temporal association allows us to examine how the aftermath of Wari imperial decline and an ongoing drought structured the lifeways of these populations, particularly as it relates to exposure to violence and dietary practices among children. By comparing cranial trauma and stable isotope ratios between the Wari and post-Wari eras, we can evaluate whether post-Wari childhoods were distinct from that of their Wari-era ancestors. The claim that these LIP populations are indeed biological descendants of the Wari heartland populations is supported by previous research on ancient mtDNA that shows genetic homogeneity and shared maternal lines between the two temporal groups (Kemp et al. 2009). This relationship is important to establish because it ensures that we are not comparing morbidity and diet between two biologically distinct populations that may have had different disease susceptibilities or that lived in distinct ecological zones.

The absence of antemortem trauma among the eight juveniles matches what was previously observed among the ten juveniles from the LIP component at Huari-Monqachayoq (Tung 2008). Thus, among 18 LIP juveniles from the former Wari heartland studied thus far, the antemortem cranial trauma frequency is zero, which is identical to the preceding Wari era when none of the 39 children exhibited healed head wounds (Tung 2012). This suggests that in both cultural eras, children were not victims of sublethal trauma, such as might be seen in cases of repeated child abuse.

Although antemortem cranial trauma is absent in both eras, lethal (perimortem) cranial fractures significantly increase in later post-Wari times. Previous studies show that three out of ten Monqachayoq children have perimortem head wounds (Tung 2008), rates that are statistically similar to the combined

Vegachayoq Moqo and *machay* sample presented here (4/8 = 50 %) (Fisher's exact, $p = 0.6305$). Thus, among all child LIP crania from Vegachayoq Moqo, Monqachayoq, and the *machays*, seven out of 18 (39 %) juveniles died from a violent blow to the skull; this is significantly higher than in Wari times (Fisher's exact, $p = 0.0001$).

The location of head wounds on the children from Monqachayoq and Vegachayoq Moqo is nearly identical. The three juveniles from Monqachayoq exhibit cranial fractures on the left side, and two of them also have fractures on the posterior of their crania (Tung 2008). In total, there are 12 perimortem head fractures on the seven fatally injured children from LIP-Huari: Six are on the left side and six are on the posterior. This is a striking pattern of perimortem trauma on juveniles, suggesting that these injuries are not from accidents. The severity of the fractures in which large portions of the cranium are dislodged further suggest that these were not accidental injuries, but resulted from forceful, violent blows to children's heads that were delivered in a standardized manner. It is remarkable that in the post-Wari era, deadly violence was directed at children, and the inflicted injury patterns are remarkably similar, observations that indicate there were dramatic changes in post-Wari society.

What actions led to these massive fatal head traumas on children? Intra-household abuse (i.e., child abuse) seems unlikely. Studies of modern child abuse have documented fatal head traumas perpetrated by parents, their romantic partners, or other caregivers, but it is less common that those head injuries result in death [e.g., 20 % of 151 cases of abusive head trauma against children from Colorado resulted in death (Starling et al. 1995)]. Further, although child maltreatment is unacceptably high in the USA—state agencies documented 678,810 cases in 2012—a low percentage of them resulted in fatalities: 1,593 child deaths (0.02 %) (Children's Bureau 2012).[7]

Warfare battles can certainly result in fatal head traumas among young children, but children are rarely present in planned violent confrontations, such as war. The patterned trauma does, however, highlight the possibility of systemic lethal violence against a particular subgroup: children from the urban core. Targeted violence could have occurred within the context of a specific attack on the community, in which adults (Tung 2008) and children were killed in something akin to a massacre that occurred during a raid. The posterior location of perimortem fractures on children's crania is particularly relevant to this claim, because it suggests that children either were fleeing or were in a defensive position when attacked.

Patterns of trauma can also provide clues to the attacker's intent, a psychological state that is notoriously difficult to document, even among the living; yet, repeated perimortem fractures on a cranium may reveal the deadly intent of the aggressor (Tung 2014). Among the Huari-LIP child crania, the multiple

[7]The report warns that the number of child maltreatment cases documented by state agencies is an underrepresentation. The number of reports of child abuse is approximately 3 million (affecting 6 million different children because one report can involve multiple children), of which only a fraction are documented by the US government.

perimortem traumas suggest that the aggressors intended to kill them, a goal that they accomplished, likely during raids on the community. This interpretation is further supported by the observation that 30 % of the females at Monqachayoq also suffered perimortem cranial fractures (Tung 2008). Females in the Andes rarely sustain deadly battlefield injuries (Andrushko and Torres 2011; Murphy et al. 2010; Torres-Rouff 2011; Torres-Rouff and Costa Junqueira 2006; Tung 2007), so the high percentages of lethal trauma on both children and females together support the interpretation that warfare—in particular, community raids—was the likely source of the injuries. It is unknown who perpetrated the attacks.

In broader comparison, the perimortem cranial fracture rate among the LIP children is also significantly higher than antemortem and perimortem trauma observed at many other Andean sites. In the prehispanic era in the San Pedro de Atacama of Chile, only one out of 52 juveniles (2 %) (Early Intermediate Period to the Late Horizon) exhibited healed head trauma, and that one affected child dated to the LIP (Torres-Rouff and Costa Junqueira 2006). At the early post-contact site of Puruchuco-Huaquerones in Lima, eight out of 73 subadults had some form of a head injury (11 %), five of which were perimortem (5/73 = 7 %) (Gaither and Murphy 2012), rates that are significantly lower than the post-Wari frequency presented here (Fisher's exact, $p < 0.001$). The authors attribute the deadly violence against children to the general "escalation of violence"that characterized the early years of the Spanish invasion, which may be reflecting "a complete upheaval of the social fabric" (Gaither and Murphy 2012, p. 474). These post-contact children with perimortem cranial fractures, however, were consistently older than those at the LIP-Huari site: at Puruchuco, all five injured subadults were 15–20 years old,[8] while at Huari, all seven children were less than 12 years of age. Thus, at Puruchuco, as the authors suggest, adolescents may have been actively engaged in warfare and the defense of their community against the Spanish invaders. At LIP-Huari, in contrast, it is unlikely that younger children were actively involved in warfare battles, though they could have been fatally injured while defending their homes or they could have been specific targets of violence as nearly whole communities were eliminated by the attackers. It is also possible that they were "collateral damage" during outbreaks of violence. However, the severity and patterned locations of the child head traumas make unintentional violence (i.e., "collateral damage") seem unlikely. But whatever the specific context, the violence that affected these post-Wari communities was significantly more severe than that documented in the violent era following the Spanish invasion, hinting at similar ruptures in the social fabric of society as communities transitioned to new sociopolitical structures and simultaneously dealt with a long-term drought.

[8]Tung (2007, 2012) has suggested that in the ancient Andes, older adolescents (15–19 years) should be grouped with the adults when calculating general trauma frequencies, while juvenile trauma should include individuals younger than 15 years.

10.8.1 Carbon Isotope Ratios: Dietary Differences Between Wari and Post-Wari Era

The carbon isotope data from enamel apatite and dentin collagen show a significant decline in the childhood consumption of carbon-enriched foods in the post-Wari era, and that dietary shift likely relates to less consumption of C_4 plants, such as maize. This pattern of difference is apparent in both early-forming teeth and later-forming teeth, suggesting that in Wari times, breastfeeding women and breastfed babies, children transitioning to solid foods, and post-weaned children all had greater access to the socially valued food (maize) relative to the post-Wari groups. This dietary difference may well be related to the extended and severe drought in the Andes during the LIP, a condition that may have been quite detrimental to maize production. Moreover, the decline of Wari state structures may have altered food production and distribution systems, changing such things as irrigation networks, their ongoing maintenance, and trade alliances that would have previously brought more and diverse resources to the populations in the Ayacucho Basin.

If maize production had decreased, decisions about distributing this valued resource would then become paramount. Did post-Wari communities attempt to equitably distribute maize, or did this apparent scarcity lead to inequities in terms of who had access to it? As it relates to distribution among girls and boys, the carbon isotope ratios from dental apatite show no sex-based differences, suggesting equal investment in boy versus girl offspring, at least as it related to providing them with access to maize and/or other carbon-enriched foods. Whether this gender-based equity in food consumption continued into adulthood has yet to be established.

Unequal consumption of maize, however, is apparent when comparing the two LIP sites. At the urban site of Huari, children (and breastfeeding mothers) had significantly more access to dietary maize than those at the rural cave sites. This dietary difference between sites represents a change from the preceding Wari era, when individuals at various Wari heartland sites exhibited nearly identical carbon isotope ratios (Finucane 2009; Finucane et al. 2006). This suggests that in the post-Wari era, social inequality emerged, at least as it relates to the consumption of maize. This shift to dietary inequality reflects a profound change in post-Wari society, a change that could be a bellwether of sorts for increasing social tensions, and thus accords well with the cranial trauma data showing more violence in this era.

10.8.2 Nitrogen Isotope Ratios: No Dietary Differences Between the Wari and the Post-Wari Era

The nitrogen isotope ratios from dentin collagen showed no significant differences between the two eras, suggesting that, for juveniles, there was no significant change in the trophic-level sources of foods. For example, it appears that no marine foods were introduced to childhood diets in the post-Wari era, which could have significantly raised the $\delta^{15}N$, nor is there evidence of prolonged childhood starvation, which could also potentially raise the $\delta^{15}N$ value (Mekota et al. 2006). There is also no evidence that there was a significant shift to a more plant-based diet during childhood, which could have lowered the $\delta^{15}N$ values. In all, we did not detect a change in this aspect of childhood diet.

10.8.3 Oxygen Isotope Ratios: A Possible Non-Local at the Machay (Caves)

Among the 24 LIP dental samples processed for oxygen isotope ratios, one individual—a middle-aged female from one of the caves—exhibited a significantly different value, suggesting that she may have spent her childhood outside of the Ayacucho Basin. However, her unique oxygen isotope ratio may be explained, not by geographical differences, but by food/liquid preparation differences. That is, it is remotely possible that the majority of the water she imbibed as a child was prepared in a very different manner; perhaps she primarily consumed liquids that were boiled, as in soups, or that sat in containers while fermenting, as in *chicha* (maize beer). Those processes lead to greater evaporation of ^{16}O (and thus enriched ^{18}O) and may explain her higher $\delta^{18}O$ value. But, when we consider her other stable isotope ratios, she shows the lowest $\delta^{13}C_{dentin\ coll}$ (−18.12), $\delta^{13}C_{dental\ apat}$ (−12.15), and $\delta^{15}N_{dentin\ coll}$ (9.57) values of all the *machay* samples. Together, all of these highly distinct isotope values, particularly the high $\delta^{18}O$, suggest that she is a non-local individual, an interpretation that still needs to be tested with strontium isotope data.

10.9 Conclusion

The LIP was a tumultuous time in the former heartland of the Wari Empire, and children suffered violent deaths as a result. Relative to earlier Wari times, the quality of life for juveniles—as measured by deadly violence—plummeted in the post-Wari era. This high level of lethal violence against children likely reflects a larger milieu of social unrest that led to warfare, particularly community raids, in which children less than 12 years of age were killed with blows to the head. Notably, although raids tend to be frenetic, chaotic times, the wound location patterns—on the posterior and left sides only—suggest that these fatally injured children were dispatched somewhat systematically. Whether or not they were specifically targeted or killed execution style is unclear because posterior skull trauma can also result from a defensive bodily position. Nonetheless, lethal trauma—or any kind of cranial trauma—on children is exceedingly rare in the Andes (except in cases of child sacrifice), so it is particularly revealing of the unstable sociopolitical conditions in the LIP in the Ayacucho Basin. Moreover, previous studies show that cranial trauma—both sublethal and lethal—affected more than two-thirds and one-third of adults, respectively (Tung 2008), further demonstrating the climate of violence that permeated LIP communities in the region.

There are likely multiple causes for this widespread violence, but the timing of Wari imperial decline and the ongoing drought seem particularly relevant. Although these human remains date to approximately 150 years after the decline of Wari, this major transition in political organization likely had lasting effects on how communities planned for and responded to environmental crises, like droughts. The shift in political organization can be seen in the abandonment, or at least major depopulation, of heartland Wari sites (Finucane 2009; Leoni 2004) along with the decline of public architecture projects and the decline in polychrome ceramic and textile production in Ayacucho and surrounding regions (Arkush and Tung 2013; Conlee 2006; Covey 2008). This political decline meant that the Wari state infrastructure that oversaw the construction and maintenance of agricultural terraces, irrigation canals, and road networks for trade was no longer present, or apparently took new forms, which could have been an impediment to food production and distribution strategies. This is not to suggest that states are essential to manage these kinds of programs; local communities often organize labor to plan and implement infrastructure for food production, public buildings, and communal ritual activities. However, in the Ayacucho region during the LIP, local strategies apparently did not translate into forms of social and political organization that fostered peace. These local groups, however, may have created new forms of organization that facilitated both defensive and offensive planning, showing that state infrastructure is not needed for communities to protect themselves from external threats or to plan and carry out attacks on other settlements.

Whether the conflict documented here and in previous studies (Tung 2008) was related to competition over scarce resources should be considered (Carneiro 1970), particularly in light of the stable isotope data that show a decline in the consumption of maize among children. If this socially valued resource was declining, then it is worth examining whether this dietary change is a reflection of dwindling *access* to maize. However, although Carneiro (1970) makes an important point about resource scarcity and its potential for fomenting conflict, particularly in circumscribed environments, the process by which conflict is—or is not—manifested depends greatly on decisions about how to increase production (or not) or how to fairly or inequitably distribute the resources that are available. For example, the early decades of the Wari empire (ca. 550–600 C.E.) were similarly characterized by a drought, though shorter than the one that plagued the LIP, yet Wari political leaders apparently used this climate crisis to expand their authority by increasing the construction of irrigation canals and thus agricultural potential in some parts of their imperial domain (Williams 2002). There is currently no evidence that communities in the LIP engaged in similar infrastructural strategies, but decisions about the distribution of maize did change relative to the preceding Wari era. That is, while individuals from various Wari heartland sites had nearly identical carbon isotope ratios (Finucane 2009), indicating equitable distribution of maize, the post-Wari era sees this food equality decline. In the LIP, those who were buried at the former urban capital have significantly greater access to the crop than those from rural cave sites, a pattern that may reflect unequal access to irrigation canals, agricultural lands, or the unequal distribution of resources at community and household levels. This inequality in the LIP may be part of a larger pattern of systemic disadvantage, akin to structural violence, in which long-standing cultural practices and historical patterns of infrastructural investments lead to a pattern in which a subgroup (non-urban peoples in this case) had less access to a food resource (and presumably suffered nutritional consequences as a result). Given the social and political importance of maize in the Andes (Hastorf 1993), its low levels of consumption among the cave burials may be a proxy for other kinds of inequities, such as diminished political authority for those outside what was once the urban core. But this case is not so straightforward, for it is the individuals from the former urban site of Huari that suffer the higher rates of deadly trauma. The reasons for the deadly attack on those communities are unknown, but the isotope data suggest that they may have been a privileged group of individuals with significantly greater access to a socially and politically valued resource: maize.

Although the differential access to maize among the LIP individuals could be related to temporal differences (the *machay* LIP population may predate the Huari-LIP population by about 100 years), when compared to the previous Wari-era samples that span 300 years, the LIP dietary heterogeneity is even more remarkable. That is, the Wari-era samples from four different heartland sites span three centuries, and they nevertheless exhibit nearly identical carbon isotope ratios; the LIP samples from two sites span approximately 150 years, and they exhibit significant differences between sites. Thus, in this particular regard, Wari heartland society seems to have valued, and made efforts to ensure, the equitable distribution of a valued food item, a social practice that shifted dramatically in the subsequent centuries of the LIP.

Acknowledgments We would like to express our gratitude to Jose Ochatoma at the Universidad Nacional de San Cristóbal de Huamanga for granting access to the skeletal collections discussed here, and we thank Taylor Macdonald for assistance in editing the bibliography. We also thank the following funding agencies for providing support for this study: The National Science Foundation-Archaeology and Biological Anthropology Divisions; The Wenner-Gren Foundation for Anthropological Research (#8169); the Nashville School of Science and Math at Vanderbilt; the College of A&S at Vanderbilt. Finally, we thank Amber VanDerwarker and Greg Wilson for inviting us to participate in the conference at UCSB and to contribute to this edited volume.

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Chapter 11
Trauma, Nutrition, and Malnutrition in the Andean Highlands During Peru's Dark Age (1000–1250 C.E.)

Danielle S. Kurin

In this study, warfare is approached as the instrumental and situational use of armed violence—and the strategic manipulation of institutional disparities—to achieve ideological or material objectives and is enacted by politicized participants who see themselves linked by common membership. To complement existing studies of warfare, a growing body of scholarship now focuses on *structural violence*, the chronic and systematic ways in which social structures harm, deprive, or otherwise disadvantage individuals and groups. Entrenched in institutions and practice, structural violence may inhibit access to clean water, diverse and nutrient-dense foods, hygienic living conditions, and mobility and transhumance (Gluckman et al. 2007).

Accompanied by skeletal fractures indicative of direct, physical violence, the scars of chronic deprivation become sedimented into the skeleton and are detectible through changes in the shape and elemental composition of bones and teeth. Recent paleodemographic analyses of historic cemeteries have shown that skeletal indicators of morbidity (sickness) early in life are linked to increasing frailty and shortened life spans (DeWitte and Wood 2008; Wood et al. 1992). Moreover, research in the public health domain suggests that the same institutional factors which maintain structural inequalities associated with increased morbidity are often linked with a higher risk of *excess* mortality (higher than predicted rates of premature death) (De Walque 2005; De Walque and Verwimp 2009; Horton 2004).

The correspondence between increased morbidity and excess mortality often emanates from the enduring and multifarious shock waves of sociopolitical and economic insecurity brought about by the "failure" of modern states and the collapse of ancient empires (Akresh et al. 2012; Brubaker and Laitin 1998; Le Billon 2001;

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_11

Rotberg 2003). While scholars have sought to identify how social inequalities play out among hierarchically oriented groups (Gravlee 2009; Leatherman and Goodman 1997), disparities in health and nutrition can also be variably experienced heterarchically within a society (see Farmer et al. 2004). Horizontal inequalities, such as those that exist between or within different social factions (Farmer 1996, 2003), are concerned with deprivation at the group level, but remain largely unexplored in the prehistoric past (Klaus 2014; Martin and Tegtmeyer 2014). Moreover, bioarchaeologists have yet to fully examine how elevated morbidity early in life may be related to future (life-ending) experiences of excess mortality caused by violent physical trauma.

This paper contributes to debates regarding elevated morbidity and excess mortality by evaluating how food and warfare were differentially accessed and experienced during a well-known period of tumultuous violence and staggering deprivation in Andean prehistory. Known as the Late Intermediate Period (LIP, 1000–1400 C.E.), this era witnessed both the sequela of archaic imperial collapse and the impacts of a slowly worsening drought. Among regions most affected by these shocks was the mountainous south-central province known as Andahuaylas (Fig. 11.1).

Fig. 11.1 Map of the study region, Andahuaylas, Apurimac, and Peru

11.1 Defensive Living and Subsistence in LIP Andahuaylas

Sometime around 1050 C.E., the once prosperous Wari Empire (ca. 600–1000/1050 C.E.), based in central highland Peru disappeared from Andahuaylas and other imperial provinces (Kurin 2012). The causes of Wari's fragmentation remain enigmatic, and it is unclear whether collapse was a seismic phenomenon which emanated from the core and rippled out, or a corrosive phenomenon, where seceding provinces undermined the cohesion of the capital. While some Wari outposts clearly show evidence of planned, tactical retractions, with rooms cleaned and sealed, others evince signs of hasty, unanticipated withdrawal, accompanied by site-wide burning episodes, and direct, physical violence (Tung 2012).

