

Chapter 6

Evolutionary Biology and the Emergence of Agriculture: The Value of Co-opted Models of Evolution in the Study of Culture Change

Melinda A. Zeder

Introduction

The application of macroevolutionary theory to the study of cultural evolution is only one of a number of cross-disciplinary incursions by archaeologists seeking epistemological inspiration for higher order explanation of culture change. Archaeologists have been rummaging around in the closets of evolutionary biologists since Darwin, trying on a wide variety of different approaches to the study of biological evolution in the hope of finding overarching theories that can be applied directly to the evolution of human culture. The origin of agriculture, along with the sweeping reordering of economy, social organization, and belief systems that generally accompanied agricultural emergence, is frequently used as a case study opportunity for the application of co-opted evolutionary models. One of a handful of major transitions in human history, the Neolithic Revolution has been promoted as an ideal proving ground for establishing the efficacy of these different explanatory approaches.

In this chapter, I explore the application of three different co-opted evolutionary models to this watershed in cultural evolution—neo-Darwinian or selectionist evolutionary archaeology, macroevolutionary archaeology, and human behavioral ecology. I examine the basic tenets of each evolutionary model as it has been applied to the study of human cultural evolution, reviewing in particular how researchers have used the model in the study of agricultural origins. I then turn to the archaeological record of agricultural emergence in the Near East, arguably the “Mother of all Neolithic Revolutions,” where we have the deepest and most comprehensive documentation of the panoply of culture change that accompanies agricultural origins. This consideration allows an assessment of how well, or how poorly, each of these evolutionary approaches matches this empirically rich example of cultural evolution.

M.A. Zeder (✉)

Archaeobiology Program, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560, USA
e-mail: zederm@si.edu

Neo-Darwinian “Selectionist” Archaeology

Archaeologists enrolled in the neo-Darwinian or selectionist school of evolutionary archaeology tend to be the most evangelical in their application of biological evolutionary theory to the study of culture change (Dunnell 1978, 1980; Leonard and Jones 1987; O’Brien and Lyman 2000; see discussion in Zeder 2009). These archaeologists draw inspiration from the evolutionary models generated by the “modern synthesis” school of biological evolution which brought together Darwinian concepts of natural selection with principles of population genetics (e.g., Dawkins 1986; Huxley 1942; Mayr 1942, 1963; Simpson 1944). Neo-Darwinian models of biological evolution portray evolution in terms of changes in allele frequencies within individual organisms that are shaped by gene flow, genetic drift, and natural selection operating on phenotypic expression of random genetic variation. Selectionist archaeologists acknowledge that human cultures differ from biological systems in that the units of variability on which selection acts in cultural evolution are human behaviors, not genes, and that variability is transmitted through cross-generational behavioral emulation and instruction, or social learning, and not by genetic transmission in the course of sexual reproduction (following Boyd and Richerson 1985; Lyman and O’Brien 1998: 619; Rindos 1984:54). Nevertheless, they embrace the neo-Darwinian “trait level” point of view, arguing that the study of cultural evolution requires tracing the operation of directly analogous processes of selection, drift, and transmission operating on the discrete attributes of material culture, argued to represent “the hard parts of the behavioral segment of [past] phenotypes” (Dunnell 1989:44; Leonard and Jones 1987; O’Brien et al. 1998: 490). And while the possibility that selection may also operate at the level of groups of individuals is acknowledged, especially in the case of complex societies (Dunnell 1989; Rindos 1984:49), emphasis here is placed on the individual culture bearer and the array of behaviors (and their artifact trait proxies) he or she engages in. Understanding the course of cultural evolution to these archaeologists involves tracing the genealogies of traits, specifically the variation of traits through time (Lipo et al. 2006; O’Brien et al. 1998:487). The primary task in this endeavor is to chart the trajectories of trait variability and to determine whether the phylogeny of genealogically related traits are shaped by selection operating on “functional” traits, whose “replicative fitness” is judged by their differential persistence through time, or the result of random factors of drift and transmission errors operating on “stylistic” traits without adaptive significance (Dunnell 1978; Leonard and Jones 1987: 214).

While selectionist archaeologists acknowledge the role of deliberate human intent in the invention of new behaviors and in decisions of whether to adopt one behavior over another, they adamantly deny the role of human intentionality in cultural evolution. They argue that the intentions behind such choices are unknowable, and that, at least in the archaeological record, the behaviors resulting from such deliberations are indistinguishable from behavioral variability arising from unintentional transcription errors and recombinations of behaviors in the transmission from one generation from the next (Lyman and O’Brien 1998:619; O’Brien and Holland 1992:45; Rindos 1989a, 1989b). In any event, it is not the source of behavioral

variability that is significant in the selectionist scheme of things. Instead, selectionists focus on the ways in which selection, drift, or transmission (“meme flow”), as the ultimate drivers of cultural evolution, shape the trajectory of behaviors (represented in artifact traits) through time (Lyman and O’Brien 1998:644; Rindos 1985).

Selectionist archaeologists also recognize that the different modes of transmission in biological and cultural systems affect the tempo of change, acknowledging, in particular, that the transmission of culture traits through social learning can quicken the rate of culture change to the extent that even “punctuated” events of rapid evolutionary change are possible (Lyman and O’Brien 2001:408), Nevertheless selectionist archaeologists are more comfortable with the neo-Darwinian model of phyletic gradualism as the dominant mode of culture change, which is characterized as continuous and proceeding at a gradual and incremental pace (Rindos 1985). Apparent instances of punctuational culture change, they argue, are more likely artifacts of an incomplete archaeological record or the result of faulty analytical methods directed at an inappropriate scale of change (Lyman and O’Brien 1998: 627; O’Brien et al. 1998:487).

This issue of scale of change also leads this school of evolutionary archaeology to reject the classical typological groupings of cultures followed by most archaeologists of the earlier “processualist” school of archaeology (i.e. the band, tribe, chiefdom, and state classificatory system of Service [1962] and Fried [1967]). Such higher order groupings, they maintain, serve mostly to blur variability or mask the selective forces shaping variability, arbitrarily “(c)arving a continuum of variation into chunks” that are then classified in terms of their “central tendencies” (Lyman and O’Brien 1998:627). They contend that these false cultural taxonomies are especially pernicious, since they can be confused with evolutionary stages and the arbitrary divisions between these false stages mistaken for instances of rapid transition from one to another—transitions that essentially require explanation through appeal to nomothetic, universal, prime-mover forces (Dunnell 1978, 1980, 1988; Leonard and Jones 1987). To selectionists, the burden in the explanation of culture change lies not in accounting for general patterns of macroevolutionary change that cut across many unrelated cultural entities but instead on tracing “historical patterns of differential trait representation” within individual genealogically linked cultural lineages and then identifying the microevolutionary processes responsible for the patterns of variation observed (Jones et al. 1995; Lyman and O’Brien 1998:615, 2000). Efforts at isolating drivers of evolution across unrelated cultural lineages (outside of selection, drift, and transmission) are considered to be a waste of time, since each lineage is a unique product of a particular set of historical contingencies—of the product of selection, drift, and transmission operating on randomly generated behavioral variability.

The first and best known application of “cultural selectionism” to the study of agricultural origins can be found in David Rindos’ book “Origins of Agriculture: An Evolutionary Perspective” (Rindos 1984) which uses agriculture as the ideal case study application of neo-Darwinian theories to the study of culture change. Rindos rejects earlier models of agricultural origins that cast this development in progressivist terms as the product of conscious human inventiveness, arguing instead

that agriculture is the product of a co-evolutionary process between humans and plants (and presumably animals) akin to co-evolutionary symbiotic relationships found in nature—in effect no different from co-evolutionary mutualism between social insects and plants. He also rejects earlier models that portray agricultural origins as revolutionary events caused by prime-mover catalytic forces. Instead Rindos advances a gradualist model that sees agriculture as an outgrowth of a relatively slow incremental process involving at least three different “modes” of relationship characterized as “incidental domestication,” “specialized domestication,” and “agricultural domestication.” And while these modes are sometimes mistaken for progressivist stages or phases in the process of agricultural emergence (i.e. O’Brien 1987), Rindos maintains that they were instead meant to portray types of human/plant relationships that may or may not, depending on highly localized conditions, pave the way for the next modal relationship (Rindos 1987:192).

An application of this model to a specific case study example, O’Brien’s consideration of sedentism, population growth, and resource utilization in the Midwestern United States, traces the complicated and reinforcing co-evolutionary events that led to the intensification of plant use and the origin and/or adoption of domestic plants into the resource base of Middle and Late Woodland peoples (O’Brien 1987). He argues that no one factor (i.e., population pressure, sedentism, or climate change) can be singled out as causal in this sequence of events and that agricultural origins in this region evolved in a gradual, incremental co-evolutionary way. This early attempt at applying the tenets of selectionist archaeology to agricultural origins drew fire from Dunnell (1987), the patriarch of the selectionist school (and a more gentle rebuke from Rindos [1987]) for failing to demonstrate how selection operates on variation to produce culture change in this case, a failure that O’Brien, in response, attributed to the lack of data of sufficient resolution to allow such a demonstration (O’Brien 1987:193).