Although the nature of Wari collapse is still uncertain, the ensuing period (1050–1250 C.E.) coincides with profound changes in individual and community experiences with food, disease, and warfare (Fig. 11.2). Indirect evidence of tumult is most strongly signaled by shifts in settlement practices (Bauer et al. 2010; Gómez Choque 2009; see also Covey 2008). Once-dispersed hamlets were abruptly abandoned as populations moved upslope to hills, promontories, and ridgetops located between 3200 and 3600 MASL. Well-contextualized AMS radiocarbon dates indicate that displacement was widespread, swift, and permanent; settlements were constructed between 1050 and 1100 C.E. (Bauer et al. 2010; Covey 2008; Kellett 2010; Kurin 2012). Roughhewn stone masonry was

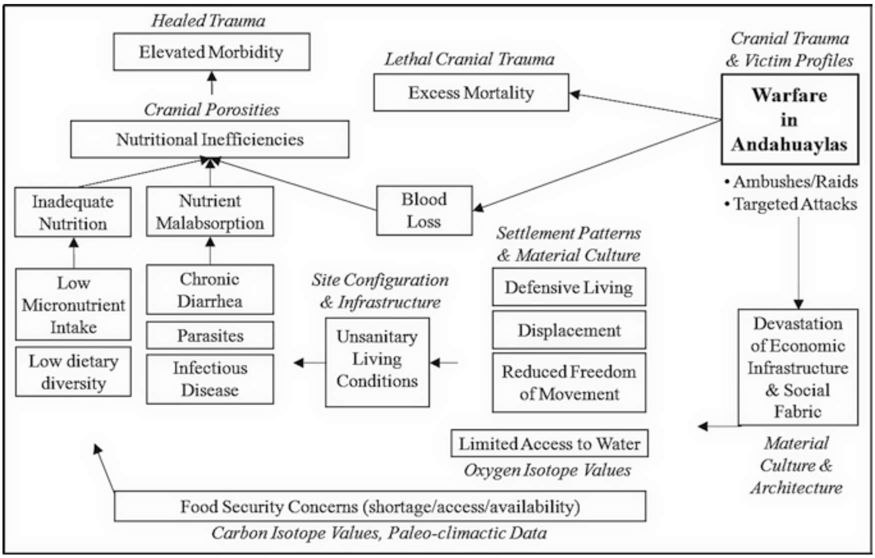

Fig. 11.2 Biocultural model of how elevated morbidity and excess mortality relate to warfare, diet, and disease in Andahuaylas. *Italics* denote bioarchaeological correlates which were assessed in this study

opportunistically quarried from the settlement slopes and haphazardly arranged into densely clustered patio groups. Sites lack plazas, monumental works, and other public infrastructure, and there are no large and stately homes, tombs, or luxury goods commonly associated with self-aggrandizing, high-status elites.

Some have hypothesized that LIP populations moved upslope as a means of coping with drought; hilltop sites were built to facilitate the intensification of camelid pastoralism and the cultivation of crops that thrive in higher, drier altitudes (Bauer and Kellett 2010; Bauer et al. 2010; Kellett 2010). However, even in the best of times, only around 10 % of Andahuaylas Province is suitable for agriculture (INEI 2010). Moreover, sediment cores drawn from Laguna Pacucha, in the middle of the study region, indicate that drought conditions only began to intensify around 1250 C.E., several centuries after Wari imperial collapse and the proliferation of high-altitude settlements (Hillyer et al. 2009; Mosblech et al. 2012; Valencia et al. 2010).

Instead, LIP settlement configurations appear to be more strongly structured around community security and group defense. Foremost, settlements had commanding views of the landscape and other sites: Up to 85 % of the terrain would have been visible (Kellett 2010, p. 172); lookout posts and sangars were constructed in strategic positions nearby (Gómez Choque 2009). Agricultural terraces were located about a 30-min walk from habitation sites, and corrals were situated about twice as far. Andahuaylas travel much farther today, safely walking several hours to-and-from inherited plots of land (Gómez Choque 2009). Material evidence of weaponry (e.g., caches of donut-stone maces, hafted clubs, and sling stones) is ubiquitous in grave good assemblages and on surface surveys (Gómez Choque 2009). The ramparts which encircled habitation areas, along with baffled entries, protective ditches, long defensive curtain walls with posterns, boulder *glacis*, and steep cliffs and ravines, all served to impede movement by attackers while at the same time confining residents within the relative safety of the settlement (Kurin 2012; sensu Arkush and Allen 2006).

Moreover, recent research points to increasing social isolation and spatial balkanization across the entire region. Settlement survey work (Gómez Choque 2009) and studies of non-metric cranial characteristics (Pink 2013) support a scenario of population decline and reduced gene flow in the aftermath of Wari collapse. Nearest neighbor analysis of settlements shows that site frequency and total site area decrease after collapse, but settlement size remains the same (Kellett 2010). The reduction in site frequency and stasis in settlement size point to population aggregation, but not population growth. Additionally, diminished total site area usually results from buffer areas formed by the negative space between fortifications (LeBlanc 2006). Consequently, larger buffer zones would have impacted food production, because in Andahuaylas, the buffer zones *are* the productive zones. Finally, based on the number of houses built within site walls, hundreds of people were aggregating on rugged terrain that spanned mere hectares. Clean water sources were located far off-site at hillslope springs (*puquios*) and in deep ravines (*quebradas*) (Gómez Choque 2009; Kellett 2010, p. 348). Given potential hazards such as high population densities, food security concerns, burdensome access to clean water, a conspicuous dearth of infrastructure related to sanitation, reduced freedom of movement, a cold windy environment, and violent attack, living conditions in fortified settlements were likely substandard and could have contributed to elevated rates of morbidity and mortality (Arriaza et al. 2013).

11.2 Affixing Social Identity in Infancy

Although archaeological correlates point to a flattening of status hierarchies after Wari collapse, novel social distinctions were reified through boundary-marking practices (e.g., Barth 1969) which included artificial cranial modification. In Andahuaylas, purposefully elongated heads were produced through the continual adjustment and tightening of turban-like wrappings and the use of *kiraw* compression cribs (Cieza de Leon 1996[1553]; Kurin 2012). Just days after delivery, newborn babies—heads and all—were swaddled and affixed to the cribs which restricted their movement (Guaman Poma de Ayala 2012[1616]). Direct pressure from the bindings and the crib constricted the growth of certain skull bones and prompted the expansion of others. Varying the placement and location of the head wrappings vis-à-vis, the crib would establish the permanent form of the reshaped head. This remodeling process continued until a child was at least two or three years old; by that age, the fontanels (soft-spots) close, and modification would be more or less permanent (Tiesler 2014).

Yet despite—or perhaps because of—its great antiquity and ubiquity, cranial modification meanings, and motivations remain a moving target for Andean bioarchaeologists. For instance, on the north coast of Peru, head shaping was simply the result of widespread normative childrearing practices (Verano et al. 1999), while different groups on Peru's south coast used modification to represent occupational identities, residential descent groups, or lineages (Hoshower et al. 1995; Lozada et al. 2005). Among highland populations, modification often denoted social or ethnic affiliation (Blom 2005; Torres-Rouff 2002) and was even mandated by the Inca as a biopolitical instrument of social control (Pachacuti Yamqui Salcamaygua 1995[1613], p. 23; see also Torres-Rouff 2002).

While there is currently no information about head reshaping in Andahuaylas during the period prior to Wari's expansion, Grossman (1972) identified a modified cranium that was AMS radiocarbon dated to the sixteenth century B.C.E. This find shows that cranial remodeling was adopted at least intermittently throughout time (Grossman 1972; Tiesler 2014; Torres-Rouff 2002). Furthermore, as previously reported (Kurin 2012), not a single observed crania ($N = 36$) evinced modification during the Wari era. However, following Wari's collapse, cranial modification was swiftly adopted by the majority of individuals (77.6 %, 191/246) (Fisher's exact test, $p = 0.0001$; $N = 282$).

Intriguingly, people with modified and unmodified crania were entombed together. Given what we know about pre-Hispanic cave ossuaries and their skeletal and material contents (Arriaga 1968[1621]; Baca et al. 2012; Black and Kurin 2014;

Duviols 1986), perceived common biological affiliation—possibly patrilineal—was the basis of burial collectivity in Andahuaylas, but not head shaping itself. More generally, rates of modification do not correlate with variables including sex, elite status, site, sector, polity, or place of birth (Kurin 2012).

Consequently, cranial modification in Andahuaylas likely marked a caste or ethnic-like grouping or kin category (see Kurin 2012). For instance, one appellation commonly cited was the *piwi churi*, or designated heir category[1] (Betanzos 1996[1557]; Julien 2009; Yaya 2012). Modification could have also indexed aspects of birth order (from the first-born *sapa,* to the last-born *sullka*) and/or legitimacy (e.g., the child of a wife versus the child of a concubine) (Urton 1999). Another separate nomenclature was used to denote particular associations with either *apukikuna* (esteemed ancestral lineages) or *wakcha* (deprived heritage) (Holguín 1901[1608]). Lastly, head shaping (or lack thereof) could have been structured by auspicious perinatal circumstances. Infants like those born breech (*chacpa*) or twins would be included in this category (Arriaga 1968[1621]; Staller and Stross 2013). Like other affiliations, these sorts of ranked, heterarchical groupings were used to order and maintain social and economic rights and relationships (Urton 1997). Regardless of semantic ambiguities, both modified and unmodified heads were emblemic markers that communicated important information about group membership, affiliation, and identity (Tiesler 2014; Torres-Rouff and Yablonsky 2005). So too, the enduring permanence of a remodeled head allows us to reconstruct aspects of childrearing practices, identify the role caregivers played in social reproduction, and examine the biocultural consequences of perpetual, conspicuous signaling.

11.3 Indexing Nutritional Disease

Despite its entrenchment in social institutions and practices, structural violence is not invisible. In fact, a key characteristic is the instantiation of chronic deprivation within certain social groups (Galtung 1969; Galtung and Höivik 1971), and the clearest signs of deprivation stem from nutritional inefficiencies (Baro and Deubel 2006; Bhattacharya et al. 2004; De Meer et al. 1993; Sen 1982).

Fortunately, bioarchaeologists can index nutrient inefficiencies and health disparities through analysis of sclerotic bone indicative of elevated morbidity (DeWitte and Wood 2008; Larsen 1997). The present study examines the proliferation of pinprick-sized holes on the cranial vault and in the upper eye orbits, known as *porotic hyperostosis* and *cribra orbitalia*, respectively (El-Najjar et al. 1976; Kent 1986; Stuart-Macadam 1992; Walker et al. 2009; Wapler et al. 2004).

[1]By the sixteenth century, cranial modification was outlawed, and categories including the *piwi churi, sullka,* and *chacpa* largely collapsed as the Spanish instituted a new system of social ordering and administration (Betanzos 1996[1557]).

Current research suggests that these lesions reflect a combination of both inadequate nutrition which may be caused by low micronutrient intake and dietary diversity, as well as nutrient malabsorption caused by infectious diseases or parasitic worms that inhibit absorption and promote nutrient loss through diarrhea (McIlvaine 2013; Rothschild 2012). Blood loss from trauma is another potential factor (Walker et al. 2009). Finally, although healed lesions observed in late adolescents and adults may reflect health problems during early childhood (Stuart-Macadam 1985), other groups, such as pregnant women and informal miners (usually adult males), are also at increased risk for the types of micronutritional deficits and diseases (e.g., anemia) which actively cause porosities (Bethony et al. 2006). When examined in conjunction with additional lines of evidence (see below), cranial lesions can inform on morbidity rates and help reconstruct ancient diets by isolating potential etiologies of malnutrition and disease.

11.4 Reconstructing Food and Water Bioavailability and Accessibility

Ethnohistoric and ethnographic accounts suggest that by middle childhood (roughly five to nine years of age), Andahuaylan youths engaged in many of the same agricultural, pastoral, and domestic activities as older members of the community. Already weaned by that age (Guaman Poma de Ayala 2012[1616]), these *warmas* (kids) also consumed the same types of food and drink as other folks, but in smaller quantities (Arguedas 1956; Guaman Poma de Ayala 2012[1616]; Isbell 2005; Orr 2013; Skar 1982).

Relative proportions of zooarchaeological and macrobotanical remains from Andahuaylas suggest sources of subsistence varied only slightly between the pre- and post-collapse eras (Kellett 2010, p. 95). The proportion of maize (*Zea mays*) was steady over time (~33 % of the total), while amaranths (*Amaranthus caudatis*) increased in relative ubiquity during the LIP as potatoes (*Solanum tuberosum*) decreased. Similarly, the faunal data suggest that camelids (Camelidae) consumption and fecundity rates remained constant between the Wari era and LIP (Kellett 2010, p. 497). Small proportions of guinea pigs (*Cavia porcellus*), dogs (*Canis familiaris*), and deer (Cervidae) round out the assemblage of available comestibles (Baiker 2012; Gómez Choque 2009).

Yet these data are hard to interpret due to significant preservation biases and small sample sizes.[2] So, although previous studies of food habits in the region have largely focused on faunal proxies and macrobotanical remains (e.g., Kellett 2010), this paper uses stable carbon and oxygen isotope results from human dental

[2]For instance, quinoa (*Chenopodium quinoa*), a major cultigen throughout the Andes during multiple periods (Meddens and Branch 2010), was conspicuously absent.

enamel to more directly infer key aspects of diet, malnutrition, and freedom of movement in the past.

The science is relatively straightforward: As the tooth crown forms, enriched isotopes ingested in food and drink are permanently embedded in the enamel's mineral (apatite) matrix. The apatite is inorganic, highly resistant to diagenesis, and thought to offer a more accurate account of food proportions in the total diet than other biogeochemical techniques (Lee-Thorp et al. 2010).

Specifically, analysis of carbon isotopes[3] from enamel apatite ($\delta^{13}C_{apatite}$) relies on the fact that plants synthesize carbon in different ways (Kellner and Schoeninger 2007). Andean comestibles such as potatoes and quinoa use the C_3 pathway with resulting $\delta^{13}C_{apatite}$ levels that fall between −22 and −36 %. In contrast, plants such as maize and amaranth maintain C_4 pathways with $\delta^{13}C_{apatite}$ values that vary from −14 to −11 ‰, (Turner et al. 2010; van der Merwe 1992). The C_4 values are also enriched by eating terrestrial mammals. Finally, a photosynthetic pathway known as Crassulacean acid metabolism (CAM) overlaps both C_3 and C_4 ranges (Kellner and Schoeninger 2007; Lee-Thorp et al. 2010), although plants of this sort are not regularly consumed in Andahuaylas (Finucane et al. 2006; Skar 1982).

Somewhat uniquely, major plant cultigens in the Andes Mountains are fixed to different vertically stacked ecological zones (Cadwallader et al. 2012; Murra et al. 1986). While maize and quinoa grow between 2000 and 3200 MASL, amaranths and tubers are cultivated upslope between 3200 and 3800 MASL, and camelid herding takes place at 3800 MASL to 4200 MASL, which also represents the upper limits of human habitation in the region (Table 11.1).

One can infer the ratio of C_4 to C_3 in human diets based on fractionation rates or the shift (enrichment) of a plant's isotopic composition as it moves up the trophic chain. In the case of humans, $\delta^{13}C_{apatite}$ values are offset by about +9.5 to +12.5 ‰ (Lee-Thorp et al. 1989, 2010). Thus, a diet comprised almost entirely of C_3 plants would have a $\delta^{13}C_{apatite}$ value of −13 to −16 ‰, while a diet comprised almost entirely of C_4 plants (and/or the animals that ate them) would fall between −2 and +1 ‰ (Loftus and Sealy 2012).

Similarly, oxygen isotope values may further highlight disparities with respect to nutritional access, mobility, and food security (Kurin 2012). Annotated as $\delta^{18}O_{apatite}$, this analysis follows the premise that values derive from local drinking water sources (Knudson 2009). While factors such as weaning, boiling, and terrestrial versus meteoric (rain) water can impact $\delta^{18}O_{apatite}$ values, these factors are negligible in Andahuaylas or can be confidently corrected as they similarly impacted everyone in the population (e.g., all major cultigens need to be boiled).

Ecological research on oxygen isotopes provides insight on the physical limits of habitation and reaffirms that higher, drier elevations and lower temperatures are associated with lower $\delta^{18}O_{apatite}$ values (values that are depleted/more negative) (Knudson 2009; Lambs et al. 2012). This is relevant given that Andahuaylas'

[3]As usual, $\delta^{13}C$ values are reported relative to VPDB using NBS-19 as the standard reference material.

Table 11.1 Relative ubiquity of pre-Hispanic cultigens consumed in rural Andahuaylas today

Taxonomic name	Local vernacular name	Ubiquity[a]	Photosynthetic pathway	Cultivation zone[b]
Zea mays	Sara/Maize	1	C_4	Intermontane valleys
Amaranthus hybridus	Atacco/Verde	3	C_4	Intermontane valleys
Amaranthus caudatus	Kiwicha	3	C_4	Rolling grasslands
Solanum tuberosum	Papa	1	C_3	Rolling grasslands
Erythroroxylum coca	Coca	1 (to chew)	C_3	Cloud forest zone
Ullucus tuberosus	Ullucu	2	C_3	Rolling grasslands
Oxalis tuberosa	Oca	2	C_3	Rolling grasslands
Tropaeolum tuberosum	Mashua	2	C_3	Rolling grasslands
Chenopodium quinoa	Quinua	2	C_3	Rolling grasslands
Lupinus mutabilis	Tarwi	2	C_3	Rolling grasslands
Curcurbita maxima	Zapallo	3	C_3	Intermontane valleys
Phaseolus lunatus	Pallar	4	C_3	Intermontane valleys
Schinus molle	Molle	4	C_3	Intermontane valleys
Eryngium foetidum	Huacatay	4 (condiment)	C_3	Intermontane valleys
Capsicum annuum	Uchu/Aji	4 (condiment)	C_3	Intermontane valleys

[a]Represents the most common answer to the question: How often do you eat this? *1* several times/day; *2* once per day/every other day; *3* once every few days; *4* on occasion
[b]Where unfertilized crops are primarily cultivated today: *cloud forest* 1800–2200 MASL; *intermontane valleys* 2200–3200 MASL; *and rolling grasslands* 3200–4000 MASL

vertical topography can rise 2000 m over a few kilometers of distance (Baiker 2012). When used in conjunction with other lines of osteological evidence, $\delta^{13}C_{apatite}$ and $\delta^{18}O_{apatite}$ analyses allow us to better understand total diet homogeneity and individual mobility during childhood.

11.5 The Cultural Context: Warfare and Trauma

Aside from health risks, the threat of physical conflict appears to have been a pressing concern for communities in the ancient Andes during the Late Intermediate Period. Here, the nature and severity of violent encounters is evaluated through the analysis of cranial trauma. This type of approach assesses the number, type of lethality, location, and frequency of head wounds and compares it to factors including age, sex, social affiliation, and health and nutritional status to better understand the contexts of violence (Martin and Harrod 2014; Martin et al. 2012; Tung 2012; Walker 2001).

For instance, wound lethality informs on the intent of an assailant. Sublethal (antemortem) injuries evince bony growth around fractures that are indicative of healing and survival. In contrast, lethal perimortem wounds, received around the time of death (and possibly representing the cause of death), lack bony remodeling. While sublethal injuries suggest intent to harm, lethal wounds signal an intent to kill. A close inspection of the co-occurrence of healed and unhealed wounds is an unambiguous indicator of recidivism (repeated assault) (Martin et al. 2012).

Recording wound location allows us to reconstruct the spatial relationship between the aggressor and the victim at the moment of blunt force impact (Larsen 1997; Galloway 1999; Tung 2012). Cross-cultural bioarchaeological, ethnographic, and clinical studies have further demonstrated that wound patterning on the skeleton is strongly structured by factors such as age, sex, and social status (Walker 1989, 2001). For instance, when females attempt to escape and evade assailants, wounds tend to concentrate on the back of the head (Tung 2012). However, when females display sublethal injuries including broken nasal bones and front teeth, they are likely the victims of domestic violence (Baustian et al. 2012). And as other cases have shown, spiral fractures of the long bones (from twisting/torsion) on youths tend to be common in cases of child abuse (Lewis 2007); Cambodian political prisoners in the Khmer Rouge regime were executed using standardized blows to the base of the skull (Ta'ala et al. 2006); during the Rwandan Genocide, the Hutu *modus operandi* was to hack Tutsi people to pieces with machetes (Koff 2007; Taylor 1999). Sobering as it may be, bioarchaeological approaches are uniquely positioned to identify cranial trauma and address its cultural context.

11.6 Materials

In order to address how warfare correlates with persistent dietary and nutritional deficiencies among distinct social groupings, the Andahuaylas Bioarchaeology Project excavated mortuary contexts from the later Wari era and the ensuing Late Intermediate Period. During the twilight of Wari's reign, beginning around 880–990 C.E. (AMS, 2σ), the remains of at least 36 men, women, and subadults were buried in a stone-lined, semi-subterranean circular tomb in an ancient village located near the modern towns of Turpo and Natividad. Nestled in one of the most maize-rich valleys in the region and surrounded by extensive pre-Hispanic terracing, the style of the tomb is similar to those uncovered in the Wari heartland and hinterland (Ochatoma 2007; Tung 2007, p. 251). Several classes of artifacts attest to Wari's influence in Andahuaylas, including high-quality Viñaque style ceramics and locally produced vessels with emulated Wari motifs (Menzel 1968, p. 143). After Wari's collapse, places such as Turpo were abandoned as populations moved upslope. Burial practices also changed. The use of small cave ossuaries—called *machays*—to collectively entomb mummified and skeletonized remains became widespread. Caves were used by descendants for about a century, or five to six generations. After that, apertures were sealed with large boulders or rough-cut stone blocks.

In this study, 301 individuals from 17 cave ossuaries that date to the early LIP, 1080–1260 C.E. (AMS, 2σ), were systematically recovered and assessed. Caves were all associated with higher altitude habitation sites. The largest subsample derives from Cachi (3380 MASL), a site affiliated with the well-documented Chanka polity. The settlement is defined by two major features: the Mina rock salt mine and a five-hectare fortified settlement located on a nearby promontory with commanding views of the Pampas River Valley. The accessible south side of the settlement is protected by a wide ditch and a series of concentric ramparts and long, defensive walls. Cave ossuaries were carved out of the existing bedrock both within and outside of the fortification. Prehistoric corrals and agricultural terraces are reached in less than an hour.

Smaller skeletal collections derive from Ranracancha (3430 MASL), also affiliated with the Chanka polity, and Pucullu (3600 MASL), an enclave community of people associated with the Quichua polity. While historical texts suggest the Chanka and the Quichua were rivals, they share similar cultural features including artifact assemblages, burial traditions, and subsistence practices. Thus, for this study, both polities were aggregated into one post-collapse LIP population.

11.7 Methods

11.7.1 Osteological Methods

Data from human remains were analyzed following established standards (Buikstra and Ubelaker 1994). Age was determined through dental development, tooth wear, and cranial suture closure, while sex was assessed through dimorphic features of the cranium. To assign broad social groupings, crania were classified as either modified or unmodified (Torres-Rouff 2002). Because there were no significant differences in demographic distribution and cranial modification rates, the Ranracancha, Cachi, and Pucullu were collapsed into one LIP group and compared with the smaller Wari era sample from Turpo. Cranial lesions were scored as present if at least one square centimeter of porosity was present on the vault bones or in the eye orbits (Walker et al. 2009). The number, size, shape, type, lethality, and location of fractures on each cranium were tabulated (Lovell 1997). Trauma patterns were then evaluated against age-at-death, sex, isotopic values, cranial lesion presence, and cranial modification rates to determine whether there were meaningful and significant correlations.

11.7.2 Isotopic Methods

Forty-three human teeth—fourteen from Cachi, ten from Ranracancha, ten from Turpo, and nine from Pucullu—underwent carbon isotope analysis to inform on ancient diets, and oxygen isotope analysis to inform on mobility (Table 11.2). Maxillary molars still in occlusion with intact antimeres were preferentially selected, since those teeth form during childhood. Enamel apatite extraction procedures follow methods outlined in Lee-Thorp and van der Merwe (1991) and were conducted at the University of Florida. Samples were vertically sectioned and cleaned of surface contaminants and dentin using a high-speed Brasseler dental drill with a diamond tip under 10X magnification. Cleaned samples were finely ground with an agate mortar and placed in 5-ml plastic centrifuge tubes with locking lids. To remove organics and humic acids, a 50 % sodium hypochlorite solution was added for 16 h, centrifuged, and decanted. Samples were then rinsed three times in distilled water. To remove exogenous secondary carbonates, a 0.2 Molar acetic acid solution was left to react for 15 h. Samples were rinsed again several times with distilled water. Finally, the vials of apatite were freeze-dried and subjected to spectroscopic analysis.

Previous strontium isotope analysis of dental enamel revealed four non-local individuals (Kurin 2012), who were removed from this study. Furthermore, first molars, which begin to form before children are weaned, were removed from some calculations because they are disproportionally enriched, reflecting breast milk and weaning food supplements rather than normative diets. In other cases, 1st molars with the corrected values (derived from site-specific average weaning enrichment rates) were included as part of the analysis because they were not significantly enriched—only around +0.6 ‰. Current scholarship suggests that $\delta^{18}O_{apatite}$ differences of more than ±2 ‰ are outside the normal range of human variation, even in highly seasonal environments, and as such may signal imbibed water from non-local sources (Wright and Schwartz 1999). Similarly, for $\delta\ ^{13}C_{apatite}$, a difference of more than ±3 ‰ is considered a significant enrichment from comestible to consumer (Turner et al. 2010). Finally, descriptive statistical functions in SPSS provide another avenue to interrogate potentially significant differences in data patterns, as well as to identify statistical outliers.

11.8 Results

11.8.1 Cranial Lesion Rates

In total, 252 crania could be evaluated for evidence of cranial lesions caused by nutrient inefficiencies, which index elevated morbidity. Significantly, observed pathology rates more than quadruple after the collapse of the Wari Empire. While only 8.8 % (3/34) of all observable imperial era crania had lesions, 40.3 %

Table 11.2 Inventory and profile of individuals sampled for stable isotope analysis

Era	Affiliation	Site-Cave #	Skull #	Tooth	d18O	d13C[a]	Age[b]	Sex[c]	Cran Mod[d]	Trauma	Cran Lesion
MH	Warified	Turpo-1	01.12A	RMx2	−10.88	−4.91	A	M	0	0	1
MH	Warified	Turpo-1	01.04A	LMd2	−12.69	−4.74	MA	M	0	0	0
MH	Warified	Turpo-1	01.12B	RMx2	−10.37	−4.7	YA	U	0	0	0
MH	Warified	Turpo-1	1.05	RMx1	−10.4	−4.16	YA	M	0	1	0
MH	Warified	Turpo-1	1.11	RMx2	−9.43	−3.85	MA	F	0	0	0
MH	Warified	Turpo-1	01.01	LMd2	−10.25	−3.77	CH	U	0	0	0
MH	Warified	Turpo-1	1.2	RMd3	−9.04	−3.72	YA	M	0	0	0
MH	Warified	Turpo-1	1.19	LMx3	−10.71	−3.71	CH	U	0	0	1
MH	Warified	Turpo-1	1.14	RMx1	−8.1	−3.56	A	M	0	0	0
LIP	Chanka	Cachi-Masu 7	7.01	RMd2	−10.46	−5.93	A	U	0	0	0
LIP	Chanka	Cachi-Mina 1	1.14	RMx2	−10.79	**−8.47**	YA	M	0	1	0
LIP	Chanka	Cachi-Mina 1	1.13	RMx1	−8.65	−5.9	YA	F	1	1	1
LIP	Chanka	Cachi-Mina 1	1.01	LMx2	−9.83	−5.04	YA	F	0	1	0
LIP	Chanka	Cachi-Mina 1	1.1	LMx2	−9.94	−4.97	MA	M	0	0	0
LIP	Chanka	Cachi-Mina 1	1.02	RMx2	−10.07	−4.52	MA	M	1	0	0
LIP	Chanka	Cachi-Son 1	01.Rincon	LMd1	−8.48	−6.25	OA	F	1	1	U
LIP	Chanka	Cachi-Son 1	0.04–1.57	RMx2	−9.52	−3.46	MA	M	1	1	0
LIP	Chanka	Cachi-Son 2	3.18	LMx1	−8.62	−3.75	YA	M	0	1	0
LIP	Chanka	Cachi-Son 2	3.36	RMd3	−10.24	**−1.55**	YA	F	0	1	0
LIP	Chanka	Cachi-Son 4	4.01	LMx2	−9.18	−3.63	YA	F	1	1	1
LIP	Chanka	Cachi-Son 7	1.02	RMx2	−9.1	−4.55	MA	M	0	1	1
LIP	Chanka	Ranracancha-1	1.23	LMx1	−9.7	−8.05	YA	F	1	1	1

(continued)

Table 11.2 (continued)

Era	Affiliation	Site-Cave #	Skull #	Tooth	d[18]O	d[13]C[a]	Age[b]	Sex[c]	Cran Mod[d]	Trauma	Cran Lesion
LIP	Chanka	Ranracancha-1	1.24	RMx1	−8.7	−7.53	YA	F	1	1	1
LIP	Chanka	Ranracancha-1	1.27	LMx1	−8.73	−7.4	CH	U	1	1	1
LIP	Chanka	Ranracancha-1	1.44	RMx1	−8.73	−6.88	YA	F	1	1	1
LIP	Chanka	Ranracancha-1	1.04	LMx2	−9.12	−6.18	YA	M	1	1	1
LIP	Chanka	Ranracancha-1	1.03	LMx1	−9.68	−4.88	YA	M	1	0	0
LIP	Chanka	Ranracancha-1	1.14	LMx2	−11.28	−4.69	YA	F	1	1	1
LIP	Chanka	Ranracancha-1	1.1	LMx1	−8.87	−4.61	YA	M	1	1	1
LIP	Chanka	Ranracancha-1	1.06	RMx2	−9.2	**−1.54**	JV	F	1	1	1
LIP	Quichua	Pucullu-1	1.19	LMx1	−9.18	−6.57	CH	U	0	0	0
LIP	Quichua	Pucullu-1	1.2	RMx3	−9.92	−6.23	MA	F	1	1	1
LIP	Quichua	Pucullu-1	1.03	RMx2	−9.83	−6.15	JV	F	0	0	0
LIP	Quichua	Pucullu-1	1.22	RMx1	−10.09	−5.94	JV	F	0	0	0
LIP	Quichua	Pucullu-1	1.13	RMx2	−9.73	−5.62	MA	M	1	1	0
LIP	Quichua	Pucullu-1	1.09	LMx2	−10.13	−5.6	JV	F	0	0	0
LIP	Quichua	Pucullu-1	0.01.26	RMx3	−9.37	**−2.48**	YA	M	1	1	1

[a]Site-derived C_4 dietary outliers are in **bold**
[b]Child (0–12); Juvenile (12–20); Young Adult (20–35); Middle Adult (35–50); Old Adult (+50); Adult (20–50)
[c]Male; Female; Unknown
[d]*0* No; *1* Yes; *U* Unknown

(88/218) of post-imperial LIP crania showed these porosities (Fisher's exact test, $p = 0.0002$). Yet not all subpopulations experienced chronic health inefficiencies equally.

Among the sexes, there was little difference in the frequency of cranial porosities. Thirty percent of LIP males (32/104) and 36 % of females (32/90) exhibit lesions (Fisher's exact test, $p = 0.5411$; $N = 194$). In contrast, morbidity rates are significantly different between social groupings: Over 54 % (116/214) of individuals with cranial modification also have cranial lesions, while only 25 % (10/40) of LIP unmodified individuals have them (Fisher's exact test, $p = 0.0009$; $N = 154$). These patterns demonstrate that while the health of the overall population declined in the aftermath of Wari collapse, those with artificially remodeled heads had higher rates of diseased bone linked to nutritional inefficiencies.

11.8.2 Carbon and Oxygen Isotope Results

Mixing models based on carbon and oxygen values more thoroughly inform on aspects of the total diet and mobility during childhood. Mapping isotopic values against known data on local settlements, subsistence, geography, and water consumption allow for more meaningful—albeit somewhat relativistic—analysis of ancient diets in a precipitous region such as Andahuaylas. Foremost, there appears to be a marked shift in dietary trends overall between the Wari era and the early LIP (Fig. 11.3). Average $\delta^{13}C_{apatite}$ values do not change significantly[4] over time, but their ranges do. During the Wari era, $\delta^{13}C_{apatite}$ values of local individuals[5] ranged from −4.91 to −3.71 ‰ (mean = −4.2 ‰; s.d. = 0.55 ‰), and $\delta^{18}O_{apatite}$ values of all teeth ranged from −12.69 to −9.04 ‰ (mean = −10.48 ‰; s.d. = 1.17 ‰). In contrast, after Wari collapse, $\delta^{13}C_{apatite}$ ranges increased (−1.54 to −8.47 ‰; mean = −4.89 ‰; s.d. = 1.606 ‰), and $\delta^{18}O_{apatite}$ ranges decreased (to −11.28 to −8.47 ‰ mean = −9.5 ‰; s.d. = .692 ‰).

In the post-collapse era, the greater spread of the $\delta^{13}C_{apatite}$ and $\delta^{18}O_{apatite}$ data potentially signal greater intra-group dietary variability (Ezzo 1992). To discern the basis of this disparity, other variables were interrogated. For instance, results show that females and males have similar total dietary profiles (e.g., female $\delta^{13}C_{apatite}$ mean = −4.87 ‰, range = −1.54 to −8.05 ‰, $N = 13$; male $\delta^{13}C_{apatite}$ mean = −4.64 ‰, range −2.48 to −8.47 ‰, $N = 11$). Cranial modification (Fig. 11.4) is not strongly correlated with consumptive patterns either (unmodified $\delta^{13}C_{apatite}$ mean = −4.87 ‰, range = −1.54 to −8.05 ‰, $N = 13$; modified $\delta^{13}C_{apatite}$ mean = −4.64 ‰, range −2.48 to −8.47 ‰, $N = 11$). Finally, cranial lesion frequencies were also compared to the isotope data. Intriguingly, lesions were most strongly associated with people who had enriched $\delta^{18}O_{apatite}$

[4] Dietary outliers were identified as stable isotopic values that were enriched/depleted by ±2–3 ‰ in relation to individual cave means (Turner et al. 2010; Wright and Schwartz 1999).

[5] Local residential origin was confirmed through strontium isotope analysis (Kurin 2012).

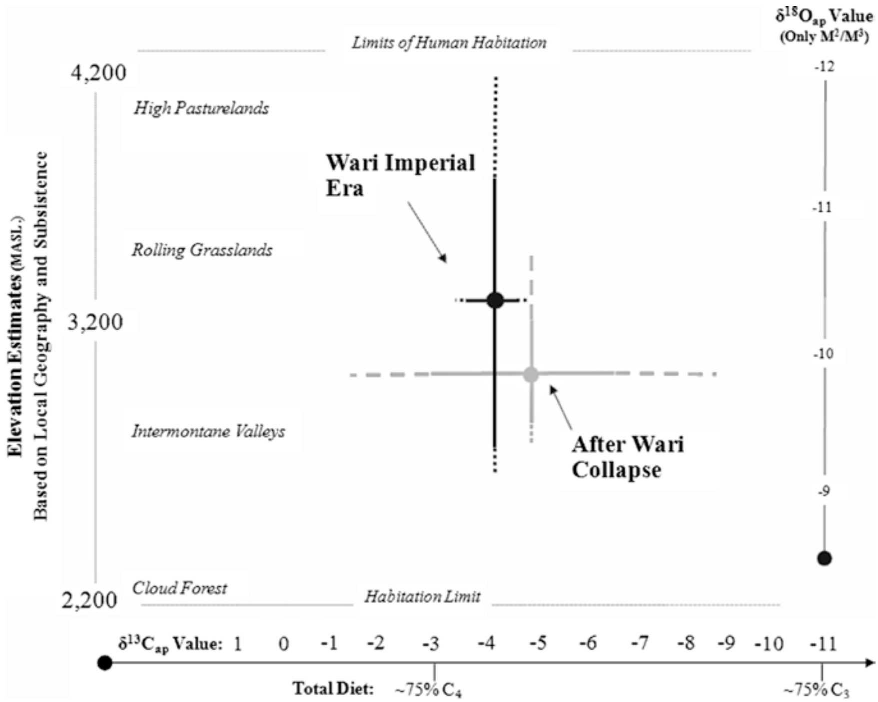

Fig. 11.3 Schema of relative mobility and consumption in Andahuaylas during the Wari era and the LIP. Elevation estimates and attendant cultivation zones (shown in *italics*) are inferred from ecological, geographic, and subsistence data and mapped using stable isotopes values

values [with offsets: (cranial lesion $\delta^{18}O_{apatite}$ mean = −4.87 ‰, range = −1.54 to −8.05 ‰, $N = 13$; no porosities $\delta^{18}O_{apatite}$ mean = −4.64 ‰, range −2.48 to −8.47 ‰, $N = 11$)], but not $\delta^{13}C_{apatite}$ values.

Here, the status of dietary outliers is particularly revealing (Fig. 11.5). One outlier was a juvenile female with fronto-occipital oblique cranial modification. She demonstrated healing and active cranial lesions and extremely enriched C_4 rates. A lethal execution blow was present at the base of her skull. Another outlier, a late adolescent/young adult female with no cranial modification, also consumed significantly more C_4 foods in her total diet, but has no cranial porosities. Much of the left side of her head was shattered by at least two lethal blows. Finally, two young adult male outliers are also present. One has frontal–occipital oblique cranial modification, high dietary C_4 rates, mostly healed cranial porosities, both antemortem and perimortem cranial trauma, and an unhealed trepanation. The other male has no modification, no cranial lesions, high dietary C_3 rates, a healed wound on the right parietal, and a healing trepanation—a sign of intervention normally associated with the stressors of elevated rates of deprivation and warfare (Kurin 2012).