Macroevolutionary Archaeology

The selectionist perspective on culture change drew fire from early advocates of macroevolutionary archaeology who, like proponents of macroevolutionary theory in biology (Eldredge 1989a; Eldredge and Gould 1972; Gould 1989 2002; Vrba and Eldredge 1984), often framed their ideas about cultural evolution in terms of a critique of neo-Darwinian evolutionary approaches (Chatters and Prentiss 2005; Rosenberg 1994a, 1998; Spencer 1997; see discussion in Zeder 2009). Macroevolutionary archaeologists reject the selectionist view of cultures as discrete, independently varying traits whose persistence over time is determined solely by processes of selection, drift, and transmission. They embrace, instead, the alternative macroevolutionary view that sees organisms (and by extension cultures) as integrated wholes or constellations of interacting traits whose form is shaped as much by historical contingencies and constraints to change as by the specific adaptive attributes of individual traits (Gould and Lewontin 1979; Seilacher 1972).

Many working within this paradigm have co-opted the term “*Bauplan*” from evolutionary biology to stand for the basic designs, or blueprints, that organize linked constellations of culture traits into coherent and enduring forms (Chatters and Prentiss 2005:47; Rosenberg 1994a:308; Spencer 1997: 234). Used with more uniformity in biology as a series of homologous characters nested in a series of ever more general structural plans at higher taxonomic levels (Hall 1996:223–227), macroevolutionary archaeologists are less consistent in how they define cultural *Baupläne*. Chatters and Prentiss, for example, define *Baupläne* in terms of socioeconomic variables, as sets of resource management strategies (RMS) that consist of “constellation[s] of shared ideas directed at the acquisition, distribution, and consumption of energy and resources”. These constellations of increasingly more generalized “*Baupläne*” blueprints are arranged in a hierarchy of levels which at the highest scale are the constellations of traits that separate very broad sets of resource strategies like hunter-gatherers and food producers (Chatters and Prentiss 2005:48–50). Spencer, on the other hand characterizes the structural plans that undergird cultural forms in term of sociopolitical factors, arguing that the admittedly flawed cultural typologies of Service and Fried still have utility in defining the basic structural features that define cultural units with different leadership formats (Spencer 1990, 1993, 1997). Rosenberg (1994a) takes a different tack, restricting the term *Bauplan* to mean the ideational structure or *ethos* of a culture that provides the highest-order and most conservative organizational framework for a culture. These ideational organizational rubrics sit at a “superstructural” level subsuming lower-order “structural” levels consisting of a society’s economic and political systems, which themselves sit above a society’s “infrastructural” level that consists of its “productive capacity”.

Macroevolutionary archaeologists also find the selectionist trait-based focus of culture change insufficient to account for major cultural change (Spencer 1997:225–226). They acknowledge that selective pressures operating at a localized inter-individual or inter-group level may help cultures respond to changes in the physical or social environment, but, they contend, such microevolutionary forces are more likely to preserve culture norms and cannot on their own account for major shifts scale or complexity (Chatters and Prentiss 2005:48; Rosenberg 1994a:333; Spencer 1997:226). Instead, and once again following the lead of macroevolutionary biologists, these archaeologists adopt a more hierarchical approach which acknowledges that evolution works at multiple levels—from individuals, to families, to local communities, to regional polities (Rosenberg 1994a:320–321; Spencer and Redmond 2001:201). Just as these higher order forces are held to be responsible for major cladistic change in biological systems (Gould 2002:726; Gould and Eldredge 1993:224; Vrba and Eldredge 1984), macroevolutionary archaeologists also argue that major cultural changes in which one cultural *Bauplan* is replaced by another are driven by the combined forces of evolutionary processes operating across hierarchical levels of social organization (especially those that affect higher-order levels above that of competing individuals).

The conditions under which new cultural *Baupläne* arise to replace old ones differ depending on how a cultural *Bauplan* is defined. Chatters and Prentiss, for

example, hold that diversification of RMS and the creation of new socioeconomic *Baupläne* are most likely under conditions of economic opportunity rather than under periods of stress and heightened intergroup competition (Chatters and Prentiss 2005:51). They characterize cultural diversification in terms of allopatric speciation (following Mayer 1963) which occurs when groups that are either geographically or effectively isolated from other groups experience conditions that reduce the risk of experimenting with strategies that deviate from the dominant cultural behaviors. Periods of cultural diversification are usually followed by a period of “culture sorting” (again a concept co-opted from evolutionary biology, [Elredge and Gould 1972]) in which new *Baupläne* come into increasing competition with each other and with parent groups, resulting in the decimation (or abandonment) of less fit strategies and the proliferation or adoption of *Baupläne* more suited to the natural and social environments (Prentiss and Chatters 2003). Rosenberg, on the other hand, sees cultures as more conservative and resistant to change with stress being the major precipitating factor behind culture change (Rosenberg 1994a, 1998). Stress-driven innovations in behaviors, he argues, are more likely to be accepted if they conform with cultural norms, or at least if they can be seen as relieving stresses at the level of the productive capacity of the system, especially if they can be accommodated by the logic of its political and economic system and do not threaten the underlying societal ideological norms that, to Rosenberg, form the society’s cultural *Bauplan*. Such responses are seen as helping the society maintain itself, keeping the group in a state of equilibrium rather than inducing new cultural forms. Old cultural *Baupläne* are only abandoned and replaced by new ones, according to Rosenberg, under conditions of severe stress that cannot be alleviated by such lower level adjustments, but that require responses that seriously deviate from the societies’ conceptual underpinning at this highest organizational level. Spencer, in contrast, allows that both opportunity and stress are capable of propelling scalar shifts in organization and control within societies which drive the emergence of new sociopolitical *Baupläne*. Such shifts, he argues, happen under circumstances in which enhanced organization capacity allows the group to either take advantage of opportunities or defend itself against external or internal threats. They come about through a process he terms “extrapolation” in which one unit of organization control begins to assert authority over another resulting in a more inclusive political entity (Spencer 1990, 1993, 1997:238–239; Spencer and Redmond 2001:199).

Regardless of how one characterizes cultural *Baupläne* and the ways in which new ones arise and replace old ones, all macroevolutionary archaeologists subscribe to the basic principle that evolutionary change from one *Bauplan* to another proceeds as a punctuational process in which periods of rapid transition (that according to Rosenberg [1994a:314] typically occur in a century or less) are followed by longer periods of relative stasis (Chatter and Prentiss 2005:50; Rosenberg 1994a:318; Spencer 1990, 1997:237). Such periods of abrupt, revolutionary change in the archaeological record are not, as selectionists hold, artifacts of gaps in the record or the product of artificial typologies (Lyman and O’Brien 1998: 627) but represent actual times in which there is a major restructuring of cultural norms (whether in resource management, administration, or ideology) driven by major

macroevolutionary forces of change. Periods of apparent stasis that separate broadly different cultural forms are also real and represent periods of relative stability in which cultures actively preserve basic structural continuity by making small microevolutionary adjustments in response to various external and internal pressures (Rosenberg 1994a:333).

While selectionists acknowledge that the forces of selection operating on adaptive traits and the transmission of behaviors through social learning may lend an appearance of directionality to cultural change, they steadfastly reject the importance of directed variation in cultural evolution claiming that it explains nothing about how that change came about (Dunnell 1980; Lyman and O'Brien 1998:621). Macroevolutionary archaeologists disagree stressing the importance of directionality in both cultural and biological evolution. They argue that the hierarchical nature of culture process operating simultaneously within and across different levels within a society lends an important element of directionality to culture change (Spencer and Redmond 2001:201), as does the element of historical contingency (or path dependency) when non-conflicting, neutral, or at least not maladaptive cultural attributes are carried over from the ancestral form into the descendent form (Rosenberg 1994a:329). The retooling of behaviors that evolved to serve one function to serve a new adaptive function (analogous to the macroevolutionary concept of "exaptation" [Gould 1988 2002:49, 726–730]) is also an important factor that lends directionality to culture change.