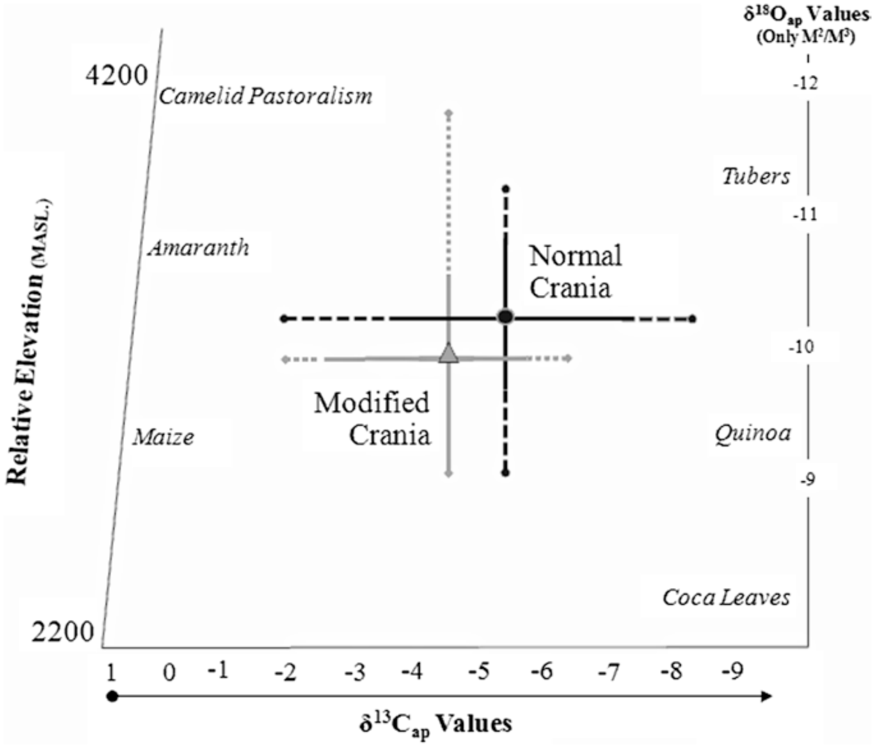

Fig. 11.4 Spatial schema of relative mobility and consumption among modified and unmodified individuals in LIP Andahuaylas plotted using stable isotopes. Italics denote a major C_3 or C_4 contributor, inferred from uniform ecological factors, subsistence practices, and ethnographic data

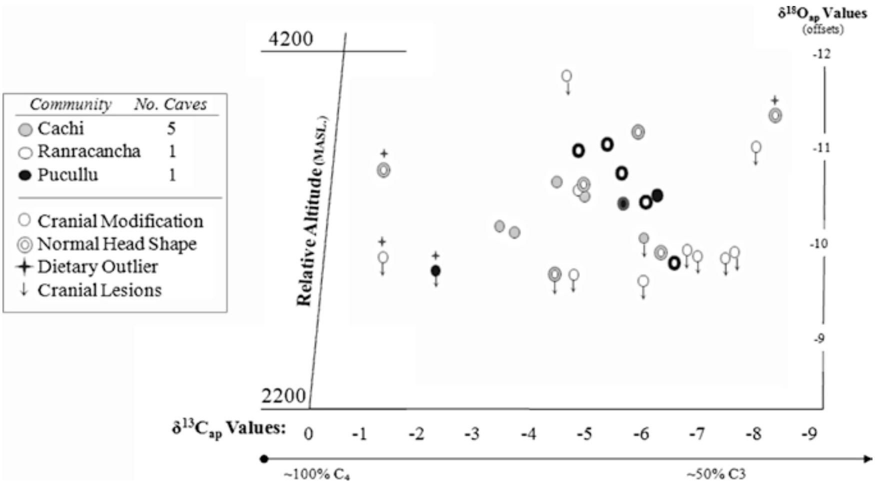

Fig. 11.5 Schema of intra-group mobility and consumption in LIP Andahuaylas. Results on cranial modification, diet, and disease within a single cave/site are plotted using stable isotopes

11.8.3 Cranial Trauma

During the Wari era, only 7.7 % (2/26) of late adolescents and adults in Andahuaylas have cranial trauma and all observable wounds showed long-term healing. In contrast, after Wari collapse, trauma rates increased significantly. Nearly 49 % (131/267) of LIP late adolescents and adults have cranial trauma (Fisher's exact test, $p < 0.0001$, $N = 293$). Equally dramatic disparities in trauma patterning are apparent at the subpopulation level. For instance, at the Quichua polity site, significant differences exist in wound rates, lethality and distribution between males and females. In contrast, at the contemporaneous Chanka polity sites, trauma was directed toward those who were conspicuously marked by cranial modification (Kurin 2012). Of 167 individuals with modified heads, 93 (55.7 %) had at least one wound. In contrast, only 13/43 (30.2 %) unmodified crania had any trauma (Fisher's exact test, $p = 0.0035$; $N = 210$). Wound distribution also suggests modified Chanka individuals were singled out for brutal, dehumanizing attack (sensu CVR 2003; Kimmerle and Baraybar 2008; Ta'ala et al. 2006; but see Ferguson 2005). Although sample sizes are small, only modified individuals exhibit: (1) lethal and sublethal wounds received in consecutive attacks; (2) lethal ring fractures on the cranial base associated with execution blows on incapacitated individuals; and (3) multiple lethal wounds (overkill trauma) which obliterated much of the face and vault (Kurin 2012).

Intriguingly, signs of increased disease show a significant *negative* correlation with excess mortality—perimortem trauma—within the majority group of modified individuals (Fisher's exact test, $p = 0.0032$, $N = 78$). Of 48 individuals with cranial lesions, 22 (46 %) had at least one lethal perimortem wound. The wounded-to-killed [w:k] ratio (Kimmerle and Baraybar 2008), a relative index of lethal intent and violent context (catastrophic vs. attritional), is a devastating 1.2, a rate often observed in massacres. In stark contrast, modified counterparts with cranial lesions experienced significantly lower rates of excess mortality (4/30 = 13 %; w:k = 6.5), In fact, the excess mortality rates and wounded/killed ratios of the porosity-marked modified subgroup are more similar to patterns observed among those who retained their natural head shape, where 18 % (7/39) experienced perimortem trauma (w:k = 4.6). These rates and ratios are more in line with sustained low-intensity conflict such as intermittent sieges and raids.

11.9 Discussion

It is clear from the archaeological record that significant changes in human behavior occurred after Wari's retraction from Andahuaylas. Material correlates signal the abrupt, widespread, and wholesale rejection of Wari sociopolitical and socioeconomic institutions. Burial practices shifted from circular tombs to cave ossuaries. Grave goods marked by Wari iconography were abandoned in favor of stone weapons. Lastly, a marked shift in settlement patterns from valley hamlets to fortified hill and ridgetop sites indicate concerns about threats of violence or actual attack. Because direct evidence of past life experiences is sedimented into human bones and teeth, the data from this study inform on how the nature of social disparities changed and were made manifest over the span of generations

11.9.1 Nutrition and Warfare During the Wari Imperial Era

Consumption patterns gleaned from $\delta^{13}C_{apatite}$ values show little internal variability and suggest that those entombed together at death also shared a common diet during early life. This consumptive parity is contrasted by a wide range of $\delta^{18}O_{apatite}$ values that, given low sublethal trauma rates (e.g., Arkush and Tung 2013), likely reflect individual freedom of movement and safe access to even the most distant ecological zones. Moreover, the correspondence between enriched $\delta^{13}C_{apatite}$ values and depleted $\delta^{18}O_{apatite}$ values suggests dietary C_4 is being culled from higher elevation sources such as high-protein amaranths or nutrient-dense camelid meat. This could also explain why rates of cranial porosities in the population are low and comparable to elevated disease rates in contemporary developing nations outside of sub-Saharan Africa (Arimond and Ruel 2004). Thus, it appears that prior to Wari collapse, most individuals were getting adequate calories and micronutrients from both plant and animal sources. Moreover, these local Andahuaylas, influenced by the style and tastes of the Wari Empire, were living in conditions largely free of the hazards that can chronically rob the body of crucial nutrients (but see Klaus 2014).

11.9.2 Nutritional Inefficiencies and Elevated Morbidity After Wari Collapse

A prominent nutritional shock experienced in the generations after Wari disintegration is apparent via the significant increase in the ubiquity of cranial lesions which are the result of chronic nutrient inefficiencies caused by factors including blood loss, inadequate nutrition, and nutrient malabsorption. In Andahuaylas, these inefficiencies appear to have been primarily provoked by chronic[6] and subclinically symptomatic micronutrient deprivation and parasitic infections.

Historically, regional diets have been characterized by low protein and micronutrient intake (i.e., iron and vitamins A, B9, C, D, and folic acid, the latter which is almost solely derived from meat) and a general lack of diversity in terms of food types (Larrea and Freire 2002). Even today, during times of growing abundance, only 6 % of the protein intake within rural populations comes from animal sources

[6]Skeletal lesions may not have time to form in acute, virulent, and fatal infections (Wood et al. 1992).

(The World Bank 2014); over half of all Andahuaylas preschoolers are anemic (INEI 1994) and exhibit high rates of stunted growth (height-for-age). However, by grade school, body mass indices (weight-by-age and weight-by-height) lie several standard deviations above the mean. This pattern confirms that although caloric intake may be adequate, it is of little nutritive value (Oths 1998).

In addition, unhygienic waste disposal, prolonged water storage, cross-contamination, or improper food preparation within a closely quartered host population can all introduce nutrient-depleting parasites into sensitive digestive systems (Araújo et al. 2011; Awasthi and Agarwal 2003; Bhatnagar and Dosajh 1986; Kyobutungi et al. 2008). As one can imagine, the grim realities of persistent warfare can exacerbate these hardships for generations (Pedersen et al. 2008). For example, Ministry of Health records compiled during Peru's recent civil war illustrate the pervasiveness of deprivation during troubled times. During the war's worst years in the early 1990s, over three-quarters of children demonstrated significant stunted growth. Chronic or recurring diseases which impacted nutrient absorption were endemic. From 1991 to 1993, 29 % of more than 83,000 visits to the central Andahuaylas Hospital involved *only* gastrointestinal infection, diarrhea, amoebas, helminthes, and hookworms among 34 possible maladies (INEI 1994).

Some of these hardships were almost surely present in ancient war-torn Andahuaylas as well. For instance, as noted earlier, those with cranial porosities demonstrated significantly disparate C_4 values but very similar (and lower than average) $\delta^{18}O_{apatite}$ values. This pattern would be expected if folks were consuming different foods but accessing drinking water from a similar elevation or shared source. The correspondence between porosities and $\delta^{18}O_{apatite}$ values intimates that water imbibed from lower, warmer elevations was a possible pathway for parasitic infection (Araújo et al. 2011). Nevertheless, water would have been absolutely necessary in every home, every day, and at every meal, if only to properly cook all major cultigens and comestibles. Consequently springs and *quebradas* have long been resources ardently defended, with access strictly structured by ranked kinship and descent (Arguedas 1956; Skar 1982).

Lastly, dietary rules could have impacted nutritional access and rates of violence (Horton 1988; Larme 1997; Madise et al. 1999; Taylor 1999). Even in times of plenty, food in the highland Andes—especially animal protein, coca, and maize—was allocated by age and to a lesser extent by sex and birth order (Cieza de Leon 1996[1553]; Graham 1997; Guaman Poma de Ayala 2012[1616]; Holguín 1901[1608]). However, if times were lean and disparities grew, real or perceived social inequalities and insecurities between groups would be politicized and marshaled to legitimate acts of violence (Skar 1982).

11.9.3 Social Identity, Food Security, and Excess Mortality

Material signatures of displacement upslope motivated by security concerns are supported by significant increases in trauma frequencies in the aftermath of

Wari's collapse. Moreover, reduced $\delta^{18}O_{apatite}$ ranges point to greater circumscription and less access to different outlying ecological zones. As freedom of movement decreased, intra-group diets became more variable. This is supported by the fact that significantly distinct amounts of C_4 plants were being consumed by people entombed in the same cave within a few generations of each another, at most. Wide $\delta^{13}C_{apatite}$ ranges (from 75 % C_4 to 75 % C_3) highlight the presence of dietary outliers in caves and may reflect a well-documented practice in which lineages send kin to till fields in distant ecological zones (Murra 1972). As young children, the outliers in this study joined older individuals eating whatever bi-/mono-crop that was being cultivated.

However, unlike an efficient vertical archipelago that facilitates exchange (e.g., Murra et al. 1986), evidence of trade largely disappears during the LIP. Instead, lineage members were probably engaging in semipermanent agricultural outposting to provide greater dietary diversity and thus better nutrition in the face of perceived threats from theft or usurpation (Fig. 11.6). In turn, these concerns could have stoked competition and violence between groups. Indeed, trauma data illustrate a palimpsest of encounters, from raids and ambushes, to selective attacks which targeted specific members of a community.

Because household survival depends on acquiring food during times of crisis (Sen 1982), and because conflict is also associated with food insecurity, people often revert to potentially dangerous coping strategies. In Andahuaylas, exposing kin to elevated risks of violent death apparently did not outweigh the need to

Fig. 11.6 Semipermanent outpost in the high pasture lands above contemporary Cachi (Andahuaylas). Groups of women related by blood and marriage—and their daughters—form defensible habitation–corral compounds. *Foreground* supplies protected from scavengers; *Background* Camouflaged *chozas* (shacks), which reproduce the same spatial and social relationships found at lower elevation homesteads. *Photo* by Enmanuel Gómez Choque

ensure that agricultural, herding, and mining activities continue unabated year-round (see Flannery et al. 2008). As such, outlier profiles reveal commonalities—such as lethal trauma, particular head shapes, compromised health and well-being, and young ages-at-death—that attest to the lifelong (if not intergenerational) consequences of agricultural out-posting in marginal, turbid environments (sensu Devakumar et al. 2014).

Notably, because cranial modification was likely affixed to certain resource rights and social obligations—and were totally conspicuous—those individuals were overwhelmingly singled out for brutal attack. Yet significant intra-group heterogeneity exists (Oths 1998): Modified individuals with osseous evidence of disease and deprivation have significantly different wounded-to-killed ratios than their unimpaired modified counterparts. This stark disparity could be explained if hunkering down in fortified settlements was indeed an underlying factor in the expression of cranial lesions. While digging-in would protect people from lethal violence during sieges and multipronged attacks, it would also expose them to multiple and significant risk factors for elevated morbidity. Importantly, excess mortality rates demonstrate that it was those traveling outside the confines of the settlement walls who were more likely to be picked off. When tensions are high and resources few, even travel time to fields, corrals, and springs would have put a person at risk for ambush (see also VanDerwarker and Wilson, this volume).

Given the evidence, marked increases in nutrient inefficiencies and intra-group dietary heterogeneity in LIP Andahuaylas were due to violence and food security concerns, rather than any perceptible environmental changes (Gregory et al. 2005; Messer 1997). Isotope data from this study demonstrate that while climate-sensitive food *availability* did not change significantly in the tumultuous wake of Wari collapse, socially structured food *accessibility* did. Similar to contemporary and historic societies emerging from state collapse, as competition and conflict disrupted food access in Andahuaylas, insecurities regarding the attainment of food appear to have simultaneously provoked and sustained devastating warfare and violence.

11.10 Conclusion

A multi-focal, well-contextualized bioarchaeological approach allows us to reconstruct the lived experiences of individuals, biological and/or social groups, and entire populations. This study focused on domains including cranial modification to ascertain social affiliation, cranial lesions to gauge nutritional inefficiencies, carbon and oxygen isotope analysis to inform on dietary homogeneity and transhumance, and cranial trauma as a proxy for violence. Scrutinizing the tangled intersections of these axes allows us to better understand how warfare and deprivation get under the skin (sensu Clarkin 2010) in the generations following imperial fragmentation.

More broadly, this study shows that as even as complex political hierarchies and economic institutions crumble or flatten, novel inequalities may still emerge. Following Wari collapse in Andahuaylas, traditional elite/commoner status distinctions did not form the basis for structuring who was advantaged or deprived (sensu Earle 1991; Hastorf 1990), but rather these outcomes were patterned heterarchically according to newly coalescing, bounded, social groupings. In ancient Andahuaylas, the LIP was characterized not only by a striking surge in warfare, but also dramatic changes in patterns of diet and mobility. The strong association between elevated morbidity and excess mortality ultimately attests to profound and systemic differences in human well-being, highlighting the complex articulation between direct and structural forms of violence among populations emerging from the shock of archaic imperial collapse.

Acknowledgments Thanks to the editors, Amber VanDerwarker and Greg Wilson, for inviting me to be part of this volume and for their patience. I am appreciative of their comments, as well as those of the anonymous reviewers, whose prescient insights vastly improved the quality of this manuscript. Enmanuel Gómez Choque codirected excavations and aided in every step of the research program, which was supported by funding from Fulbright Hays, the National Science Foundation, and Vanderbilt University. The Peruvian Ministry of Culture granted research permissions, Scotti Norman made the map, and Ellen Lofaro helped with the isotopic work.

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Chapter 12
Managing Mayhem: Conflict, Environment, and Subsistence in the Andean Late Intermediate Period, Puno, Peru

BrieAnna S. Langlie and Elizabeth N. Arkush

Extant archaeological and ethnohistoric research indicates that warfare profoundly shaped the trajectory of life in the Lake Titicaca Basin, Peru, during the Late Intermediate Period (LIP, 1100–1450 C.E.) (Arkush 2011; Hyslop 1976; Julien 1983; Stanish 2003; Tschopik 1946) (Fig. 12.1). Regional surveys show that populations strategically relocated their settlements to defensive hilltop forts in response to the political perils of the time. While the unstable climate and dry environment in this region has always presented difficulties for farmers (Erickson 2000; Erickson and Balée 2006), a prolonged drought and new social tensions likely amplified subsistence stresses for LIP peoples (Arkush 2005; Bird et al. 2011; Frye 1997; Thompson et al. 1985). We broaden the discussion of agropastoral risk management to consider both social and environmental pressures that affected peoples' decisions about food production during the LIP in the Titicaca Basin.

Inter-annual fluctuations in the environment caused by climate changes can lead to crop failure, food shortages, and even starvation among human populations. Traditionally, research on agropastoral risk management has focused on strategies developed by farmers that mitigate the hazards caused by these probabilistic fluctuations (Adams and Mortimore 1997; Augustine 2010; Browman 1987, 1997; Gallant 1991; Halstead 1990; Howden et al. 2007; Marston 2011; O'Shea 1989). This literature focuses primarily on how present and past agropastoralists adapt to the local natural environment, without consideration of the political landscape of an era. In contrast, recent research has highlighted the effects of social

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_12

realities, such as warfare, on food procurement and nutritive quality (Ferguson 2006; LeBlanc 2006; LeBlanc and Register 2003; Milner et al. 1991; Otterbein 1999; Zori and Brant 2012; see also VanDerwarker and Wilson, this volume). Following current usage in anthropology, warfare is defined as a state of hostility between politically autonomous social groups involving armed, potentially lethal conflict and acts of destruction (Ferguson 1984; Milner 1999; Webster 1998). Notably, warfare and environmental stress can produce a feedback loop observed in contemporary and ancient times because repeated crop failures and food shortages brought on by inter-annual climate variance can lead to increased social tensions and warfare (Allen 2008; Lape and Chao 2008; Nel and Righarts 2008; Zhang et al. 2007). At the same time defensive nucleation results in people employing agricultural strategies that exacerbate environmental stress (Kowalewski 2006; Netting 1973, 1974).

Here, we examine how social and environmental pressures articulated, creating a context for trade-offs seen in ancient peoples' economic choices. Furthermore, we propose a methodology to measure these trade-offs. Because of the flexibility inherent in agropastoral subsistence strategies (Browman 1987), Andean populations were able to adapt to either warfare or environmental variability; however, different strategies would be chosen depending on which source of risk was prioritized. We posit that by observing the combination of subsistence adaptations implemented by ancient agropastoralists, archaeologists can pinpoint the perceived importance of each of these hazards in the past.

Even in times of peace, agriculture has been a risky undertaking in the central Andes Mountains of South America since its adoption in the region. *Altiplano* farmers have coped with chronic cold temperatures, unpredictable annual rainfall, and nutrient poor soils (Erickson 2000; Erickson and Balée 2006) by devising three primary strategies to reduce the possibility of inter-annual food shortages. First, several hardy, frost-resistant species of indigenous grains and hundreds of varieties of tubers were domesticated and cultivated in the region (Hastorf 2008; Pearsall 2008; Piperno and Pearsall 1998). Remains of these plants have been documented in archaeological contexts during earlier periods in the Titicaca Basin (Browman 1989; Bruno 2008; Rumold 2011; Whitehead 2007; Wright et al. 2003). Second, plant cultivation is complemented by camelid pastoralism (llamas [*Lama glama*] and alpacas [*Vicugna pacos*]), which provides a direct source of food and dung, the latter used to amend barren soils. Third, ancient farmers increased the productivity of soils by engineering the landscape; they constructed raised fields, sunken gardens, and terraced hillsides (Bandy 2005; Diaz Zeballos and Velálsquez Coaquira 1992; Erickson 1992, 1993, 2000; Flores Ochoa 1987; Janusek and Kolata 2004; Kolata and Ortloff 1996; Smith et al. 1968).

Yet even with these ingenious solutions, agropastoral subsistence strategies would have been particularly challenging in the Late Intermediate Period. Several lines of regional paleoclimatological evidence indicate a prolonged drought led to diminution in lake levels, particularly during the early part of the LIP (Abbott et al. 1997; Baker et al. 2009; Binford et al. 1997; Bird et al. 2011; Calaway 2005; Melice and Roucou 1998; Thompson et al. 1985; Thompson et al. 1986;

Thompson et al. 1998). These climate changes would have affected water availability for humans, livestock, crops, and wild vegetation in the region. At the same time, the threat of conflict drove warring LIP ethnic groups to resettle in defensive hilltop forts (Arkush 2005, 2011; Julien 1983; Stanish 2003; Tschopik 1946). Warfare may have intensified toward the end of the LIP, as Arkush (2011) found that most fortresses date from 1300 to 1450 C.E. These hillforts often contained dense populations living on marginal lands. As a result, warfare in the Titicaca Basin surely caused hardships that fundamentally structured economic choices (Arkush 2011).

Recent archaeological research at Ayawiri, one of the largest fortresses in the western Titicaca Basin, has allowed us to investigate how risk management strategies were implemented during a period of social conflict and environmental fluctuation. Ayawiri is located on a hilltop west of Lake Titicaca at an altitude of 4100 masl (see Fig. 12.1). Radiocarbon dates for its LIP occupation fall within the range of cal. 1275–1500 C.E. This fortified site covers over 13 hectares of the

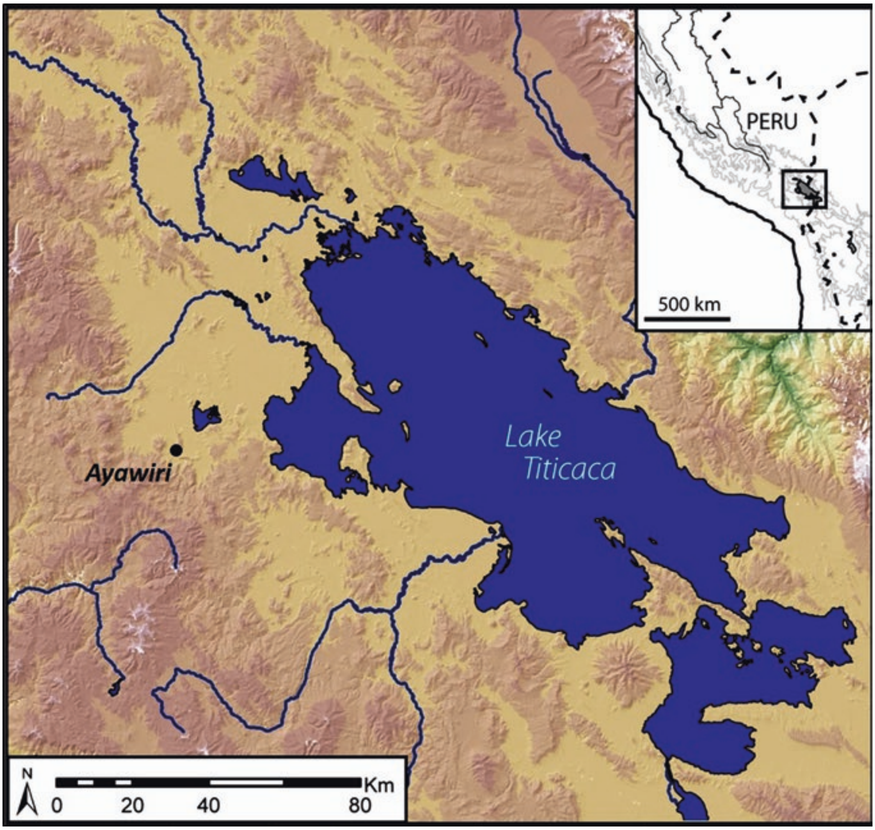

Fig. 12.1 Map of the Lake Titicaca Basin (*dot* indicates the location of the site Ayawiri)

southern portion of a flat mesa (Fig. 12.2). Three stacked-stone defensive walls measuring approximately 1.8 m high and 2 m thick protect the northern approach to the site, and a stacked stone wall encircles the rest of the habitation area. The protected area of the site south of the defensive walls includes about 120-stone wall-enclosed compounds, within which over 670 houses and 450 small storage structures have been identified (Arkush 2011). The mesa upon which Ayawiri was constructed is surrounded by steep hillsides for most of the west, south, and east sides. In prehistory, farmers carved these steep hillsides into viable agricultural terraces.

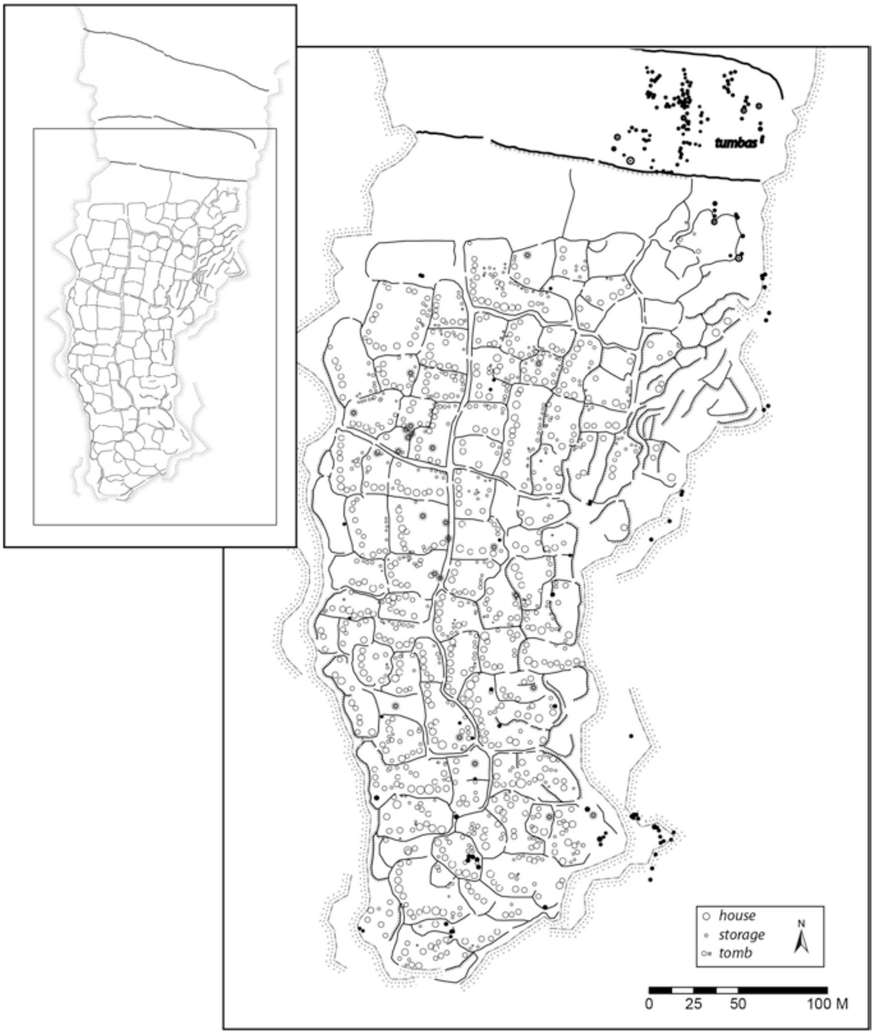

Fig. 12.2 Map of the fortified habitation area at Ayawiri

The territory surrounding Ayawiri is located in the Andean ecozones of *suni* and *puna* (Pulgar Vidal 1946), and is dominated by shrubs and grasslands. Within this territory, we have identified three distinct *ecotopes*, or the smallest ecologically relevant units on the landscape (Troll 1950) (Fig. 12.3). First, flanking the site, agricultural terraces, which are still farmed today, contain shrub plants and crop weed companions when not in cultivation. Indigenous crops grown on the terraces today and probably in prehistory include quinoa (*Chenopodium quinoa*), and tubers such as oca (*Oxalis tuberosa*) and potatoes (*Solanum tuberosum*). Second, to the east of the site, there is a valley that is partially flooded in the rainy season and has very low agricultural potential today due to the high salinity of the soil, although relic fields in the eastern part indicate a far area of the valley was cultivated in the distant past. This valley is composed of predominantly of bunch grasses (e.g., *Stipa ichu*). Third, to the south and west of Ayawiri, there is another valley with a year-round river that is also abundant in bunch grasses. Parts of this river channel into a rich swampy *bofedal*, used as a pasture for herd animals today. This *bofedal* is rich in lacustrine and riverine plants that thrive in wetland areas, such as sedges (Cyperaceae).

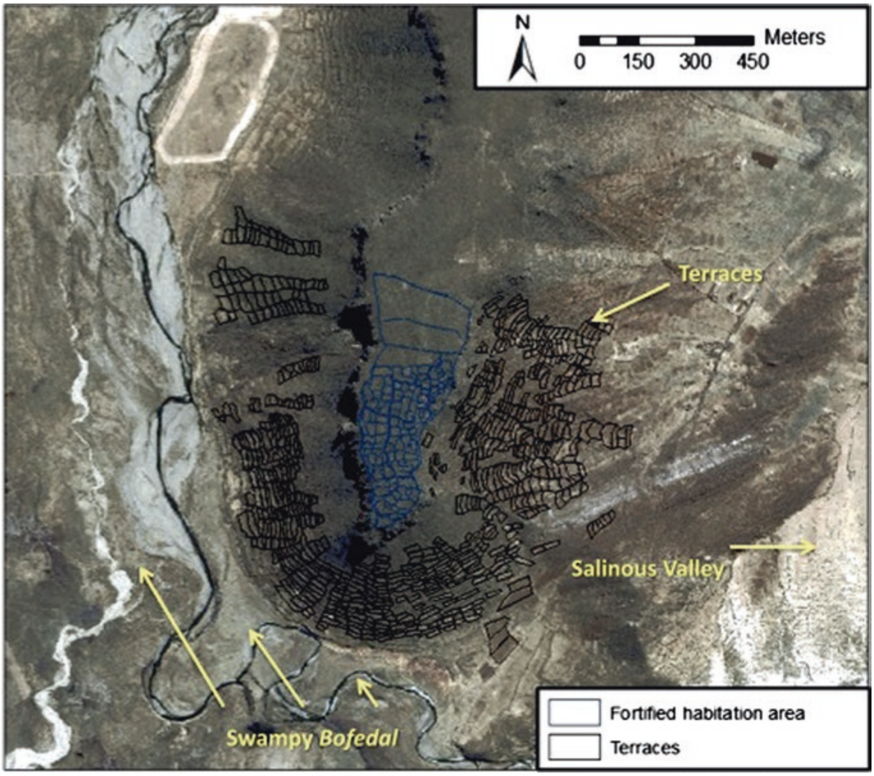

Fig. 12.3 Map of the ecotopes surrounding Ayawiri

From 2009 to 2014, Proyecto Machu Llaqta, directed by Arkush, carried out research at the habitation area at Ayawiri. We have conducted architectural mapping and intensive excavations, and Langlie conducted macrobotanical analyses of recovered plant remains. With these materials, we aim to clarify the trade-offs that the ancient people of Ayawiri made in managing different kinds of agropastoral risks.

12.1 A Model for Managing Risk at Ayawiri

In constructing a model for risk management at Ayawiri, we distinguish among three kinds of interrelated risks: (1) *environmental stress* caused by climatic variability; (2) *intra-group stress* caused by tensions within a community; and (3) *inter-group stress* caused by conflict between communities or enemies. In reviewing ethnographic and archaeological literature about agropastoralism, we found that strategies adapted to cope with environmental stress are qualitatively different than those adapted to deal with inter- and intra-group stresses. Thus, we propose that it is possible to measure ancient farmers' perceptions of these stresses in the past by identifying which strategies they chose to mitigate risks. We begin this discussion by outlining these three types of risk.

Environmental Stress: In the frost-prone and drought-prone Andean *altiplano*, perturbations in the climate such as a prolonged drought would have a specific influence on subsistence strategies. Ayawiri residents would have needed to mitigate the impact that environmental stress potentially had on inter-annual variability in the food supply. Farmers coud have dealt with inter-annual variability logistically in terms of crop management and field management, and socially by sharing foodstuffs within and between communities.

Intra-group Stress: Defensive nucleation into large towns, like Ayawiri, created new health problems of crowding, sanitation, and pressure on local resources, as indicated in several archaeological studies from North America (e.g., Cobb and Steadman 2012; Emerson 2007; Milner 2007), and generated new intra-group tensions among community members and factions (Birch 2013; Johnson 1982; Kowalewski 2006). These tensions could have been mitigated through practices that build group cohesion, such as collective ceremonies, and conformity in the choices of households and individuals. This new social environment could also have affected the ways in which a community organized food storage, processing, and consumption choices.

Inter-group Stress: The threat of warfare drove resettlement to defensive hilltop fortresses, often on marginal lands. This choice of location affected food production strategies. Specific cropping schemes, field locations, and camelid grazing areas could be adjusted to a context of violent conflict if the threat were severe. For example, planting crops and grazing camelids near the site would reduce exposure to enemy attack by reducing time spent outside fortifications (Milner et al. 1991; see also Kennett et al. and VanDerwarker and Wilson, this volume).

How can we assess the impact of these stresses on the lives of prehistoric populations? Drawing on ethnography, traditional ecological knowledge, historical data, and comparative archaeology, we propose a model to assess the trade-offs between environmental stress, intra-group stress, and inter-group stress (Table 12.1). This model is specific to agropastoralism in the *altiplano*, but has

Table 12.1 Choices Ayawiri residents may have made to cope with environmental, inter-group, and intra-group stress

Strategy		Effects on:		
		Environmental stress	Inter-group risk of attack	Intra-group stress
Field location	*Field fragmentation*	↓ risk of crop failure	↑ farmers' risk of attack and crop raiding	↓ competition between neighbors' claims to nearby fields
	Reliance on nearby field	↑ risk of crop failure and depletes soil nutrients	↓ risk of attach because farmers remain closer to fort	↑ competition between neighbors' claims to nearby fields
Grazing strategy	*Extensive grazing on wild plant stands*	↓ risk of crop failure	↑ Camelid exposure to theft	↓ social tensions sparked by camelids grazing on neighbors' cultivated fields
	Grazing in fields and on crop plants	↑ risk of crop failure	↓ Camelid exposure to theft	↑ social tensions sparked by camelids grazing on neighbors' cultivated fields
Types of foods consumed	*Diverse diet*	↓ risk that harvest will fail	↑ risk of exposure to attack because traversing diverse ecologies	None
	Constrained diet	↑ risk that harvest will fail	↓ risk of exposure to attack because traversing diverse ecologies	None
Settlement pattern	*Fissioning into small settlements*	↓ stress on local resources	↑ risk and exposure to attack	↓ social tensions
	Nucleation	↑ stress on local resources	↓ risk and exposure to attack	↑ social tensions
Storage and consumption	*Communal pooled storage and/or consumption*	Evens out and ↓ risk among households	None	??
	Privatized storage and/or consumption	↑ risk to a household's inter-annual food supply	None	↓ social tensions

the potential to be adapted elsewhere. We target several behaviors that are sensitive to these risks and stresses: choice of field location, grazing strategies, types of foods, settlement patterns, and storage and consumption practices. Settlement patterns and storage and consumption practices can be gleaned from survey and excavation data. Decisions regarding field locations, grazing strategies, and types of crops grown can be assessed using data gathered from analyses of macrobotanical remains recovered from the habitation area of the site, and through comparing these data with ecotope analysis of the landscape surrounding Ayawiri. Unless the context of charred plant remains is clear (i.e., burned food in a storage structure), most macrobotanical evidence in this project yields data potentially related to human diet, types of crops cultivated, camelid grazing, and the natural environment. This is because, in addition to periodic cooking accidents, charred seeds excavated from Ayawiri represent routine dung burning. Particularly in xerophytic environments where trees are rare, and at high altitudes where lower oxygen levels are insufficient to stoke wood fires, several archaeobotanists have shown that small carbonized herbaceous seeds recovered from various contexts likely entered the archaeological record through dung burned as fuel (Hastorf and Wright 1998; Klinge and Fall 2010; Miller 1984, 1997; Miller and Gleason 1994; Miller and Smart 1984; Spengler et al. 2013). In the Andes, camelid dung fires explain the herbaceous weedy seed signature of many archaeobotanical samples (Hastorf and Wright 1998; Pearsall 1989). Because camelid dung has been a preferred fuel source for fires in the Andes, archaeobotanical remains preserve the digested remnants of grazing (Hastorf and Wright 1998; Miller and Smart 1984). We compare these remains to the ecotope signatures surrounding Ayawiri to assess locations where ancient agropastoralists grazed their herds (Spengler et al. 2013). These analyses allows us to identify risk management strategies chosen by Ayawiri residents during the LIP.

12.1.1 Field Location

Regarding environmental stress, farmers recognize that microenvironmental differences in soil quality or climate mean that they never know whether a specific crop or variety will prosper in any given year (Baksh and Johnson 1990). Ethnographic and ethnohistoric sources have noted that agropastoralists deal with this issue by cultivating fields in various locations, a practice known as field fragmentation. In the Andean context, field fragmentation appears as a form of spatial diversification that capitalizes on diverse microenvironmental zones to hedge against local climate variability (Browman 1987; Bruno 2011; Chibnik 1990; Goland 1993; Marston 2011; McCloskey 1976; Stone and Downum 1999). Simultaneously farming in multiple ecotopes, such as locating fields in wetlands, at low elevations, and on hillsides, takes advantage of natural microclimates (Browman 1987; Bruno 2011; Marston 2011). Where water is already scarce, field fragmentation would have increased the probability of crop success, particularly during periods of drought (Stone and Downum 1999). If farmers were foddering or grazing their animals on crops, then field fragmentation would also provide food security for livestock.

Additionally, we postulate that field fragmentation might result in decreased competition between families over claims to nearby fields, therein minimally reducing intra-group stress. However, for the residents of Ayawiri, spatially extensive field fragmentation would have heightened inter-group stresses by increasing time spent outside of defended zones rendering farmers more susceptible to enemy attack (see also VanDerwarker and Wilson, this volume). Furthermore, faraway fields would be left unattended and exposed to possible crop theft or crop damage by enemies (Netting 1973).

Under similar conditions to the social situation at Ayawiri, modern warring populations in west Africa intensified agriculture adjacent to areas of settlement nucleation, and farmers abandoned fields near contested frontiers to reduce exposure to inter-group violence (Netting 1973, 1974). Similarly, archaeologists of North America have found that Pre-Columbian warring peoples' diets were constrained due to "feelings of insecurity resulting in excessive caution when conducting subsistence practices" (Milner et al. 1991, p. 590; see also VanDerwarker and Wilson, this volume). If inter-group tensions were high and violence was a perceived risk to Ayawiri farmers, then we would expect them to intensify agriculture in the ecotope nearest the site. In doing so, intensification near the site would reduce the risk of attack by other groups because farmers can readily retreat to a defensive position. Nevertheless, intensifying production near the site often causes an increase in environmental stress by degrading soil fertility, thereby resulting in a subsequent decline in yields over time (Boserup 1965); additionally, this strategy could increase intra-group tension through competing claims to nearby fields.

At Ayawiri, intensification near the site would have taken place on the terraced hillsides that flank the fortress. Survey of the agricultural terraces near the site recovered LIP ceramics from surface contexts. Based on these ceramics and proximity to the site, we posit that if LIP Ayawiri residents abandoned frontier zones and intensified agricultural production near the site, they would have done so on the adjacent terraces. Macrobotanical data yield evidence regarding field location and grazing strategies. Specifically, abundant and diverse macrobotanical remains that grow in multiple ecotopes would point to an extensive agropastoral land-use strategy, while a low abundance of plant remains from riverine and the valley-bottom ecotopes would point to probable agricultural intensification on the terraces.

12.1.2 Grazing Strategies

Like field location, peoples' choices regarding grazing and foddering herd animals would have been made with sensitivity to both environmental and social stresses. In other parts of the world, if the environment does not allow farmers to produce sufficient yields to meet the demands of human subsistence, then fields and crops are reserved for human consumption, while domesticated animals are grazed extensively or foddered on wild plants (Boserup 1965; Marston 2011). Extensively grazing animals might also decrease intra-group tensions sparked by grazing on their neighbors' field crops. Additionally, extensive grazing would expose livestock to possible raids. Nevertheless, it is worth noting that in comparison with agricultural field fragmentation, grazing on wild stands requires fewer people to be exposed to possible attack outside of defensive hillforts. Depending on the size of the herd, often only a single person needs to accompany the camelid herd to pasture, an inference based on our observations in the region today.

While Miller (1996, p. 524) notes that humans likely consumed some of the wild taxa found in archaeological contexts where dung was also burned, she contends that "most of the actual specimens of these taxa became charred through the burning of dung as fuel." With this taphonomic understanding that charred herbaceous seeds are "*primarily* fuel remains" we are propelled to ask more nuanced questions of macrobotanical data (Miller 1996, p. 527). Thus, analysis of macrobotanical remains from Ayawiri elicits information about the diet, and ranging behaviors of ancient camelid herds.