These archaeologists also argue that the capacity for directionality in culture change is significantly enhanced over anything found in biological systems by the human ability to evaluate outcomes of behavior and to abandon, adjust, and perpetuate behaviors based on this evaluation. This capacity for conscious human decision making in the invention and transmission of the behaviors (following Boyd and Richerson 1985; Eerkens et al. 2006; Richerson and Boyd 2005:69; Spencer 1993:46–47, 1997:239) introduces a Lamarckian dimension to cultural evolution that greatly enhances its potential for rapid and radical directional change (Rosenberg 1990:399–400, 1994a:313; Spencer 1997:230). And while, as we have seen, selectionists acknowledge that the mode of transmission is a major feature that separates cultural from biological evolution and that it may have an impact on the tempo and pace of culture change, they nevertheless deny human intent any significant role in cultural evolution (Rindos 1984:6 1985:72). Rather than as an incidental and noncritical aspect of cultural change, macroevolutionary archaeologists see this unique element of human agency as perhaps the most important driver of cultural evolution—one that imparts entirely new and unique characteristics and capacities to cultural change, which, in turn, clearly and definitively distinguishes cultural from biological evolution (Boyd and Richerson 1985; Spencer 1993:46).

The focus of explanation of culture change following this paradigm involves isolating the processes operating across multiple levels in a cultural system that are responsible for the abandonment of old cultural behaviors and the adoption of new ones. Macroevolutionary archaeologists are, however, much less likely to embrace the prime-mover nomothetic, one-size-fits-all explanations of culture change of earlier evolutionary anthropologists, focusing instead on teasing out the variables that

shape the trajectory of individual historically linked ancestral and descendent cultural forms (Chatters and Prentiss 2005:52). At the same time, they are likely to employ a comparative approach that looks across convergent examples of cultural forms both for processes held in common and for those that are unique to individual expressions of these forms (Spencer 1990:233–234).

Insights into how a macroevolutionary perspective might be applied to the origins of agriculture are found in Prentiss and Chatters' initial applications of macroevolutionary theory to archaeology, in which they characterize the shift from mobile foraging to storage dependent collectors in the Pacific Northwest as prime case study example of punctuated evolutionary change (Chatters and Prentiss 2005; Prentiss and Chatters 2003). Following their macroevolutionary model, they argue that the relaxation of intergroup competition in the Pacific Northwest during a period of more optimal climatic conditions from about 5600 to 4200 cal. B.P. allowed the diversification of previously ubiquitous foraging strategies, resulting in a proliferation of different combinations of mobile foraging and residential mobility strategies across the region. An ensuing climatic downturn beginning about 4200 cal. B.P. resulted in a period of increased intergroup competition that effectively weeded out less well adapted strategies which were subsequently replaced by relatively uniform storage-dependent collector strategies throughout the Pacific Northwest. Prentiss and Chatters revisit these issues in their respective chapters in this volume. Here, they expand the scope of this earlier work to include macroevolutionary scale concepts of "emergent character" and "emergent fitness" (Arnold et al. 2001; Vrba and Eldredge 1984) applied to Wright's (1931, 1932) fitness landscape model as a way of mapping, in Prentiss's chapter, the punctuational shifts in resource strategies in the Pacific Northwest and, in Chatter's chapter, the emergence of agrarian Mississippian chiefdoms in the southeastern US. And while these studies do not specifically address issues of plant and animal domestication or agricultural origins within this macroevolutionary perspective, the changes in resource management strategies that result in reduced logistical mobility, intensification of exploitation strategies, and storage of surplus in the Pacific Northwest example, and the crystallization of stratified social groups, based on intensive maize agriculture in the Mississippian case study, do bracket these developments and provide a template of how macroevolutionary models might be applied to domestication and agricultural origins.

Kuijt and Prentiss's contribution to this volume applies a similar model in their consideration of changing resource management strategies during the Late Epipaleolithic in the Near East. Here they develop the concept of cultural niches to describe the ways in which humans manage habitats under various socioeconomic *Baupläne*. They trace an alternating tempo of stability and rapid change, in which, over the course of the climatically dynamic Late Epipaleolithic, periods of sudden niche diversification and equally sudden constriction are each followed by longer periods of general stability—a process that leads up to, but that does not include, the domestication of plants (and in other places animals) and the emergence of agricultural economies in the subsequent Pre-Pottery Neolithic.

Also operating within a macroevolutionary framework, Rosenberg (1990, 1994a, 1998) casts these same developments in a very different light. While Chatters,

Prentiss, and Kuijt see novel resource strategies arising in times of opportunity, Rosenberg believes that changes in mobility and intensification of resource extraction can only arise in periods of stress, in particular demographic stress, which in turn leads to territorial compression, and increasingly restrictive and proprietary rights to resources. And yet while the mechanics and context of change are different in Rosenberg's model, he too envisions the shift from a non-surplus-producing mobile hunter-gatherer system to a surplus-producing (if not food producing) one of punctuated revolutionary change.

Human Behavioral Ecology

The most recent co-opted evolutionary theory to enter the arena of archaeological explanation is behavioral ecology. Targeted at discovering the principles that shape adaptive behaviors in animals, especially with respect to resource acquisition or foraging (Charnov 1976; Krebs and Davies 1978; MacArthur and Pianka 1966; Stephens and Krebs 1986), concepts of behavioral ecology were quickly and eagerly adopted by both archaeologists and ethnographers interested in human foraging behavior, particularly within hunter-gatherer societies (Hawkes and O'Connell 1992; Hawkes et al. 1997; Kelly 1995, 2000; Winterhalder and Smith 1981). This fast growing school of human behavioral ecology (HBE) occupies at least some common ground with the earlier described neo-Darwinian or selectionist school of evolutionary archaeology. The overlap between these two approaches is especially evident in the HBE emphasis on the "microscale" of evolutionary change, which focuses on the role of individual actors in the process of microevolutionary change (Bettinger this volume, Winterhalder and Kennett in press). HBE practitioners and selectionist evolutionary archaeologists also share a deep suspicion of macroscale, universalist, prime-mover explanations of culture change (Layton et al. 1991; Winterhalder and Goland 1997). Moreover, both selectionist and HBE approaches to the study of culture change feature human behavior as the primary unit of cultural evolution and stress the role of social learning in the transmission of behaviors. As we have seen, however, selectionists profess no interest in the ways in which novel behaviors are generated and transmitted. Adherents of HBE, on the other hand, concentrate almost entirely on the decisions that shape these behaviors. Thus while selectionist archaeologists focus on tracing the genealogy of related behavior proxies (traits) and identifying the hand of selection, drift, and transmission in shaping these genealogies, archaeologists working with an HBE framework focus instead on isolating the underlying principles responsible for these behaviors in the first place.

An extreme application of behavioral ecology to human systems might argue that the behaviors of both birds and humans are guided by the same set of optimizing principles and that the human evaluation of energy expenditures and returns in making foraging decisions involves no more conscious intent than do the foraging choices of nonhuman animals. Most HBE practitioners, however, are quite comfortable with incorporating intentionality and conscious human decision making into

their models (Piperno 2006:164) and, in fact, tend to feature rational human decision making as a primary driver of culture change (Bettinger 2006). This emphasis on the role of conscious deliberation in cultural evolution is something that human behavioral ecologists hold in common with macroevolutionary archaeologists and is a major point of departure from the selectionist view of culture change.

The underlying principles held to guide behavioral choices in behavioral ecology are grounded as much in microeconomics as they are in biology (Bettinger 1991:83–84, 2006:306; Winterhalder and Kennett in press) and are laid out with exemplary clarity and precision in Winterhalder and Kennett (2006:11–17). The central assumption behind both behavioral ecology and human behavioral ecology is that of optimization, usually measured in terms of net energy returns of a particular foraging behavior over acquisition and processing costs. Behaviors in both human and nonhuman animals are, however, never fully optimal but are constrained by certain physiological, morphological, cognitive, and, in the case of humans, technological parameters that limit the range of behavioral choices. Optimality may also be impinged upon by delays in the development and spread of adaptive behaviors or in the sorting out of different sets of competing goals. Other basic concepts that shape adaptive behaviors include considerations of “marginal value” and “opportunity costs” that help determine the decision when to shift from one behavior to another by weighing the benefits of engaging in the new behavior against the diminishing benefits of the original behavior. “Discounting” (weighing of future returns against immediate returns) and “risk assessment” (assessing the probability of realizing expected returns) are additional factors that guide optimizing behavior.

These general concepts are operationalized in the form of various HBE models, which apply these fundamental behavioral features to a cost/benefit assessment of different courses of action under different circumstances. Most familiar to archaeologists are diet breadth models, which are based on the assumption that optimal resources (those with the greatest net energy gain over acquisition and processing costs) are always selected over less optimal resources. The inclusion of a lower ranked resource in the diet, following a strict application of the diet breadth model, has nothing to do with their ubiquity but is instead determined by the abundance and availability of higher ranked resources (Bettinger 1991:84–86; Hawkes and O’Connell 1992). Diet breadth add-ons discussed in Winterhalder and Kennett (2006:14–17) include considerations of the distribution of resources over the landscape, the ranking of resource patches, and the computation of the variables that will determine the amount of time dedicated to harvesting resources in one patch before moving to another. Other HBE models with a spatial dimension include the “ideal free distribution” model which examines habitat selection choices and the rate and direction of new habitat colonization, as well as central place foraging models that model habitation choice by adding travel time from foraging site to home site into the computation of resource net energy returns.