Following a method detailed by Marston (2011), we query the macrobotanical data to better understand landscape use by Ayawiri pastoralists. Based on information derived from modern Andean camelid foraging studies, we know that modern alpaca and llama herds in the Andes eat a diverse and broad diet (Bryant and Farfan 1984; Flannery et al. 1989). Andean camelids can consume an array of forage plants and cultigens (Bonavia 2008). Furthermore, among Andean farmers, it is a common practice to share cultivars with herd animals (Hastorf and Wright 1998). In this study, an abundance of crop and companion weed plant remains would indicate an intensive land-use strategy where farmers grazed their herds on agricultural fields and/or shared their food with camelids, whereas wild and riverine plant remains would indicate an extensive herding strategy or human land-use pattern. Abundant and ubiquitous crop, weed, and herbaceous macrobotanical remains would be indicative of a mixed strategy of intensive agriculture in the terraced fields and extensive grazing/foddering, indicating that farmers made choices to balance risks posed by both environmental stress and intra-group conflict.

12.1.3 Types of Foods

Social and environmental factors affect choices about the varieties of crops grown and types of animal protein consumed. For example, diversification among agropastoralists hedges against the risk of failure of any one crop or loss of herd animals due to climatic forces (e.g., frost or drought) or disease (e.g., nematodes or animal sickness) through the production of multiple agropastoral products with different resistances and different rates of maturation (Browman 1987; Marston 2011). By employing a diverse economic strategy, agropastoralists can readily make seasonal, annual, or inter-annual shifts in time spent herding or farming in order to account for environmental fluctuations as well as social situations. However, inter-group conflict can affect a community's access to fields in various ecotopes, grazing areas, and hunting grounds. For instance, based on bioarchaeological data, Milner et al. (1991) inferred that prehistoric warfare in North America actually decreased the types of plants in local diets because peoples' daily activities were constrained; VanDerwarker and Wilson's presentation of plant data (this volume) from this same region essentially confirms Milner's conclusion.

To assess how social and environmental stress affected the diversity and types of food grown, we examine macrobotanical data for evidence of either a diverse or constrained diet. In combination with our preliminary impressions of the excavated faunal assemblage, we are able to establish whether inhabitants were consuming crop plants, grazing extensively, and hunting wild animals from various ecotopes.

12.1.4 Settlement Patterns

The way that a group settles on the landscape is largely dependent on social or environmental factors. For example, nucleation for defensive purposes is a common response to the threat of inter-group conflict (Arkush 2011; Haas 1989; Keeley et al. 2007; LeBlanc 1999; Nelson 2000), whereas a dispersed settlement pattern ensures that each family group has sufficient land to produce food (Boserup 1965). A nucleated settlement pattern not only places pressure on nearby lands, it can also increase intra-group stress. While an extensive settlement strategy reduces competition over resources between neighbors, nucleation brings many families together into densely packed settlements (LeBlanc 2000; Plog and Solometo 1997). As settlements grow, it is reasonable to expect that the site's inhabitants experience challenges to public health and an increase in social tensions. How did these intra-group stresses articulate with environmental risk and the risk of attack in the past? One classic solution to intra-group stress *and* environmental pressures—fissioning—would have directly increased the risk of enemy attack on these hillfort communities.

To understand residents' choices about settlement organization at Ayawiri, we assess the environmental context of the site location, in addition to the external and internal architecture of the site. Proximity to natural resources lends insight into whether the site was chosen to cope with environmental pressures of such a large population, or whether residents chose the location for its natural defenses. Furthermore, the organization of both household and communal space at the site can lend insight into how residents managed and assuaged intra-group tensions. For instance, civic architecture and public space are often interpreted as architectural constructions that bring residents together and potentially mediate intra-group tensions in cases of nucleation or rapid settlement growth (Cohen 2010;

Pluckhahn 2010; Rodning 2013). Creating such space for collective ritual is one way a defensible, densely packed community could choose to lessen intra-group stress.

12.1.5 Storage and Consumption Practices

Specific storage and consumption practices are often regarded as risk management strategies chosen to minimize inter-annual food shortages (Winterhalder 1990). Storage of agricultural surplus guards against food shortages due to variable crop yields caused by climatic fluctuations, especially in places like the *altiplano* where the seasons dictate that farmers can only plant and harvest a single annual crop (Low 1990; Marston 2011; Winterhalder et al. 1999). Communal storage or intra-group food sharing ensures no single household will suffer in case of individual agricultural loss (Davies and Bennett 2007; Kaplan et al. 1990). Thus, people might have engaged in risk pooling—food sharing, feasting, and/or communal storage—in order to minimize the damage that crop failure wrought on any particular family or kin group. However, this strategy requires cooperation and might not be possible if intra-group tensions and mistrust were strong. In the absence of food sharing, household surplus accumulation could have elevated intra-group stress as some households aggregated stores and others did not, making inequalities apparent. However, if stores were hidden, this may have mitigated intra-group hostilities (DeBoer 1988; Zori and Brant 2012).

Various archaeological indicators at Ayawiri point to how residents carried out storage and consumption during the LIP. The location and size of storage architecture indicate whether surplus was stored at a household or communal level. We look at evidence of cooking and processing to pinpoint how and where these activities were carried out. Finally, evidence regarding the nature of feasting can indicate whether food sharing was common among Ayawiri residents. These indicators shed light on the degree to which food sharing strategies were chosen to cope with environmental and/or social stresses.

To summarize, agropastoralists make calculated trade-offs in crafting subsistence strategies and in choosing and building their settlements. The benefit of engaging in any one risk mitigation strategy may or may not be offset by an equivalent cost. For example, choosing to live in a nucleated settlement may only slightly increase stress on the surrounding environment, while at the same time substantially decreasing the possibility that residents will suffer from enemy raiding. By individually assessing each strategy chosen by farmers in prehistory, we gain insight, not into a perfectly rational set of decisions, but into how farmers *perceived* environmental and social stress in their time. Placed within a paradox of trade-offs, the residents at Ayawiri were forced to develop a specific combination of subsistence strategies adapted to their perceptions of risks stemming from environmental stress, intra-group stress, and inter-group stress.

12.2 Macrobotanical Results

Macrobotanical remains were recovered during excavations from hearths, structure floors, and patios. Most macrobotanical samples were collected as 10-liter soil samples (unless features were smaller in volume) and subsequently floated using a modified SMAP-style flotation machine. While analysis is ongoing, Langlie has thus far completed analysis of 49 macrobotanical samples from 426 liters of soil. In these samples, 10,430 macrobotanical specimens have been identified, of which 9894 are seeds, 536 fragments are wood larger than 2.0 mm, and 27 fragments are charred fragments of dung (Table 12.2). These specimens represent 12 types of botanical remains, including two domesticates: chenopod (*Chenopodium* spp.) seeds and fruits, and tubers.

To analyze macrobotanical remains, we employ two commonly used quantitative indices: standardized density and ubiquity, the latter expressed as percentage presence. These measures are used to identify important plants in the assemblage. Density is the measure of the sum of the specimens of a taxon divided by liters of soil floated (Miller 1988). Ubiquity is a measure of presence of a taxon that is measured by adding the total number of samples a taxon is present in, dividing it by the total number of samples analyzed, and multiplying by 100 to obtain a percentage (Popper 1988). Ubiquity allows us to partially mitigate issues of preservation and recovery in this study by disregarding absolute counts. We assess the

Table 12.2 Ayawiri paleoethnobotanical results

	Raw counts (N)	Standardized density (N/l of soil)	Ubiquity (%)
Crop plant remains			
Chenopodium spp.	9215	21.6	96
Tuber fragments	194	0.45	24
Crop companion weedy plant remains			
Fabaceae	58	0.14	37
Relbunium sp.	20	0.05	16
Rubiaceae	5	0.01	12
Cactaceae	25	0.06	6
Malvaceae	86	0.2	49
Verbena sp.	1	<0.01	4
Riverine and lacustrine plant remains			
Cyperaceae	16	0.04	18
Herbaceous plant remains			
Poaceae	272	0.64	63
Plantago sp.	2	<0.01	4
Fuel			
Wood	536	1.26	73
Dung	27	0.06	8

relative importance of these plants in the economy at Ayawiri by comparing ubiquity values to other paleoethnobotanical studies from the *altiplano* dating to earlier time periods (Table 12.3).

12.2.1 Crop Plants

Chenopod fruits and seeds compose the vast majority of this assemblage ($n = 9215$). At least two species of chenopods were domesticated in the Andes: quinoa and *kañawa* (*Chenopodium pallidicaule*). Numerous subspecies (mostly weeds) grow in the region today. The standardized density of chenopods in this assemblage is almost identical to other *altiplano* paleoethnobotanical studies (see Table 12.3). Notably, fruits from this study appear to be domesticated species based on their comparatively large diameter, thin testa (seed coat), and truncate margin configurations (see Bruno 2006; Smith 1984).

Fragments of plant storage tissue called parenchyma in this assemblage represent tubers, which continue to be grown on the adjacent terraces today. One particular ancient specimen has a distinct eye or axillary bud and leaf scar, which indicate the recovered tissue is a potato. Additionally, excavations in 2012 uncovered seven morphologically intact and completely charred potatoes. Several stem and root tubers were domesticated in the Andes, including the potato, oca, mashwa (*Tropaeolum tuberosum*), ulluco (*Ullucus tuberosus*), and maca (*Lepidium meyenii*) (Flores et al. 2003; Pearsall 2008). The starchy content and preparation method (e.g., boiling and mashing) of tubers means that parenchyma rarely preserves in the archaeological record (Pearsall 2000). This taphonomic consideration likely contributes to the low density of tuber remains in the Ayawiri samples. Additionally, preservation issues probably contributed to the variability in the ubiquity of parenchyma recovered from other sites in the region (see Table 12.3).

12.2.2 Crop Companion Weedy Plants

We identified a group of plant seeds often considered weeds in the region that commonly thrive in disturbed *altiplano* soils such as enriched agricultural fields (Fabaceae, Malvaceae, *Relbunium* sp., Rubiacaeae, and Verbenaceae) (see Bruno 2006). Additionally, a few cactus (Cactaceae) seeds were identified. Langlie noted that cactus plants thrive today throughout the residential area of the site and on the agriculture terraces. Generally, weedy plants recovered from Ayawiri were less ubiquitous than those found at other *altiplano* sites (see Table 12.3).

Table 12.3 Ubiquity values (expressed as percentage presence) derived from comparative paleoethnobotanical studies conducted in the *altiplano* region

Site name	Ayawiri	Chiripa	Kala Uyuni	KCH 11, 21, and 56	Tiwanaku	Tiwanaku	Tiwanaku
Period name and date ranges	Late intermediate (C.E. 1100–1450)	Formative (1500–100 B.C.E)	Formative (1500 B.C.E–C.E. 200)	Late formative (200 B.C.E–C.E. 200	Late formative 1 & 2 (200 B.C.E–C.E. 500)	Middle Horizon (Tiwanaku IV C.E. 500–800)	Middle Horizon (Tiwanaku V C.E. 800–1150)
Number of samples	*N* = 49	*N* = 560[a]	*N* = 213[b]	*N* = 21[c]	*N* = 24[d]	*N* = 113[d]	*N* = 204[d]
Crop plant remains							
Chenopodium spp.	96	99	94/98*	76	96	99	92
Tuber fragments	24	67	92	81	16	6	3
Maize	0	0	0.4	0	20	43	24
Crop companion weedy plant remains							
Fabaceae	37	59	92	48	**	**	**
Relbunium sp.	16	42	71	0	**	**	**
Rubiaceae	12	0.18	51	0	**	**	**
Cactaceae	6	23	10	57	**	**	**
Malvaceae	49	93	97	76	**	**	**
Verbena sp.	4	37		0	**	**	**
Riverine and lacustrine plant remains							
Cyperaceae	18	64	91	76	**	**	**

(continued)

Table 12.3 (continued)

Site name	Ayawiri	Chiripa	Kala Uyuni	KCH 11, 21, and 56	Tiwanaku	Tiwanaku	Tiwanaku
Herbaceous plant remains							
Poaceae	63	92	98	67	40	57	26
Plantago sp.	4	4	11	10	**	**	**
Other							
Wood	73	79	99	86	80	91	88
Dung	8	13	8	24	88	98	91
*Includes *Chenopodium quinoa* and *Chenopodium* spp., respectively							
**Authors lumped these taxa into a single weedy category							

[a]Data from Whitehead (2007)
[b]Data from Bruno (2008)
[c]Data from Langlie (2011)
[d]Data from Wright et al. (2003)

12.2.3 Riverine Plants

One distinct aquatic plant type identified thrives in moist soil near stands of water is Cyperaceae, also known as sedges. Only a few sedge seeds were identified. In the *altiplano*, a perennial aquatic sedge locally known as *totora* (*Schoenoplectus californicus*) is intensively cultivated in the modern era and this practice likely extends back into antiquity (Banack et al. 2004; Orlove 1991). The white juicy rhizome located at the base of the *totora* plant is commonly consumed as food (Browman 1989; Bruno 2008), and the stalk can also be used as thatching for roofing material, boats, mats, tools, cordage, and animal fodder (Browman 1989; Orlove 1991; Whitehead 2007). Based only on the seed morphology, archaeobotanists in the Andes are currently unable to differentiate sedge seeds to species; however, Bruno (2008, p. 233) notes that Cyperaceae seeds recovered from sites in the region probably derive from one of three different genera (*Schoenoplectus* sp., *Carex* spp., or *Scirpus* spp.). Cyperaceae seeds are often common and abundant in macrobotanical assemblages in the region; however, we identified only 16 seeds from this family. The ubiquity value of Cyperaceae seeds found at Ayawiri is appreciably lower than at other archaeological sites in the region (see Table 12.3).

12.2.4 Herbaceous Plants

Additionally, two herbaceous seed types were identified that grow in most ecotopes throughout the *altiplano*: Poaceae (grass seeds) and *Plantago* sp. (the plantain family). At least four types of grass seeds were distinguished in samples; however, at least 85 species of grass grow in the region today (Whitehead 2007). For centuries, *altiplano* grasses have been used for animal forage, fodder, basketry, and building construction as thatching and roofing material (Bruno 2008; Whitehead 2007). The ubiquity of grass seeds found in samples at Ayawiri is comparable to that recovered from Tiwanaku, but markedly lower than at other sites (see Table 12.3).

We infer that cultivated crop plants were an essential component of the economy at Ayawiri, as indicated by the abundance of both crop plants and companion weed plants. Based on comparative ubiquity values, crops were just as important to the diet of Ayawiri residents as they were during earlier time periods in the *altiplano*. Due to the intensive nature of chenopod and tuber cultivation, Ayawiri farmers likely spent much of their time in their cultivated fields. Growing these plants would have required farmers to invest a considerable amount of time tilling soil, sowing seeds, tending fields, and harvesting mature crops. As none of the identified crop plants require large amounts of water, we propose that inhabitants grew their crops on the nearby terraces.

12.2.5 Fuel Plants

Charred wood fragments were found in many of the Ayawiri samples. Today, the landscape surrounding the site is almost completely devoid of trees except for a couple *keñua* (*Polylepis* spp.) trees growing near the base of the terrace complex. These trees are knotty and soft, which makes them poor candidates for building materials. On the other hand, woody shrubs predominate in the region and are common on agricultural terrace margins, on the steep hillsides, and on the top of the mesa just north of Ayawiri. These shrubs were likely used as a complementary fuel source in prehistory throughout the region (Bruno 2008). As many of the woody specimens in our assemblage are small twigs, residents of Ayawiri likely stoked their fires with the branches of dried woody shrubs. Based on the comparable ubiquities of wood recovered from Ayawiri and other sites in the region (see Table 12.3), we suggest residents of the site were using shrubs for fuel in a similar manner as in people from earlier periods.

We also found charred fragments of dung and small herbaceous seeds indicative of dung burning in many of the Ayawiri samples. Criteria outlined by Miller (1996) and Spengler et al. (2013) confirm that macrobotanical remains recovered from the site partly derive from dung burned as fuel: (1) Alternative fuel is rare and insufficient in the *altiplano*; (2) based on the zooarchaeological analysis residents possessed herd animals (specifically llamas) that produced suitable dung for burning; (3) we found burned fragments of dung, and herbaceous seeds were ubiquitous; (4) many seeds were poorly preserved or fragmented, likely as a result of mastication or digestion; (5) many seed assemblages were mixed and heterogeneous; (6) all samples analyzed were recovered from domestic use or refuse areas rather than storage contexts (no samples from discrete storage contexts were included in this analysis); and (7) there is an ethnographic history of dung used for fuel in the region. Today, dung is still used by residents living near Ayawiri and throughout the Andes to fuel cooking and warming fires. Sillar (2000) notes that in the Cuzco region, potters still prefer dung for ceramic production because it provides more even burning. Lastly, (8) there is a long archaeological history of dung fuel use throughout the *altiplano*. Browman (1989), Bruno (2008), and Whitehead (2006, 2007) have all identified charred camelid dung from Formative Period archaeobotanical samples recovered from sites located on the southern shores of Lake Titicaca. Evidence of dung fuel use was pervasive at nearby Tiwanaku, where it was found in various cultural contexts (Hastorf and Wright 1998; Wright et al. 2003). These archaeological data provide evidence that dung has a long history of use as fuel in the broader Titicaca region.

Preliminary zooarchaeological analysis of animal bones recovered during excavations from the site indicates that camelids represented a significant portion of the Ayawiri economy, whereas lacustrine and riverine animals such as aquatic birds and fish are poorly represented in the assemblage (Aimee Plourde 2014, personal communication). Considering these findings alongside the abundant remains of crop plants and companion weed plants, we posit that Ayawiri residents and their herd animals were dependent on both agriculturally and pastorally produced foods. This diet seems somewhat narrow, particularly for camelids. For humans, chenopods and tubers dominated the diet, whereas camelids only consumed companion weedy species and possibly crops, with relatively little pasturing in the *bofedal* even though it is quite close.

These data also allow us to identify ecotopes where residents grazed their camelid herds. Based on the abundance of crop and companion weed plants, our data indicate Ayawiri camelids were primarily grazed intensively in cultivated fields, probably in terraces adjacent to site. However, residents occasionally took their herds to graze in riverine or lacustrine ecotopes as indicated by the identification of a small amount of wetland-adapted plant species. Compared to Formative Period sites in the *altiplano,* the low incidence of Cyperaceae plants indicates herds rarely grazed in riverine or lacustrine ecotopes. These data point to a constrained grazing strategy during the LIP.

12.3 Settlement and Architectural Results

The site location and the layout of Ayawiri also offer insight into the choices made by its inhabitants. Survey and excavation data reveal that Ayawiri housed a large and dense population that aggregated at the site in the latter part of the LIP. Birch (2013) argues that in cases of settlement aggregation, site architecture is particularly indicative of how integration was accomplished and how interactions were fostered or discouraged; for instance, plazas or public ritual facilities might aid in the integration of communities and the construction of cosmic order, while distinct residential sectors could help to maintain separate social units within the site. At Ayawiri, there is a very marked pattern of residential separation and individuation that is much clearer than that found at other, smaller hillforts in the northwest Titicaca Basin. As we discuss below, people carried out most public and private activities, including food processing and preparation, within segregated compounds. A central north–south causeway and smaller intersecting streets divide the site into smaller sectors, and channel traffic so that residents of the same sector would have crossed paths more frequently; these sectors may also have been related to social group identities. What about community integration? There is no ceremonial or civic architecture aside from tombs, although open spaces between the defensive walls might have served as gathering spaces. It is also possible to imagine communal activities that would have left no physical trace. Nevertheless, we cannot point to any central integrative facilities, such as the platform and court complexes typical of Titicaca Basin centers in earlier periods, which were designed to bring residents together or allow for the ritual mediation of social tensions. Most tombs at Ayawiri are placed within cemeteries, and these places may have hosted periodic collective rituals. However, since there are several cemeteries at the site, and several distinct tomb clusters in the largest cemetery, such rituals likely emphasized identities related to descent groups (real or fictive) rather than a unified, collective Ayawiri identity.

Walled residential compounds are quite uniform across the site. They include houses and storage structures surrounding a central open patio (Fig. 12.4). Houses are circular structures with compacted use floors that contained ceramic, lithic, and bone artifacts. Houses are usually placed on the south and west side of compounds, often on a somewhat elevated fill level or a low platform. Where doorways are identifiable, they face out into the center of the compound. A good deal of food preparation took place inside houses. Twelve out of nineteen houses we have excavated to date had clay ovens, which are oval- or pear-shaped and about 30–40 cm wide (Fig. 12.5). They appeared to have supported a cooking vessel on top, while a fire burned in the hollow chamber inside. Houses with ovens are typically associated with grinding stones, cooking vessels, and faunal remains on floors, often right next to the oven, so these were clearly spaces for food preparation. (Grinding stones are also typically found in the patio spaces, so some food preparation took place in the open.) Because not all houses had ovens, we assume a *household* often corresponded to more than one structure: perhaps each nuclear

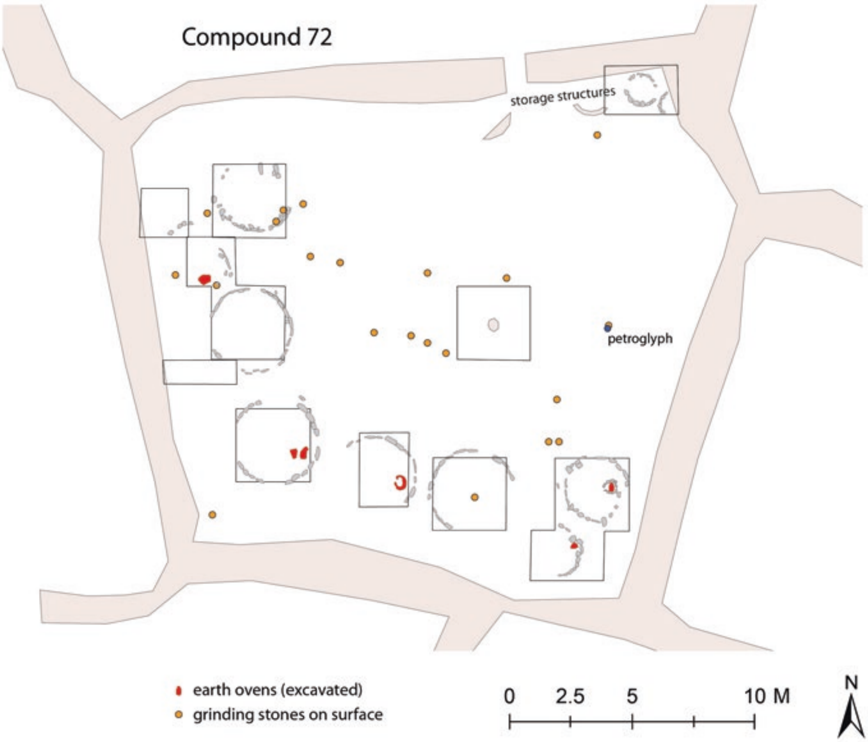

Fig. 12.4 Map of a typical compound at Ayawiri, with storage structures located in the northeast area and domestic structures that open onto the patio

Fig. 12.5 Example of an excavated clay hearth found at Ayawiri

family used from one to three structures on average. Compounds have between one and 19 large structures, with most ranging from two to eight structures, suggesting one or a few related families shared a compound.

In addition, residential compounds also have small circular storage structures, usually located on the north and east sides of the compound. Typically, these consist of a circle of larger rocks retaining an interior of loose rock rubble, creating a low platform apparently designed for drainage and perhaps some ventilation (Fig. 12.6). We infer that residents stored crops or dried meat (*charki*) on these aerated small platforms to prevent moisture and rot; a perishable superstructure may have protected the contents, as suggested by de la Vega (1990). Very similar storage structures are attested at the Inca site of Huanuco Pampa (Barnes 2012). Although no storage pits defined by stone lining or differential color or compaction were identified inside houses during excavations at Ayawiri, we did find a charred cache of potatoes and quinoa in a small pit dug into the soft fill below the floor of a structure. This pit would have been missed entirely if it were not for the charring and careful recovery of macrobotanical remains using flotation. Thus, it is possible that other small, informal and clandestine storage pits that we did not detect were placed inside structures. There is no good evidence for pooled storage. All storage structures are located in residential compounds, and if they can serve as an index of staple wealth, then wealth varied considerably across the site.

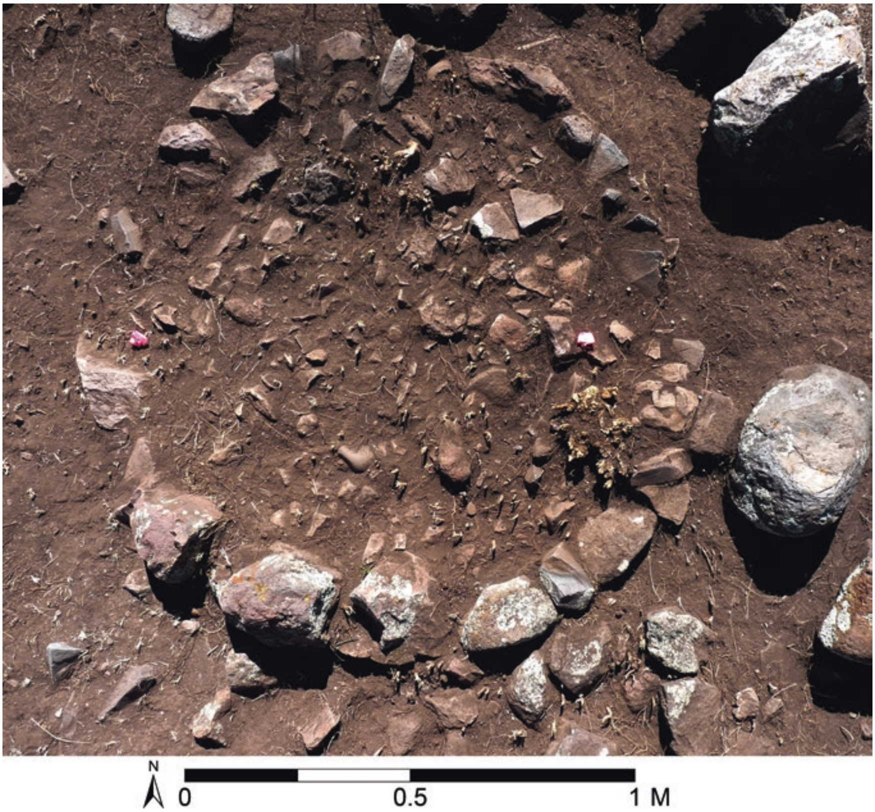

Fig. 12.6 Example of excavated storage structure consisting of a circle of larger rocks retaining an interior of loose rock rubble, creating a low platform

These data indicate that daily activities relating to food preparation and storage were segregated—they were kept within a family or kin group defined by residential compound walls. We are still in the process of assessing pooled consumption—feasting—but it is better evidenced in the earlier occupation of the site, during the Late Formative Period, than in the LIP based on the recovery of large dumps of faunal remains and ceramics during the former period. However, even if food preparation and consumption were not socially inclusive activities, they would have been public knowledge. Stored food was kept in freestanding external structures that were visible and could be counted. Because the central causeway and most intersecting alleys are raised above ground level, as people passed through the site they could look down into their neighbors' residential compounds—especially adjoining compounds—and witness storage structures and food-related activities. In addition, anyone living in an internal compound not abutting an alley would have had to pass daily through the domestic space of another group (perhaps their relatives) and would have seen evidence of their neighbors' activities and accumulated staple wealth. So a great deal of social life was observable, notwithstanding the careful demarcation of space with compound walls. Considerable similarities in the artifact assemblages and spatial layout of different compounds indicate pervasive community norms and practices, although some status differences between compounds were made visible through differences in the architecture of houses and compound walls. Our general sense is that of a site organized around conformity, fairly rigid social expectations, and segregation into kin groups.

To summarize, as with other large LIP hillforts in the region, the hilltop location, the size of the site, and the defensive nature of the walls indicate a settlement strategy that prioritized defense. Living in such a large, densely packed settlement on an inaccessible landform would have afforded residents significant protection from inter-group conflict. Furthermore, such a large population living in one area would lead to increased environmental stress such as diminished availability of local natural resources and decreased soil fertility due to intensified farming practices. At the same time, nucleation would have elevated intra-group tensions over personal space and access to resources. At Ayawiri, we do not see clear evidence for a spatial organization designed to mediate these tensions by building a closely integrated and cohesive community that engaged in many communal activities. The organization of space for living, cooking, storage, and ceremony indicates Ayawiri's residents managed their affairs separately, at the household or compound level.

12.4 Discussion

The natural environment of the *altiplano* presents persistent difficulties for agropastoralists, and paleoclimatological data indicate an extended drought that probably increased environmental stress during the LIP. However, the abundant crop remains from Ayawiri demonstrate that farmers were able to effectively grow crops during this time period, likely on the terraces adjacent to the fortress. Terrace agriculture represents a sustainable strategy that addresses some of the persistent environmental issues of the *altiplano* in that it guards against erosion, thus maintaining soil fertility, moistens the fields by capturing rainwater runoff, and protects plants from frosts that commonly occur in the region (Cook 1925; Dick et al. 1994; Inbar and Llerena 2000; Treacy 1989). Terraces in the Titicaca Basin (and at Ayawiri specifically) are primarily rain-fed, whereas raised fields and sunken gardens rely on groundwater. Based on the macrobotanical crop remains and the proximity of the terraces to the site, we infer there was sufficient rainwater for Ayawiri farmers to carry out terrace agriculture during the LIP occupation of the site.

For the LIP Ayawiri people, the environment was also sufficiently stable to fodder camelids in fields. Additionally, the environment was predictable enough during the LIP occupation of Ayawiri so that farmers could grow different types of domesticated plants.[1]

Evidence of a constrained use of the landscape for farming and herding indicates Ayawiri residents chose to live and work close to the site for the protection afforded by the defensive hillfort and nucleated population. Farming and grazing intensively on nearby terraces to calorically support such a large population at Ayawiri during the LIP probably increased environmental stress on the landscape surrounding the site. For example, fallow periods were probably decreased to grow more crops near the site, decreasing soil fertility. However, the choice to intensify agriculture reduced inter-group stress and the threat of attack on people and on the food supply. More specifically, intensifying agriculture and grazing near the site: decreased the likelihood Ayawiri residents' crops would be raided in their fields (see also VanDerwarker and Wilson, this volume, for a similar argument); reduced the susceptibility of camelid theft while grazing; and decreased the possibility of violent or contentious encounters between members of enemy groups, by nucleating and creating a buffer zone of empty land little used for farming or grazing between enemy territories. Yet all the while, intra-group stresses would have been exacerbated within the Ayawiri community by increasing competition for terrace hillslope fields among families at the site, and increasing competition for grazing rights within those fields.

Hence, our data indicate that Ayawiri's residents did not prioritize the alleviation of social tensions above other needs. This is apparent at the most basic level in their choice to relocate to a nucleated hillfort, indicating that the perceived threat of enemy attack ultimately influenced their decisions more than intra-group friction. That is, LIP peoples were willing to accept a certain level of intra-group stress in order to be part of a large defensive community. Residents dealt with intra-group social relations in specific ways between households. Based on the architectural layout of residential compounds and storage structures, they were more interested in maintaining internal divisions and separate identities than in pooling risk to mitigate environmental stress or relieve tensions over the unequal accumulation of food stores within the community. They built their community so that social activities, including those related to foodways, were segregated within small kin groups but visible to many others, potentially provoking jealousy and gossip, and enforcing conformity to social expectations. While community cooperation was essential to the construction and maintenance of terraced fields and defensive walls, effort was not directed into civic architecture built to assuage intra-community relations.

[1]Notably, a diversity index in the *altiplano* is difficult to ascertain based on macrobotanicals alone. Since tubers rarely preserved in their entirety, microbotanical analysis such as starch and phytolith techniques are often necessary to identify the diversity in crop plants grown and used in the region in prehistory (e.g., Logan et al. 2013; Rumold 2011).

12.5 Conclusion

In this model of agropastoral risk management, we consider both the environmental and social drivers affecting decisions about food production. While this model is honed to nuances of agropastoralism in the *altiplano*, it has the potential to be adapted and utilized elsewhere. With this in mind, even when environmental stress is an important driver, social responses are culturally negotiated, as clearly seen in this case study at Ayawiri. While paleoclimate records provide complementary information about the past environment, they do not reveal how humans responded to climatic fluctuations. We believe that it is important to try and focus on the emic context under which subsistence decisions were made, especially within a time of warfare. Just as in the present era, farmers do not always make perfectly rational choices. Rather, they react to their perception of the world around them. In envisioning risk management strategies in this way, even in times of relative social calm, past perceptions of social stress and climatic variability among agropastoralists can be measured.

In conclusion, Ayawiri residents overwhelmingly considered warfare between communities to be the preeminent risk factor during the LIP. Based on the paleoenvironmental data, several researchers have proposed drought and subsequent agricultural crises precipitated warfare during the LIP throughout the Andes (Nielsen 2001, 2002; Seltzer and Hastorf 1990; Torres-Rouff and Costa Junqueira 2006), but in terms of subsistence strategies our findings indicate that people at Ayawiri reacted more robustly to inter-group stress. This outcome is not what we would expect if environmental stress were the primary driver of human action. Basically, every choice made by residents of Ayawiri prioritized reducing the chances of violent conflict at the expense of increasing environmental risks and local social tensions. Hence, our data shed light on the severity of Titicaca Basin warfare as perceived by its inhabitants in the LIP. Ultimately, we suggest that a hostile social environment has the potential to powerfully shape the subsistence choices of ancient and modern peoples.

Acknowledgments We thank Amber VanDerwarker and Gregory Wilson for the opportunity to participate in the Food and Warfare conference and contribute to this resulting edited volume. Feedback from the editors, the anonymous reviewers, and other conference participants was very helpful in drafting and revising this contribution. Funding for mapping and excavations at Ayawiri came principally from an NSF grant (BCS-0849094/BCS-1101148) with additional support from the Center for Latin American Studies at the University of Pittsburgh. Botanical analysis was supported by an NSF-DIG 1305140 and Washington University in Saint Louis Graduate Research Funding. We thank the Ministerio de Cultura for the opportunity to work at the site, and we are grateful for the friendly assistance of the community of Chila, the people and authorities of Tiquillaca, and the many crew members and colleagues who have aided us in this project.

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Chapter 13
Food for War, War for Food, and War on Food

Lawrence H. Keeley

Food and war seem an arcane and arbitrary juxtaposition. Yet archaeological and ethnographic research of the past 25 years, like military history, indicates that food has played and still plays several crucial roles in warfare—functions as or even more important than weapons or tactics. Food's role in warfare is literally strategic. Tactics are those means used in contact with or in sight of a foe—movements, weapons, formations, etc. Strategy involves moving military forces to locations where they can damage or harm an adversary, the means used to try to win and the goals of warfare. The methods used in these strategic actions are called 'logistics.' An old saying among military professionals is 'amateurs discuss tactics while professionals discuss logistics.' The papers in this volume primarily employ this professional perspective. General Phillip Sheridan wrote that 'combat is but a duel in which one combatant seeks the other's life; war means much more, and is far worse than this' (Wheelan 2012, p. 123). Violence, wounds, and deaths inflicted by warfare are often the lesser part of war, while the use and destruction of food and its production can be the greater part.

13.1 Food for War

Let us begin with the obvious—no food, no humans to act, whether bellicosely or not. When food is poor or scarce, human activity of any kind is severely limited. Warriors/soldiers need food of course, but because of the extra energy they must expend in marching and fighting, they need more food than the average adult.

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4_13

The food supplies taken on campaign are also subject to greater spoilage and wastage because such food usually cannot be optimally preserved or, more rarely, is captured or destroyed by adversaries. When on campaign or at war, warriors/soldiers use more food than during peace, hence the shortage, rationing, or inflated cost of food for noncombatants during periods of active warfare.

Some kinds of food are more militarily useful than others. 'Military' foods have more concentrated nutrients, thus are easier to transport, are more imperishable, and provide more complete nutrition than other available foods. The Assyrian army used a long-lasting, light-pressed block of dried salt fish as a 'war food'; soldiers cut off pieces as needed (Gabriel and Metz 1991, p. 25). In his memoir of conquering Gaul, before he moved his legions, the celebrated general Julius Caesar always mentions, as his first step in starting a campaign, insuring his armies 'corn (i.e., grain) supply.' Wheat (*Triticum* spp.) and the less-liked barley (*Hordeum* spp.) were the staple, sometimes the only, food eaten by his army on active campaign. When marching, the Mongols heated and dried meats by curing pieces between their saddle and horse, as well as carrying hard dried cheese that was crumbled and then mixed with water for consumption. Mongol warriors also used a dried meat called *borts* and drank the mixed blood and milk of their horses (Wikipedia 2005). In the aboriginal American Southwest and East, parched maize (*Zea mays*) was carried as rations by warriors and later, after contact, by their war horses. For example, each Huron warrior in a war party carried a bag of roasted maize which would last him up to two months (HNAI 1978, p. 386). Plains warriors carried pemmican—a light, compact, and very nutritious mixture of pounded bison (*Bison bison*) jerky, rendered fat and berries. Roman and Medieval soldiers carried versions of the now unpopular fruitcake because of its long shelf life and concentrated nutrients (Thorpe 2012). The Roman version was made of barley mash, raisins (*Vitis* spp.), pine nuts (*Pinus* spp.), and pomegranate seeds (*Punica* spp.); it provided far more calories by weight than today's American MREs. More recent examples include specialized foods such as Napoleon's preserved canned foods and modern American C/K-rations. Dried fern root (*Pteridium esculentum*), a very concentrated nutrient, was used as a *march food* by the Maori (Allen, this volume). On occasion, the Maori gruesomely supplied their military units by eating prisoners who they brought along as food reserves. These unfortunates had the additional advantage of moving along under their own power. When besieged in their *pa* forts, both sides disabled prisoners to keep them as living food lockers (Allen, this volume; Vayda 1976). Of course, such portable, concentrated, relatively imperishable foods often had non-military uses. As far as I know, archaeologists have yet to document the existence or the distribution of military foods in prehistory.

Large surpluses of food are needed to inflict or withstand sieges. Indeed, the whole purpose of a siege is to deprive a foe of access to food and water. This is why many forts, even those occupied only during attacks (i.e., refuge forts), have food storage facilities. Cahen (see Keeley and Cahen 1989) found that over half the fortified area at the Early Neolithic Belgian site of Darion (c. 7000 BP) was uninhabited pasture for livestock and one area within the ditch-rampart/palisade was a small grain field. These interpretations were based on the pasture weed and domesticated grass pollen found in the basal fill of pits and ditches in the respective areas. In the pasture section, there were also a few extra storage pits (Keeley 1997; Keeley and Cahen 1989). At Maiden Castle, a Celtic Iron Age hillfort, the few traces of houses discovered had adjacent storage pits. However, many grain silos, much larger than those serving households (i.e., granaries), were also found (Eric Harkleroad 2013, personal communication). Other extensively excavated hillforts in England, such as Borrough Hill and Conderton, enclosed many store pits. Conderton had 12 huts but 60 storage pits (Dyer 1992, pp. 53, 60); one to three pits per house is normal. The earliest recorded formal sieges in the Near East were brief, seldom lasting for more than a week (Kern 1999). However, the food storage capacities present at many prehistoric fortified sites and signs of nutritional deficiencies in their defenders' bones imply that enemies could restrict an attacked group's access to food for much longer periods (also see below). Many ancient historical sieges of fortifications were a relatively bloodless contest between attackers and defenders to determine whose food ran out first (Kern 1999, pp. 36, 41, 54–56, 116, 170, etc.). For example, at Gergovia, despite Caesar's self-serving claims, his besieging army's food ran out before that cached by the Celt defenders, and the Romans had to abandon their siege. Later, the Romans took Alesia because the Celts had eaten all their own food supplies (Caesar 1960, pp. 163, 175). At Mayapán and probably other Mayan sites, food production areas for crops and for holding tame or domesticated animals were included within the circuit of fortifications (Kennett et al. this volume). Surplus food stored at fortified sites protects the food from enemy depredations, deprives him of it, as well as being essential for withstanding sieges. Fortifications protect what is important to their builders (Keeley et al. 2007), not just their persons but also sacred places, shelter, valuables, and, especially, the essential means of life—water and food.