Ethnologists working within a behavioral ecology framework use these models to isolate the factors that guide the choices that individuals make in day-to-day foraging and other productive (and reproductive) activities. HBE archaeologists use them to tease out the factors responsible for shaping the long-term trajectory of such

choices over time. There are substantial methodological challenges to marshalling empirical data with the kind of kilocalorie precision required in these cost/benefit analyses. This is especially the case for archaeologists who must infer behavior from material culture and time average the decisions of many individuals over temporal spans of hundreds of years or more (Smith 2006). Despite these limitations, HBE practitioners see great value in the dialectic their models promote between HBE principles and real-life behaviors which they maintain helps hone the effectiveness of their models in capturing the driving forces behind human behavior and, by extension, cultural evolution.

The emergence of agricultural economies presents special challenges to behavioral ecologists. Agriculture involves an emphasis on the utilization of plants, whose generally smaller energetic returns and higher processing costs put them lower down on forager's ranked resource list (Bettinger 1991:98–100; Gremillion and Piperno in press; Hawkes et al. 1982; Kennett et al. 2006a:127; Piperno 2006:142, Tables 7.1 and 7.2). In addition, agriculture inherently incurs heavy discounting costs with lots of up-front energy expenditure for a deferred and often quite unpredictable return (Alvard and Kunzner 2001; Gremillion and Piperno in press; Hawkes and O'Connell 1992: 64; Tucker 2006; Winterhalder and Kennett in press). Explaining the adoption of agricultural strategies under the central optimization principles of behavioral ecology, then, requires figuring out why people chose to focus on lower ranked resources with long deferred, risky returns.

The first serious attempts at applying principles of foraging theory to agricultural origins can be found in an extended conversation among various HBE practitioners that unfolded in *Current Anthropology* in the early 1990s (Hawkes and O'Connell 1992; Layton et al. 1991, Layton and Foley 1992; Winterhalder and Goland 1993). The discussion began with Layton et al.'s proposal that behavioral ecology (specifically diet breadth models) offers a superior approach to the study of agricultural origins than can be found in mainline directional and progressivist, cultural evolutionary approaches. Hawkes and O'Connell (1992) agreed and expanded upon this position, while also critiquing the Layton et al.'s application of diet breadth models to agricultural emergence. Following the classic tenets of optimal foraging diet breadth models (Charnov and Orians 1973; Emlen 1966; MacArthur and Pianka 1966), Hawkes and O'Connell argued that regardless of the abundance of lower ranked plant resources, foragers will always ignore them when there is a sufficiently good chance of encountering and being able to procure higher ranked resources. The broadening of a diet to include lower ranked resources, then, can only occur when there is a decline in the abundance and, subsequently, in the encounter rates of higher ranked resources. They go on to explore conditions under which the costs of searching for declining high-ranked prey begin to outweigh the net returns of these energy-rich resources, making it worthwhile to invest in lower ranked plant resources despite their relatively higher handling costs. Under conditions of continued resource depression, this trade-off between search and handling costs results in a broad-based diet where the primary foraging costs are derived from handling, or processing, lower ranked resources rather than searching for higher ranked resources. The domestication of plant resources within such a subsis-

tence economy is seen as a product of increases in handling efficiency (either from improvements in technology or from changes in the morphology of the plants themselves) that further boosts net returns. Domestication of animals is characterized not as a means of compensating for declining game as Foley earlier proposed (Foley 1982) but as a way of further reducing the handling costs of lower ranked plant resources through their conversions into meat and milk. Winterhalder and Goland (1993, 1997) added to this discussion with a consideration of the conditions under which changes in the density, reproductive capacity, and net yield of lower ranked plant resources might raise their rank in the menu of available resources, setting foraging groups on the path to farming by initiating co-evolutionary relationships between humans and plants that boost net return rate along the lines explored by Rindos (1984).

Initial applications of diet breadth models to archaeological case studies can be found in Piperno and Pearsall's study of agricultural origins in the Neotropics (Piperno and Pearsall 1998) that holds the changing environmental conditions in the Early Holocene responsible for altering the menu of resources available to foraging populations in lowland Central and South America. Expansion of forests into previously open areas during this time increased the search costs of previously more abundant, higher ranked open-habitat resources (including large and medium-sized grazers like mammoths, glyptodonts, flat-headed peccaries, and horses, as well as high-quality, low-cost plant resources like dry-land cacti and legumes). The decreasing availability of these high-ranked resources caused by the post-Pleistocene changes in Neotropical environments resulted in an increasing emphasis on a widening array of previously little exploited lower ranked tropical forest plant and animal resources (i.e. smaller, often arboreal, game animals with higher search and capture costs and plants like squashes, manioc, yams, and other wild roots and tubers which at low densities provided too little return and were too costly to process to make them a worthwhile dietary component). Increasing human focus on certain plant species (those with a combination of particular life history, nutritional, and genetic attributes) eventually led to their domestication through a co-evolutionary cycle of enhanced returns and increasing human dependence (Piperno and Pearsall 1998, see also Piperno 2006).

Another early advocate of the application of behavioral ecology to the transition from foraging to farming, Gremillion (1996, 1998) drew on a range of HBE concepts (i.e. optimization, risk management, and opportunity costs) to frame various hypotheses for the shift in resource utilization and the adoption of small seeded plant domesticates in eastern North America at around 1000 BC. In the first archaeological application of behavioral ecology to animal domestication, Alvard and Kunzner (2001) considered the circumstances under which the immediate benefits of slaughtering an animal on encounter might be deferred long enough for a herd of managed animals to reach a sustainable size. They argue that the relatively rapid reproductive rate of medium-sized mammals addressed this discounting dilemma most effectively which is the reason why animals like sheep and goats were domesticated before larger meat package animals like cattle.

Kennett and Winterhalder's (2006) recent edited volume greatly expands upon the range and scope of HBE applications to the study of agricultural origins and diffusion. Rather than a punctuated switch for one dominant subsistence mode to another, chapters in this influential volume portray the transition from foraging to farming as an attenuated process in which managed resources (either locally domesticated or introduced from elsewhere) gradually infiltrate subsistence economies based on wild plant and animal resources. In each case, authors marshal a variety of different HBE principles and models to help explain the timing and the scope of the incorporation of domestic resources into these economies. The delayed embrace of maize agriculture in both the Pacific coast of southern Mexico (Kennett et al. 2006a) and in southeastern Arizona (Diehl and Waters 2006), for example, are both viewed from the perspective of diet breadth, cost-benefit analysis in which initially more profitable foraging strategies in these regions are only replaced when maize agriculture becomes more productive. In the Mexican case, a more robust embrace of maize agriculture is deferred until evolved varieties of higher yield maize become available. In the Arizonan example, the introduction of ceramic storage technology that mitigates storage losses is the added feature that makes an investment in maize more worthwhile. Denham and Barton (2006) similarly use diet breadth concepts to show how increasing human encouragement of starch-rich tropical plants elevated their rank within the subsistence round of foragers in highland New Guinea, resulting in decreased mobility and increased dependence on plant cultivation. Concepts of marginal valuation are used to sort out why certain foragers in the Fremont region of the eastern Great Basin and northern Colorado Plateau decided to farm, while others did not (Barlow 2006).

Central place foraging models are brought to bear in Gremillion's expanded consideration of agricultural emergence in eastern North America which examines how considerations of travel time between collection/cultivation localities and habitation sites may have affected decisions about which plant resources to exploit and the evaluation of the respective costs of the cultivation of domesticates and harvesting wild plants (Gremillion 2006). Ideal free distribution models are applied to changes in herd management, agricultural strategies, and land use by Neolithic farming populations in eastern Spain (McClure et al. 2006) and to predict the pace and direction of island colonization in Oceania (Kennett et al. 2006). Aldenderfer introduces the concept of costly signaling, a male reproductive strategy that has been linked to hunting behavior (Hawkes and Bliege-Bird 2002; O'Connell et al. 2002), as a means of explaining how hunters in the Andean highlands overcame discounting impediments to become camelid herders (Aldenderfer 2006). In many cases, the authors of these thought-provoking essays acknowledge that they lack the kind of empirical data needed to rigorously test the application of behavioral ecology to archaeological case studies of agricultural origins (i.e. Kennett et al. 2006a, and see Smith 2006), concentrating instead on developing the test implications of these models as applied to these particular case study examples and describing the kinds of data that would be needed to evaluate their models.

Agricultural Origins in the Near East

Each of these different applications of evolutionary biology to cultural evolution has looked to the emergence of agricultural economies as a way of demonstrating the efficacy of these co-opted evolutionary models in the study of culture change. Selectionist archaeologists cast this major transition in human history in terms of a gradual unfolding of events in which universal Darwinian forces, operating independently of sentient human agency, shaped the trajectory of discrete attributes within unique cultural lineages. Behavioral ecologists see agricultural emergence as the cumulative product of day-to-day human decisions guided by a set of microeconomic optimizing principles. Macroevolutionary archaeologists, on the other hand, characterize the origins of agriculture as a revolutionary right-angled departure from previous hunting and gathering adaptations guided by deliberate and directed human responses to stresses and opportunities whose impact reverberated across multiple societal levels.

As we have seen, case study examples used to advance these divergent positions have been drawn from around the world, from New Guinea to eastern North America. Curiously very few of these case studies have been based in the Near East, arguably the oldest and best known example of agricultural origins and the one that produced many of the major crops and livestock animals found in agricultural economies today. Even the Rosenberg (1990, 1994a, 1998) and the Kuijt and Prentiss (this volume) case studies discussed above stop just short of the actual domestication of plant and animal species and do not consider the subsequent coalescence of agricultural economies based on plant and animal domesticates.

This is particularly surprising given the increasing resolution of the empirical record of agricultural origins in this region. After more than 50 years of concentrated research there is now a detailed and comprehensive archaeological record of agricultural origins from all parts of the broad Fertile Crescent arc that spans the Near East. The regional scope of this work includes the far eastern Fertile Crescent of the Zagros Mountains and its piedmont where, from the 1950s through the 1970s, the first interdisciplinary expeditions examining Near Eastern agricultural origins were conducted (Braidwood and Howe 1960, Braidwood et al. 1983; Hole and Flannery 1967; Hole et al. 1969; Morentsen 1974, 1975; Smith 1972; Solecki 1981; Solecki 1965, (Figs. 6.1–6.2, Table 6.1). The southern and northern Levant stretching from the Sinai to the Upper Euphrates Valley has been the focus of more than three decades of intensive investigation into agricultural origins (Aurenche et al. 1988, 1989; Bar-Yosef 1982, 1990; Bar-Yosef et al. 1991; Cauvin 1978; Goring-Morris 1987; Moore 1991; Perrot 1983). Most recently, there has been a great deal of high profile work in the foothills and highlands of the eastern Taurus Mountains of southeastern Anatolia (Hauptmann 1993, 1999; Hours and Copeland 1983; Kozłowski 1999; Rosenberg 1994b; Rosenberg and Davis 1992), in central Anatolia (Esin and Harmankya 1999; Özbasaran 2000; Watkins 1996), and even on Cyprus 60 km off the Levantine coast (Guilaine and Briois 2001; Peltenburg 2003), which seems to be the beachhead of the first diffusion of Neolithic economy out of the Near East and into the Mediterranean Basin (Vigne et al. 2003; Zeder 2008a). Moreover,

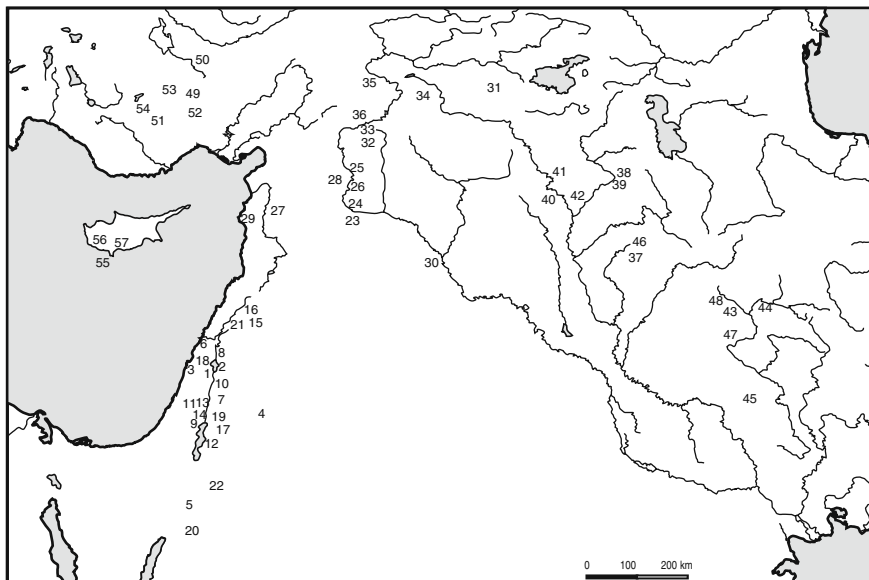


Fig. 6.1 Map of the Near East showing location of major sites. See Table 6.1 for names of sites

the past decade has witnessed remarkable advances in the documentation of domestication (see Zeder et al. 2006a, b) with increasingly well-developed archaeological and genetic analytical methods providing new insights into the process of domestication of many of the major Near Eastern crops and livestock. An increasingly refined temporal framework for these developments has also been built using precise and accurate small sample radiometric methods and calibration equations (Byrd 2005; Zeder 2009).

The Near Eastern record of the transition from foraging to farming has something to offer evolutionary anthropologists of all persuasions and would seem the ideal case study example for the evaluation of the efficacy of different evolutionary approaches to the study of culture change. The remarkable decades-long study of Kowzowski and Aurenche (2005), for example, which uses a wide array of artifact types and architectural styles to construct deep-time subregional cultural lineages provides the ideal data set for the application of a selectionist cladistic analysis (i.e. Lipo et al. 2006). The depth and scope of this region-wide record, and its increasing temporal resolution is certainly complete enough to confirm that evidence of punctuated change is real and not the artifact of a spotty empirical record or the product of a faulty cultural typology based on an inadequate understanding of cultural variability. And although even with this exemplary empirical record we are still some way from being able to monitor daily decisions of individual actors or to tabulate accurate kilocalorie estimates of the energy costs in procuring Near Eastern resources and their returns, we do have a fairly robust understanding of the range

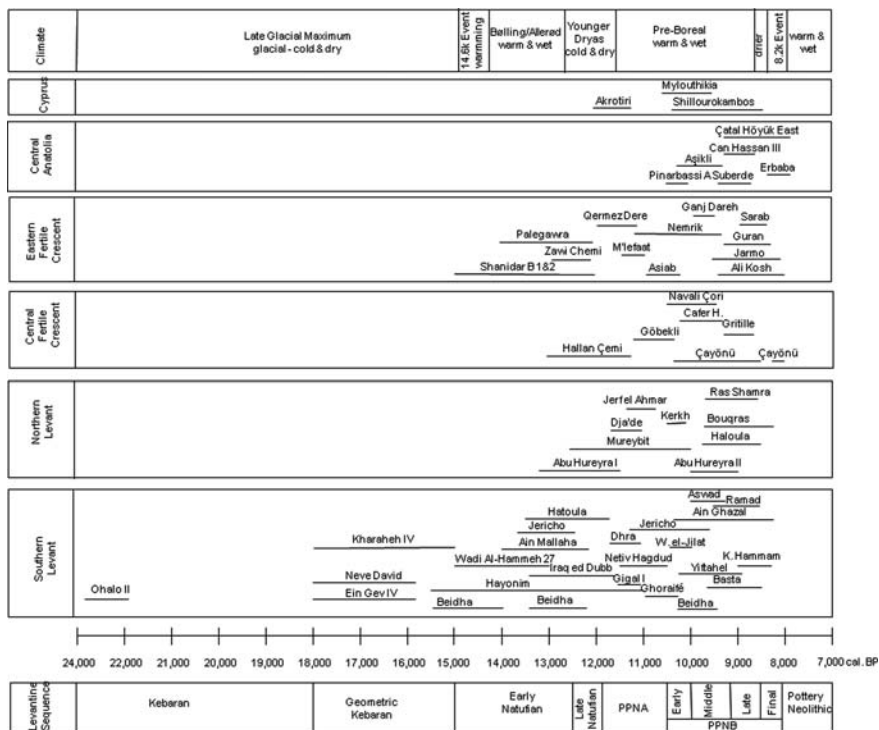


Fig. 6.2 Time line of Near Eastern sites, Levantine chronology, and climatic conditions. Compiled using information from Bar-Yosef and Meadow, 1995; Aurenche et al. 2001; Kuijt and Goring-Morris, 2002; Nesbitt, 2002, and Byrd, 2005

of resources utilized and the ways in which human interaction with these resources evolved over time, information well suited to a behavioral ecological approach to the study of culture change.