Equally important in war, representing the other half of logistics, is transportation. The greatest constraint on the movement of Roman armies involved food transport costs. One great problem with ground transport is the food consumed by human porters and beasts of burden. This self-consumption severely restricts the radius of action of war parties and armies. Hassig (this volume) discusses in detail the role this limitation had in determining the size of the Aztec Empire. Indeed, consider the relative sizes of the Aztec and Inca Empires. The Aztecs relied upon human portage, and thus, armies from the reliable center could only reach limited distances beyond the Valleys of Mexico and Oaxaca. Their control and policing of the outer regions of the empire was not very direct or tight, often involving no more than annual tribute and the erection of an image of the Aztec's primary deity in a conquered province's main temple. The Incas had beasts of burden (llamas [*Lama glama*]) and built roads, thus they could conquer and directly rule a much larger area, although their country was more mountainous than central Mexico. The Roman Empire was first established around the more easily travelled Mediterranean. Only later, using river transport and building roads, did the empire incorporate the lower Nile valley, the Seine, Loire, western Rhine, and southern Danube drainages. It was later still before Roman hegemony reached further into regions that were relatively trackless, waterless, or had short, difficult-to-navigate streams such as interior and northern Iberia, North Africa, Jordon/Syria, northern Britain, Wales, and the great Trans-Rhenish/Danubian forest.[1]

One topic neglected in general (i.e., not just regarding warfare) by archaeologists is the transportation of commodities and people by boat. Watercraft has been used by humans since at least the advent of modern humans (e.g., before the peopling of Australia and New Guinea c. 35,000 BP). Yet when prehistorians reconstruct human movements and trade/exchange, they typically neglect the great capacity and range that water transport provides versus 'humping it.' Judging from several Roman sources, including the prices set in the Edicts of Diocletian (300 C.E.), the cost of moving a given quantity of grain from Syria–Lebanon to Gibraltar by sea, a minimum of 2500–3000 miles, was the same as moving it 75 miles inland, despite many navigable rivers and a network of excellent roads. The ratios of transport costs for Rome was that land transport was 10 times more costly than by riverboat and 60 times higher than by sea (Harris 2000, p. 715). This neglect of water transport especially applies to war parties and armies (for an exception, see Roscoe, this volume). During the 1600s C.E., the Iroquois raided other tribes near St. Louis at least 800 (as the crow flies; actually more like 1000) miles away from their homeland. This only makes sense when canoe travel by Iroquois war parties and their supplies up the Great Lakes and down the Ohio/Wabash or the Illinois River systems, with portages at Chicago or Portage (Indiana), is taken into account. Of course, water transport of warriors and food may not be economical or even possible in some dry or mountainous regions with unnavigable streams but elsewhere should always be expected or at least considered.

Of course, military units could take food directly from their enemies. Such pillaging and foraging was the reason Napoleon's troops could march faster than their foes that were restrained by slow-moving supply trains. The counter to an invader's reliance on foraging entails hiding or destroying relevant food supplies and blocking or ambushing foraging parties. Thus, the French were slowed down and weakened by such 'scorched earth' actions in Spain, Portugal, and Russia before being roundly defeated. The British Celts adopted this same strategy against the invading Romans. It worked against Caesar whose army's food supplies were lost to Channel storms and whose foraging parties were commonly attacked. A century later, after their supply base of Gaul was thoroughly Romanized, given a road network, more efficient farming, and they had better (also luckier) sailing vessels, the Romans were able to survive British scorched earth tactics and slowly conquer England.

Food availability commonly affects the seasonality of warfare. Until modern times, warfare was only undertaken when food supplies were maximal—when plant foods were ripe and/or harvested, herds were most numerous, fat and

[1]There were many rivers in this huge forest, but they drained north or east, away from the Mediterranean heartland of the Empire.

healthy, preserved fish or meat was plentiful, etc. As an Europeanist, I was surprised by Hassig's (this volume) evidence that among the Aztecs, winter was the season of war because that was after the maize had been harvested. Where I do my fieldwork, and in the Near East, the 'campaigning season' was the warm season, especially the late summer or fall after the spring/summer crops had been harvested. During Caesar's conquest of Gaul, his legions dispersed into and settled down in fortified camps during the cold seasons. There is some evidence that the season for war was late summer or autumn during the Mississippian period. For example, Crow Creek was destroyed in October (Willey 1990).

13.2 War for Food

As several papers in this volume attest, wars have often been fought for food or the means of producing food. One of the circumstances that makes war more frequent and more intense is 'hard times,' that is periods when food shortages are common (Keeley 1996, pp. 138–141). LeBlanc (2003) argues that war is almost always incited by food shortages. One method becoming common in archaeology involves showing positive correlations between signs of nutritional stress on human skeletons (e.g., porotic hyperstosis, cribra orbitalia, Harris lines, enamel hypoplasia, etc.) and evidence of more common or more intense warfare (fortifications, weapons traumas and embedded projectile points, exo-cannibalism, higher incidences of weapons in male burials, more common depictions of combat and warriors, etc.). The other correlation commonly sought and often found is between more warfare and droughts with the latter implying food deficits. The implication is that food shortages, however caused, meant more competition for food or food production areas and that much of that competition was violent.

There are now many archaeological cases demonstrating such correlations. At Gebel Sahaba, Northern Sudan, 12,000–14,000 years ago, a very high proportion of the burial population bore embedded projectile points and also showed a high incidence of rickets and *cribra orbitalia*, bone conditions indicating poor nutrition. *Cribra orbitalia* was also prevalent at Norris Farms No. 36, Illinois, c. 1350 C.E. (Milner et al. 1991, pp. 591–592). The relatively short femoral bones of massacred villagers at Crow Creek (1325 C.E.) in South Dakota indicate poor nutrition possibly because of drought (Willey 1990, pp. 153–175). In the Late Intermediate Period Andes (Langlie and Arkush, this volume) and the American Southwest (Kuckelman, this volume), droughts are correlated with periods of intensified warfare. On Timor Leste, Lape (this volume) found that the period of widespread construction of fortifications was correlated with El Niño events which cause droughts in that region. He also found that the fortifications were concentrated along a border between an area that would have been especially affected by any drought and another that would have better weathered dry spells.

The direct taking of a foe's food or means of food production was a common feature of historic and ethnographic warfare. Among the Pre-Contact Chilocotin hunter-gatherers of British Columbia, small bands would seize the food stores of others and, after wiping out the rightful owners, would live that winter on these ill-gotten supplies (Keeley 1996, p. 65). Even though it was one of the staples of their diet, the Lipan Apache cultivated little maize; instead, they obtained most of their maize supplies by trade or raids (HNAI 2001, p. 948). Seizing cattle (*Bos taurus*) was the objective of raids in Bantu Africa, ancient Ireland, and protohistoric Germany; sheep/goats (*Ovis aries*/*Capra hircus*) among the Southern African Khoi-San, the Berbers of North Africa, and the Bedouin of Arabia; pigs (*Sus domesticus*) in New Guinea; and horses (*Equus ferus*) in Central Asia where they were food as well as transportation and the Great Plains where they were essential for a buffalo-based economy (Keeley 1996, p. 217, note 25; Roscoe, this volume). Archaeologists seldom consider that some of a prehistoric group's food was war booty rather than trade goods or home productions. In the future and in some cases, chemical analysis of food remains may help make a distinction between locally raised food and that raised in enemy territory (e.g., a region beyond a fortified border).

Seizing food production areas is a common spoil of war (Keeley 1996, pp. 108–112; LeBlanc 2003). Fishing stations were taken on the protohistoric Northwest Coast, hunting territories in the Northeast, and gathering areas and acorn (*Quercus* spp.) groves in aboriginal California. Besides herds, pasture lands were the spoils in the Eurasian steppes, the North African Sahel region and the East African savannas (e.g., Maasai vs. Bantu). Since the development of agriculture, arable land has been fought over almost everywhere. One of the Nazis' primary goals was to conquer the grain-growing lands of the Soviet Union. Israelis and Palestinians have fought for over 50 years over the marginally arable, desert lands of their small region. Fighting for resource locations has seldom been stated as a goal but changes in ownership or control of such food-producing areas has been an extremely common result of warfare (Keeley 1996; LeBlanc 2003).

13.3 War on Food

One area where food plays an essential role in warfare involves the destruction and vandalism of food, crops, livestock, and the means of food production. This strategy is simply the standard tactic of cutting an enemy's lines of supply but extended to encompass their whole society, including noncombatants.

Grain stores that could not be carried off were commonly destroyed in the Near East and China as were cattle in Africa and pigs in New Guinea (Keeley 1996, pp. 106–108, 217, notes 25–28). Enemies also often tried to demolish their foes' means of production. Fishing canoes were burned on the native Northwest Coast and Oceania, and horses (used to hunt bison and large game) were stolen on the Protohistoric Great Plains and the Pampas. Both wild and cultivated fruit trees were cut down or ringed in tribal New Guinea (Roscoe, the volume). Maize stores were often destroyed in the prehistoric Southwest, an action especially evident at the appropriately named prehistoric Burnt Corn Pueblo (Snead, this volume). This grand tactic/strategy has also been very effective in civilized warfare. Ancient Greek raiders burned grain fields, chopped down grapevines, and ringed olive (*Olea europaea*) trees (Hanson 1989). The Romans practiced *vastatio*, the systematic theft or destruction of crops and livestock, against enemies that would not fight battles or be besieged (Hackett 1989, p. 208). In Medieval Europe, where combat was quite stylized, the destruction of an enemy's food and means of food production were known as *chevauchèe* and such raids were very commonly used by the English during the Hundred Years War. Sherman's March did not kill or wound many Rebels nor was that its primary aim. Indeed, his force marched directly away from the main Rebel army opposing it. Instead, Sherman's 60,000 troops, while marching across Georgia, consumed or destroyed food and growing crops and demolished food storage facilities (barns, corn cribs, silos, etc.) as well as the railroads and bridges needed to transport supplies to several Rebel armies. Even after 150 years, the Navajo still revile Kit Carson even though he killed very few of their ancestors. His great 'crime' was that during the last Navajo-US War, Carson marched right into the Navajo heartland of the Canyon de Chelly, captured or slaughtered sheep herds, and cut down fruit orchards (Utley 1984, pp. 83-85). His vandalism was so effective that, after this campaign in 1864 C.E., the Navajo never again made war on other tribes, US settlers or the Army. In the Army's almost bloodless winter campaign (1874–1875 C.E.) against the Comanche and Kiowa, the soldiers killed their foes' ponies whenever they could catch them. The Army and their scouts chased the tribesmen relentlessly, giving the latter no time to hunt or gather foods. By the end of spring, the hostile tribes surrendered…for good. The destruction of the buffalo (Bison) by professional hunters was fundamental to the final defeat first of the Southern Plains tribes then of the Sioux and Cheyenne-Arapaho (Utley 1984, pp. 229–230). It is estimated that, in World War I, 450,000 German civilians died of food deficiencies because of the Allies' Blockade of food and fertilizer.

History indicates that, short of genocide, the best way to utterly defeat a foe is to take or destroy their food and the means of its production. The famous American General Phil Sheridan said: 'Death is popularly considered the maximum punishment in war, but it is not; reduction to poverty brings prayers for peace more surely and more quickly than does the destruction of human life' (Wheelan 2012, p. 123). If you want to win, don't take your enemy's lives; take their 'stuff,' especially their foodstuffs.

Warfare usually affects the availability of food, even when not a conscious strategy. During periods of frequent and intense warfare, settlements are often moved to easy-to-defend positions. Yet the best defensive locations—usually the highest spots on the landscape—are seldom suitable for food production, i.e., waterless, with thin and/or rocky soil, difficult to access for farming and herding, steep slopes, etc. In the prehistoric Southwest during periods of intense warfare, pueblos were moved from the better watered and more fertile bottoms to mesa tops and cliff sides (Haas and Creamer 1993; Kuckelman, this volume; LeBlanc 2003, p. 148; see various papers in Rice and LeBlanc 2001). But when it became more peaceful, settlements were moved back to valley floors. Roscoe (this volume) shows that settlement locations in native New Guinea represent a compromise between defense and access to food. Agriculturalists' access to wild foods, which are often important during 'hard times,' may be restricted by actual and threatened ambush of gathering and/or fishing parties (VanDerwarker and Wilson, this volume). On the prehistoric Northwest Coast, intensified warfare likely caused less sea mammal hunting and other food acquisition that involved vulnerable small groups, and more emphasis on salmon (Salmonidae) fishing which entailed militarily safer large concentrations of people (Snow 2010, p. 292). Thus, both settlement location and access to food-producing areas are often adversely affected by warfare.

The kidnapping of women is a common practice in warfare. Many scholars, but seldom archaeologists, emphasize the biological or 'evolutionary' effects of capturing women and argue that this is the principal motive for warfare (e.g., Chagnon 1983; van der Dennan 1995, pp. 539–593). Certainly, captured women can have relatively profound demographic effects on contending groups. The kidnappers' populations grow by incorporating more fertile women and the children they produce after capture as was the case with groups as diverse as the pastoral Nuer of South Sudan and the gardening Mucajai Yanomama (Early and Peters 1990, pp. 67–70; Kelly 1985). However, there may be other more immediate effects of the kidnapping of women that affect food supplies.

In many societies, because of the sexual division of labor, women are crucial as producers and processors of food. Depending on the basic economy and prevailing division of labor, women gather high calorie or staple foods, cultivate crops, tend (usually smaller) livestock,[2] and prepare various plant foods and fish for consumption and storage. By taking a foe's women, one is depriving him of the food they might produce and gaining the same for oneself. Thus, the capture of women may be motivated as much or more by economic considerations as by sexual ones (Keeley 1996, pp. 86–87). Indeed, states usually have the size and power to keep any category captive, including adult men, and do that so they can be exploited as tax payers, peons, or slaves (Keeley 2011).

Three chapters in this volume (Kurin; Langlie and Arkush; Tung et al.) are concerned with late Middle Horizon (Wari) and the subsequent Late Intermediate Period in the Andes. Langlie and Arkush found that droughts occurred 150 years before warfare reached its peak, as did Tung and colleagues. Drought is correlated with and, thus, may have caused the collapse of the Wari Empire, but it was the sociopolitical fragmentation left by imperial collapse that a century or so later exacerbated warfare in this region. Thus, evidence of food deficiencies during this prehistoric 'hard time' would be an *effect* of frequent warfare rather than a *cause* (see also VanDerwarker and Wilson, this volume).

The direct theft and/or destruction of foodstuffs, vandalism of the means of food production, forced moves of settlements to unproductive locations, and the kidnapping of primary producers (especially women) can deprive warring groups

[2]Worldwide, it seems that men and older boys are usually in charge of caring for cattle, horses, camels, elephants, etc., while women are responsible for goats, pigs, and domestic fowls.

of adequate diets; indeed, that is the primary intention and common function of such practices. This means that nutritional deficiencies may be a *consequence* of war on food, rather than a cause of fighting. This should be kept in mind when anthropogenic 'hard times' or nutritional deficiency pathologies on human remains are found correlated with evidence of intensified warfare.

13.4 Conclusions

It is clear from the descriptions of literate observers—ethnographers, ethnohistorians, and historians—that food plays several important roles in warfare. However, this book is largely by and for archaeologists. Thus, the main question necessary to ask about these ancient actions and functions is one I commonly ask my theory-dazzled students: 'But what would that look like if I saw it in the ground?' Unless a claim has some recoverable archaeological expression, it is mere speculation, very plausible at best, and purely post-processual at worst.

Food is essential for war in the universal need for rations and, where fortifications are constructed, as food for both the besieged and the besiegers. As noted above, sometimes certain concentrated, long-lived, and easily transported foods were especially used as 'march food' or war rations. Yet in most documented cases, these same foods were used in peaceful circumstances. At present, it is difficult to see how these military foods could be isolated by archaeological research. Food stored to withstand sieges is easier to document. Storage facilities, especially silo pits or granaries, found in the interior of fortifications are evidence of this practice. Pit capacity enclosed within the circuit of a site's defenses that exceeds that usual for contemporary households strengthens this inference. Food production areas such as garden plots and pastures found within fortifications are also strong evidence of siege anticipation. Presently, I cannot envision how the foods brought along by the besiegers could be found or correctly attributed.

People need food and there is plenty of evidence that they will fight to keep or to get it and/or the means of producing it. There are some implications of this truism. One is that warfare is more common during periods when food is short. As all life is based on the solar energy and water used by basic producers, declines in either essential ingredient will be deleterious for all consumers, including humans. While fluctuations in solar energy are almost impossible to detect archaeologically, changes in precipitation are easier to document. Thus, it has become more common for archaeologists to compare evidence of climate fluctuations to evidence of the waxing and waning of warfare, as do the authors of several papers in this volume (for earlier examples, see also Keeley 1996, pp. 138–141; LeBlanc 2003).[3] The reasonable implication is that when climate fluctuations make food

[3]As noted by Keeley (1996) and LeBlanc (2003), fighting over shrinking food resources does not just occur among agriculturalists because hunter-gatherers need hunting territories, fishing stations, water sources, gathering plots, and of course, food itself.

scarce, people fight for it. Indeed, many prehistoric cases are known worldwide where droughts or other ecological difficulties (coastal water temperature changes, failed monsoons, El Niño events, etc.) are highly correlated with intensified warfare. But like all climate change explanations, two points must be demonstrated: (1) that the climate change was so severe that the relevant society and its technology could not cope; (2) that similar environmental changes had not occurred without social change. Even when the environment is relatively stable, normal population increases can lead to subsistence problems. As noted above, food shortages have been more directly evidenced in human bone chemistry and changes in food remains that indicate that nutritional deficiencies were common. Such correlations between warfare and hard times have been found in so many instances that some archaeologists have reasonably argued that almost all wars are associated with difficulties in obtaining or producing food (e.g., LeBlanc 2003).

Historically and ethnographically, one of the most effective military techniques involved taking or vandalizing a foe's food and means of the production of food. Under some circumstances, archaeologists may find burned food, especially grain (e.g., Burnt Corn Pueblo, Sand Creek), smashed grinding stones or griddles, slaughtered but unbutchered livestock, destroyed storage facilities, etc. Burnt or ringed fruit/nut trees or vines are likely to be dug up and replaced and, thus, be archaeologically invisible. It should be remembered that food was often thieved so that when chemically sourced such booty would be non-local. As people usually raided those they traded with and traded with those they raided (Keeley 1996, pp. 121–126), 'foreign' food might have been obtained either way. Presently, it is difficult to envision how to distinguish between any items procured by exchange or taken in war.

It is possible to infer war on food in places and periods where and when the environment was adequate and the human population was stable but where there was also increased warfare and evidence of nutritional deficiencies. Such a combination of features logically indicates that neither climate nor overpopulation were the sources of food shortfalls, leaving warfare as the most probable culprit. Several papers in this volume possibly document such situations but are still missing pieces of evidence necessary for more definitive inferences (e.g., human paleopathology). Studies of human age/sex mortality profiles showing dearths of young women in massacred burial population, such as at the Early Neolithic (LBK) sites of Schletz-Asparn and Vaihangen and the Coalescent site of Crow Creek (Golitko and Keeley 2007; Willey 1990), provide clear evidence of the capture of young women. But were older women also taken because of their value in food production? One way to demonstrate this motive would be to show that, like the nubile young women, the reproductively useless (to their male captors, at least), men and postmenopausal women, were also taken captive.

For the past 20 years, archaeologists have gradually abandoned their 'pacification of the past' and reintroduced warfare as a possible explanation for some aspects of the archaeological record. The papers included here are a manifestation of this trend but deal with a truly novel and fundamental topic—food. They all demonstrate with clear data and logic the many mutual effects food and violent conflict have on each other. Their examples come from such a variety of places and times (i.e., the prehistoric and protohistoric periods of Polynesia, Indonesia, the North American East and Southwest, Mesoamerica, the South American Andean region and, as briefly mentioned above, Western Europe) that, collectively, imply that these phenomena are arguably universal. This means that future archaeologists should consider these war–food relationships whenever they uncover evidence of warfare in their respective region. It appears that food is essential to war; wars were often fought for food, and the restriction of food supplies were a common consequence of warfare.

Acknowledgments My thanks to Amber VanDerwarker and Greg Wilson for hosting and inviting me to the excellent conference that led to this volume. I learned a great deal from discussion with my colleagues and the papers presented here. I hope the readers will as well. Thanks to my wife, Lesley, for proofreading and everything.

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A.M. VanDerwarker and G.D. Wilson (eds.), *The Archaeology of Food and Warfare*, DOI 10.1007/978-3-319-18506-4