Although the empirical details of his model have not stood the test of time, V. Gordon Childe’s conception of the basic nature of Neolithic emergence and its key distinguishing features outlined in his classic essay on the Neolithic Revolution (Childe 1951) provides an ideal rubric for the evaluation of the efficacy of these co-opted evolutionary models in characterizing the unfolding events that surrounded the emergence of agricultural economies in the Near East. The ten components Childe identified as key constituent elements of the Neolithic Revolution include the economic, social, and ideological aspects of this transition, as well as key material culture attributes needed to evaluate each of the different evolutionary frameworks considered here—whether these components are viewed as discrete attributes shaped by Darwinian forces, as parts of a constellation of interacting traits that comprise the Neolithic *Bauplan*, or as the set of external and internal constraints that structured resource selection over the course of the transition from foraging to farming. Childe’s ten components are the following: (1) an agricultural economy based on domesticated plants and animals, (2) exponential population growth,

Table 6.1 Major Near Eastern Sites (from Bar-Yosef and Meadow, 1995; Aurneche et al. 2001; Nesbitt, 2002, Byrd, 2005)

Ref. No	Site	Region	Modern country	Dates kya cal. BP
1	Oahalo II	Southern Levant	Israel	24.0–22.0
2	Ein Gev IV	Southern Levant	Israel	18.0–16.0
3	Neve David	Southern Levant	Israel	18.0–16.0
4	Kharaheh IV	Southern Levant	Jordan	18.0–15.0
5	Beidha Early Natufian	Southern Levant	Israel	15.5–14.0
6	Hayonim Cave & Terrace	Southern Levant	Israel	15.5–11.0
7	Wadi al-Hammeh 27	Southern Levant	Jordan	15.0–13.0
8	Ain Mallaha	Southern Levant	Israel	14.0–12.0
5	Beidha Late Natufian	Southern Levant	Israel	13.4–12.3
9	Jericho Natufian	Southern Levant	Israel	13.7–12.3
10	Iraq ed Dubb	Southern Levant	Jordan	13.2–11.5
11	Hatoula	Southern Levant	Israel	13.7–12.9
12	Dhra	Southern Levant	Jordan	11.6–11.2
13	Netiv Hagdud	Southern Levant	Israel	11.5–10.8
14	Gigal I	Southern Levant	Israel	11.4–11.2
9	Jericho PPNA&B	Southern Levant	Palestine	11.2–9.5
15	Aswad	Southern Levant	Syria	10.5–9.3
16	Ghoraife	Southern Levant	Syria	10.8–10.3
17	Wadi el-Jilat 7	Southern Levant	Jordan	10.5–10.0
18	Yiftahel	Southern Levant	Israel	10.8–8.8
19	'Ain Ghazal	Southern Levant	Jordan	10.4–8.2
5	Beidha PPNB	Southern Levant	Jordan	10.2–9.5
20	Basta	Southern Levant	Jordan	9.5–8.7
21	Ramad II	Southern Levant	Syria	9.4–8.6
22	Khirbet Hammam	Southern Levant	Jordan	9.0–8.5
23	Abu Hureyra I	Northern Levant	Syria	13.3–11.5
24	Mureybit Ia-IV	Northern Levant	Syria	12.6–10.0
25	Dja'de	Northern Levant	Syria	11.6–11.0
26	Jerf el Ahmar	Northern Levant	Syria	11.3–10.9
27	Tel Kerkh	Northern Levant	Syria	10.5–10.2
23	Abu Hureyra II	Northern Levant	Syria	10.0–9.0
28	Haloula	Northern Levant	Syria	9.7–8.5
29	Ras Shamra	Northern Levant	Syria	9.5–8.6
30	Bouqras	Northern Levant	Syria	9.5–8.2
31	Hallan Çemi	Central Fertile Crescent	Turkey	13.0–11.3
32	Göbekli Tepe	Central Fertile Crescent	Turkey	11.2–10.5
33	Navali Çori	Central Fertile Crescent	Turkey	10.7–9.7
34	Cayönü Aceramic	Central Fertile Crescent	Turkey	10.5–8.5
35	Cafer Höyük	Central Fertile Crescent	Turkey	10.2–9.5
36	Grittle	Central Fertile Crescent	Turkey	9.5–8.8

Table 6.1 (Continued)

Ref. No	Site	Region	Modern country	Dates kya cal. BP
34	Cayönü Ceramic	Central Fertile Crescent	Turkey	8.4–8.3
37	Palegawra	Eastern Fertile Crescent	Iraq	16.0–12.0
38	Shanidar B1&2	Eastern Fertile Crescent	Iraq	15.0–12.3
39	Zawi Chemi Shanidar	Eastern Fertile Crescent	Iraq	13.0–12.3
40	Qermez Dere	Eastern Fertile Crescent	Iraq	12.0–11.2
41	Nemrik	Eastern Fertile Crescent	Iraq	11.5–9.2
42	M'lefaat	Eastern Fertile Crescent	Iraq	11.5–11.0
43	Asiab	Eastern Fertile Crescent	Iran	11.0–10.5
44	Ganj Dareh	Eastern Fertile Crescent	Iran	10.0–9.7
45	Ali Kosh	Eastern Fertile Crescent	Iran	9.5–8.0
46	Jarmo	Eastern Fertile Crescent	Iraq	9.5–8.0
47	Guran	Eastern Fertile Crescent	Iran	9.3–8.5
48	Sarab	Eastern Fertile Crescent	Iran	9.0–8.5
49	Pinarbassi A	Central Anatolia	Turkey	10.5–10.2
50	Aşikli Höyük	Central Anatolia	Turkey	10.4–9.4
51	Suberde	Central Anatolia	Turkey	9.6–8.8
52	Can Hasan III	Central Anatolia	Turkey	9.4–8.7
53	Çatal Höyük East	Central Anatolia	Turkey	9.4–8.2
54	Erbaba	Central Anatolia	Turkey	8.6–8.4
55	Aetokremnos	Cyprus	Cyprus	12.0–11.7
56	Mylouthikia	Cyprus	Cyprus	10.3–9.5
57	Shillourokambos	Cyprus	Cyprus	10.2–8.5

(3) storage of surplus and a system of delayed returns of productive resources, (4) sedentism, (5) trade networks focusing on nonessential items, (6) decentralized social mechanisms for the coordination of collective activities, (7) associated and enabling magico-religious traditions that focus on the promotion of fertility, (8) ground stone implements, (9) pottery, and (10) weaving implements (e.g., spindle whorls). The following discussion presents a relatively abbreviated summary of the Near Eastern empirical record for each of these key features, considering both the timing of their appearance in the archaeological record and the regional variability in how they are manifested. A more comprehensive review of this very large data set can be found in Zeder 2009.

Material Culture Attributes (Components 8–10)

The appearance of material culture attributes in Childe's model provide convenient temporal brackets for Neolithic emergence in the Near East. Weaving implements in the form of clay spindle whorls are the last of the ten components to appear. First reported about 9,500 cal. B.P., they become quite ubiquitous, especially in the central and eastern Fertile Crescent, at about 9,000 cal. B.P. (Kowzłowski and Aurenche 2005: 31, 258)—a development which indicates that the genetically driven changes that transformed sparse secondary coat hairs of caprines into dominant woolly fleece had taken place by this time (Bökönyi 1977; Ryder 1983).

Pottery is also a relatively late constituent element of Neolithic emergence in the Near East. Clay-crafted ceramics are first documented at the site of Ganj Dareh in highland Iran at about 10,000 cal. B.P. (Smith 1976). The spread of undecorated ceramics is quickly followed by painted wares found in the Zagros, south-eastern Anatolia, the northern Levant, and central Anatolia by about 9,000 B.P. with each region displaying distinctive stylistic variants (Kowzłowski and Aurenche 2005:32–34, 270–273). Pottery was not used in the southern Levant until about 8,400 cal. B.P. (Aurenche et al. 2001).

Ground stone tools, on the other hand, are the earliest of Childe's ten key components to appear in the Near East. Both bedrock and portable ground stone mortars clearly associated with cereal processing are found in the southern Levant as early as 24,000 years ago (Piperno et al. 2004; Weiss et al. 2004). They are ubiquitous throughout the southern Levant, along with pestels, querns, stone bowls, and hand stones by about 14,000 cal. B.P. (Bar-Yosef 1990, Bar-Yosef and Meadow 1998:57), with the full complement of ground stone tools widespread across the Fertile Crescent by about 13,000 cal. B.P. (Kowzłowski and Aurenche 2005:23, 145–150).

The appearance of these different material culture attributes, from 24,000 to 9,500 cal. B.P., brackets a very long temporal span of more than 14 millennia. Even if one starts the Neolithic countdown clock with the widespread appearance of ground stone tools at 14,000 cal. B.P. and Neolithic emergence with the appearance of pottery at about 10,000 cal. B.P., this is still a quite extended 4,000-year period during which the other eight constituent components make an appearance at different times and places in the Near East.

Sedentism and Storage (Components 3 and 4)

The ground stone tools whose appearance brackets the beginning of the temporal span considered here were used by mobile Early Epipaleolithic (Kebaran) period foraging populations in the Southern Levant (24,000–18,000 cal. B.P.). Even during the height of the Late Glacial Maximum (c. 23,000 cal. B.P.), small groups of foragers seem to have congregated, possibly for extended periods of time, in favored locations like Ohalo II on the shores of the Sea of Galilee. While residing in these sheltered based camps they utilized a broad spectrum of plant resources including a wide variety of small and large seeded wild cereals, legumes, nuts, and fruits, and a

diverse array of game animals (Nadel 2004; Piperno et al. 2004; Weiss et al. 2004). Mobile foraging adaptations proliferated in the ensuing Geometric Kebaran period (18,000–14,600 cal. B.P.) when, under conditions of climatic amelioration, populations expanded into more desertic areas (Bar-Yosef and Meadow 195:54). These people seem to have followed a similar seasonal round, dispersing into upland areas in spring and summer and coalescing into larger social units at sites like Neve David and in Gev IV, in the autumn and winter. Although there seems to have been a heavy emphasis on plant processing in these base camp settlements, there is no evidence for storage in Middle Epipaleolithic sites, although this may be attributable to the lack of large-scale horizontal excavation of these sites or the use of perishable baskets for plant storage (Bar-Yosef 1990; Byrd 2005:254; Henry 1989: 169–179).

Sedentary communities are clearly evident in the southern Levant in the following Early Natufian (ca. 14,000–12,050 cal. B.P.) in the form of large (c. 1200 m²) base camps situated in strategic locations with access to several different resource zones that housed as many as 60 people in small oval structures (Byrd 2005:255). Year round occupation of at least some of these base camps is indicated by the seasonality of plant and animal resources utilized and by the presence of commensal animals that exploit the niche created by long-term human habitation (Tchernov 1991). Limited evidence for storage in these base camps can be found in the plastered pits that occur outside of house structures at the site of Ain Mallaha in the Upper Jordan Valley and the paved bins at Hayonim Terrace (Bar-Yosef 1982, Kuijt in press). The smaller, ephemeral sites that radiate from larger base camps suggest continued seasonally mobile foraging activities during this first phase of the Late Epipaleolithic (Henry 1989:219).

The resumption of more mobile settlement patterns in the subsequent Younger Dryas climatic down turn of the Late and Final Natufian southern Levantine sequence (12,900–11,600 cal. B.P.) is followed by a return and proliferation of sedentary settlement patterns in the following Pre-Pottery Neolithic (PPNA) that overlaps with the end of the Younger Dryas and the ensuing climate amelioration in the Early Holocene (c. 12,000–10,500 cal. B.P.). PPNA settlements like Nativ Hagdud, Gugal, and Dhra' were often located near springs or marshy areas. They range in size from 2000 m² hamlets to 2.5 ha "villages" comprising numerous circular or oval semi-subterranean houses (Bar-Yosef 1992:34, Bar-Yosef and Meadow 1995:62). In contrast to Early Natufian settlements, there is ample evidence for storage both inside and outside of houses in the form of pits, bins, and even what have been interpreted as "silos" (Bar-Yosef and Meadow 1995:62; Kuijt 2009). There is, however, also evidence for special temporary campsites likely used for the extraction of special resources during the PPNA (Bar-Yosef and Meadow 1995:62).

The following Early PPNB period (10,500–10,000 cal. B.P.) marks the beginning of the shift from round or oval to small-scale subrectangular architecture (Kuijt and Goring-Morris 2002:385). During the ensuing Middle PPNB (10,000–9,200 cal B.P.), fully sedentary villages of up to 3 ha, situated in better watered parts of the region, comprised of free-standing, multiroom rectangular structures (Byrd

1994:659; Kuijt 2000:85). Smaller more ephemeral settlements with small rounded buildings are still found in more arid zones, however (Kuijt and Goring-Morris 2002:388–389). In the Late PPNB (9,200–8,700 cal. B.P.) settlement shifts eastward with a number of 10–14 ha “mega-villages” like Ramad, Basta, and Khirbet Hammam established in the Eastern Jordan Valley, characterized by closely packed, increasingly compartmentalized, and often two-story rectangular houses. While storage facilities can be found outside of houses in the PPNA, over the course of the PPNB storage functions shift to inside houses, with lower storey areas often dedicated exclusively to storage (Kuijt 2000:81; Kuijt 2009). A period of climatic deterioration culminating in the abrupt global pulse of cold, dry conditions at 8,200 cal. B.P. coincides with the Final PPNB/PPNC which saw the collapse of the large Late PPNB villages and the dispersal of population into more diffuse, less-nucleated settlements (Bar-Yosef and Meadow 1995:45; Kuijt and Goring-Morris 2002:413). A new village system appears in the southern Levant in the following Pottery Neolithic Period (ca. 8000–7800 cal B.P.) (Gopher and Gophna 1993).

The sparser record from regions outside the southern Levant sees the first evidence of large, semi or fully sedentary settlement during the Late Epipaleolithic climatic downturn at sites like Mureybit and Abu Hureya I (Cauvin 1978; Moore et al. 2000) in the Middle Euphrates Valley, at Hallan Çemi in the Taurus region of southeastern Anatolia (Rosenberg and Redding 2000), and at Zawi Chemi Shanidar in the Zagros (Solecki 1981). All these sites are characterized by the presence of relatively densely packed round and oval semi-subterranean structures, numerous heavy ground stone tools, and some evidence of storage. Round houses in these regions also transitioned into rectangular houses, with the earliest evidence of this transition seen in the northern Levant at about 10,900 cal. B.P. (roughly 500 years earlier than in the southern Levant) and the latest in the Zagros evidenced at the site of Ganj Dareh at about 10,000 cal. B.P. Throughout the region the transition from round to rectangular houses is accompanied by an increasing elaboration of storage facilities within houses best exemplified by the sequence of storage configurations seen at Çayönü in southeastern Anatolia (Özdoğan and Özdoğan 1989). Colonizing populations that arrived in Cyprus at about 10,500 cal. B.P., in contrast, never seem to have made the transition in architectural styles, retaining round houses throughout the Neolithic (Peltenburg 2004).

Population Growth (Component 2)

Estimating the rate and amplitude of population growth from archaeological data is never easy, which is why people often resort to using trends in resource intensification and mobility as indirect proxy measures of population size and degree of packing (Binford 2001; Rosenberg 1998)—a problematic practice when one is testing models that hold demographic pressures responsible for changes in a broadening of the resource base and sedentism (Zeder 2006a, 2009 Zeder and Smith in press). Though admittedly incomplete in many regards, survey data recording the number, size, and spacing of settlements and the intensity and duration of their occu-

pation are a preferable alternative to such proxy data. The evidence for population growth in the southern Levant comes from comprehensive studies by Henry (1989, 2002) for the Epipaleolithic up to the Early Natufian and by Kuijt and Goring-Morris (2002:424, Kuijt 2000) for the Late Natufian through the PNNB. Despite the marked increase in settlement size and thickness of deposits in Early Natufian settlements, population growth over the course of the Epipaleolithic and into the PPPNB seems to have been a rather slow and incremental process without clear evidence of packing or pressure on resources (Henry 1989). The exponential spike in population levels which is one of Childe's ten components of Neolithic emergence is not seen in the southern Levant until the Late PPNB, with a subsequent crash in population in the ensuing Pottery Neolithic A (PNA) periods at about 8,300 cal. B.P. (Kuijt and Goring-Morris 2002).

Population measures in the rest of the Fertile Crescent suggest even lower population densities in the Epipaleolithic through the beginning of the Pre-Pottery Neolithic, with possible relatively empty areas separating settlement zones in between the southern and northern Levant, southeastern Anatolia, central Anatolia, and the Zagros (Kowzłowski and Aurenche 2005:85). Evidence for demographic trends across this broad area echo those in the southern Levant suggesting a slow and gradual process of population growth that spikes toward the latter part of the sequence at about 9,500 to 9,000 years ago (Hole 1990a; 1990b; Hole and Flannery 1967; Morentsen 1974, 1975; Özbaşaran and Buitenhuis 2002; Özdoğan 2002).

Mechanisms for Social Cohesion (Component 6)

The transition from small round or oval houses to rectangular multiroom structures witnessed throughout the region provides special insight into changes in social mechanisms operating at the household level. While originally read as indicative of a shift from a system of partilineal, polygamous households to that of monogamous, nuclear families (Flannery 1972), Byrd has subsequently argued that both the smaller round houses and the later rectangular ones were occupied by nuclear families (Byrd 1994, 2005). Flannery (1993, 2002), Byrd (2000) and Kuijt (2000, 2009) all agree, however, that the move from storage structures located outside of houses to the increasing formalization of storage and other activity areas within households witnessed during this architectural transition signals the increasing importance of notions of restricted ownership over resources and resultant increases in individual household autonomy. This shift, though different in timing and in the precise details of household arrangement, is seen in all regions of the Fertile Crescent.

At the same time household-level organization was looking progressively inward, and there seems to have been corollary developments in community organization directed at leveling differences among households and promoting community cohesion. Elements of community-level organization can be traced as far back as the Early Natufian (c 13,000 cal. B.P.) in a large structure with plaster and painted benches at Ain Mallaha argued to have served a nondomestic function

(Byrd 1994:259). Late Natufian sites of Hallan Çemi and Zawi Chemi Shanidar (c. 12,500 cal. B.P.) provide several indications of structures, public areas, and possible feasting activities all believed to help promote community cohesion (Rosenberg and Redding 2000, Solecki 1981:53–54; Solecki and McGovern 1980).

The best known example of concerted communal activity in the major stone constructions built by inhabitants of PPNA Jericho (ca. 11,000 cal. BP) (Kenyon 1981). These massive structures included a wall, that may have helped divert seasonal flash flooding (Bar-Yosef 1986), and a tower, which at one point served as a repository for collective burials providing a ritual focus for the community that expended so much energy building this major stone construction (Bar Yosef 1986; Bar-Yosef and Meadow 1995:63; Kuijt and Goring-Morris 2002:373–376). Additional ritual focal points are found in Southeastern Anatolia in the large, symmetrically arranged, T-shaped stone monoliths decorated with bas-relief images of animals at the site of Göbekli Tepe and Karahan used over the course of the PPNA and into the early PPNB (11,000–9,500 cal. B.P) (Çelik 2005; Schmidt 2005). Special purpose constructions of varying form and elaboration are found throughout the Fertile Crescent in the clearly nondomestic buildings found in every phase of occupation at Çayönü in southwestern Anatolia (Özdoğan and Özdoğan 1989), the “shrines” at ‘Ain Ghazal in the southern Levant (Rollefson 2000), and the “cult buildings” at Aşikli Höyük in central Anatolia (Esin 1998). Despite variations in the form of these special function constructions, the general underlying picture that emerges from across the region is one of essentially self-contained independent communities in which highly autonomous households were bound together by community-level social events and ritual (Hole 2000)—a picture of social life that corresponds well to Childe’s image of the decentralized social mechanisms used to coordinated of collective activities in emergent Neolithic communities.

Further insight into social mechanisms that held communities together can be found in burial treatments. The first real concentration of human burials is found in the Early Natufian sedentary communities of the southern Levant. The grave goods, body placement, and burial architecture of often collective Early Natufian burials has been interpreted by Byrd and Monahan (1995:283; Byrd 2005:257) as indicative of horizontal rather than vertical differentiation between individuals, with burial practices reinforcing affiliations between different age, grade, and sex distinctions that cut across kinship distinctions and promote community cohesion. More mobile Late Natufian people in the southern Levant returned to abandoned Early Natufian camps to bury their dead, often as secondary burials with few or no grave goods, perhaps as a way of connecting with the community structure that emerged during easier times. Despite the lack of any form of social distinction in Late Natufian burials, Byrd and Monahan (1995:283) see the practice of selective skull removal of certain individuals from these graves as a signal of emergent notions of individual leadership. The primary burial of unornamented bodies and selective secondary removal of skulls, which may be decorated and reburied in extra-household more public places, continues into the PPNA and intensifies in the ensuing PPNB in the southern Levant. This practice is interpreted by Kuijt (2000; Kuijt and Goring-Morris 2002) as evidence of ritual practice directed at minimizing differences between households,

while emphasizing a collective community ethos built around lineage lines and a sense of shared leadership among households.

While once again different in many details, burial practices elsewhere in the Fertile Crescent seem to echo themes seen in the southern Levant. The necropolis at Çayönü containing the remains of some 300–400 individuals, including up to 90 disarticulated skulls, and some evidence of animal and perhaps even human sacrifice (or less dramatically, but perhaps more likely, post-mortem dismemberment) provides a particularly good example of the dead forming a focus point for the cohesion of the community of the living (Hole 2000; Özdoğan 1997). Skull removal and decoration also finds its way to central Anatolia at the well-known Late PPNB site of Çatal Höyük. Instead of being placed in a central community focal point as done in the southern Levant, the decorated skull found at Çatal Höyük is placed within a house—a practice interpreted as reinforcing household-level ritual at a site that is argued to lack evidence of corporate ritual or civic leadership (Asouti 2006).

Magico-religious Traditions Emphasizing Fertility (Component 7)

Insight into ideology and views of the cosmos can be sought in the small portable clay or stone figurines often thought to be vehicles of magic or charms used in ritual acts (Ucko 1968; Voigt 2000). In a radical departure from Natufian figurative art dominated by representations of animals or genderless humans, the PPNA (c. 12,000–10,500 cal. B.P.) sees a proliferation of female figurines and other clay objects emphasizing fecundity and reproduction (Bar-Yosef and Meadow 1995:64; Kuijt and Goring-Morris 2002:377) that seem to correspond quite well with Childe's seventh component of Neolithic emergence. While much has been made of the ascendancy of "mother goddess" symbols during the PPNA (as well as the later rise of bull symbols in the ensuing PPNB) (Cauvin 2000a, b), it is important to note that there is ample representation of male and genderless imagery in portable art, as well as continued representation of a wide variety of animal symbols. Moreover, while female figurines can be found across the Fertile Crescent during the PPNA and later, there is a great deal of regional variation in posture, ornamentation, and style in female representation (Kowzłowski and Aurenche 2005:28-29). The degree of regional variation in the use of these symbols runs counter to the Cauvin's evangelizing scenario of the spread of northern Levantine symbols and other aspects of Neolithic life across and, eventually, out of the Fertile Crescent. Although certain symbolic elements recur in both portable and nonportable art across the region (female figurines, bull representations and animal crania set into architecture, snakes and birds of prey in glyptic art, and wall murals), there is enough regional variability in this art to suggest that peoples of the central Fertile Crescent, with their distinctive megaliths and figurative art, shared a common symbolic system (and possibly a common language) that was distinct from people in the southern Levant, Zagros, and central Anatolia (Kowzłowski and Aurenche 2005; Stordeur 2004).

Trade Networks (Component 5)

Although Childe maintained that emergent Neolithic communities were essentially self-sufficient, he also predicted that trade among food-producing communities, especially in nonessential or luxury items, established essential communication channels that were responsible for the spread of Neolithic lifestyles. Trade in exotic items (obsidian, marine shells, rare stones) is seen in the Near East as far back as the Epipaleolithic (Byrd 2005:254), overlaying a process of increasing regionalization in lithic industries. Over the course of the PPNA, the process of localization in many elements of material culture continues, with a corollary increase in the range and amount of long distance exchange of traceable trade items (Bar-Yosef and Meadow 1995, Bar-Yosef Mayer 2000; Kuijt and Goring Morris 2002).

An exponential expansion and elaboration of interregional trade, however, is not seen until the PPNB, during which time a vast “interaction sphere” seems to have existed linking all areas of the Fertile Crescent. These far flung trade networks are sometimes portrayed as the primary vehicles for the diffusion of Neolithic lifeways across the region, whether emanating from the southern Levant (Bar-Yosef 2001; Bar-Yosef and Belfer-Cohen 1989), from the Euphrates Valley (Cauvin 2000a b), or from the region between the upper Euphrates and the Tigris (Kowzowski and Aurenche 2005). However, there is also considerable evidence for a more polycentric view of the PPNB world as made up of more fragmented distinct local cultures that both evolved and remained relatively independent of one another (Gebel 2002, 2004; Rollefson 2004; Rollefson and Gebel 2004). Despite the persistence of local traditions in different parts of the Fertile Crescent, there can be no denying that the PPNB witnessed an explosion of trade items across the region that included exotic goods, lithics, and other elements of domestic technology (including plant and animal domesticates), as well as various elements of social and religious behavior that can be found from the southern Levant to the Zagros and into central Anatolia. The spread of so many aspects of Neolithic life, when combined with the continued regional identity of material culture across the region, suggests the existence of a pan-regional social, economic, and ideological interaction sphere into which local communities selectively subscribed, adopting and tailoring certain foreign elements to meet localized needs (Asouti 2006).

Agricultural Economy Based on Plant and Animal Domesticates (Component 1)

The final and central component of Childe’s Neolithic model, the domestication of plants and animals and the development of agricultural economies, is coming into increasingly high-resolution focus in the Near East. Documenting the process of domestication and the emergence of agriculture has been a primary objective of research in the region for more than a half a century (Braidwood and Howe 1960; Braidwood et al. 1983). The last decade, in particular, has witnessed remarkable advances in our understanding of how this process unfolded in the Near East,

thanks in large measure to the development of breakthrough archaeological, genetic, and chronometric methods for detecting and dating the process of plant and animal domestication (see discussion in Zeder et al. 2006a, 2006b). Perhaps the greatest breakthroughs have been in the development of powerful new markers of domestication that are not only transforming our understanding of how this process unfolded but are also causing a reconsideration of the very concept of domestication and the relationships between domestication and agricultural emergence (see discussion in Zeder 2006a, 2006b).

The earliest morphologically altered plant domesticates in the region have been argued to be the handful of plump grains of rye recovered among the large quantity of wild cereals and other wild plants remains from Late Natufian (c. 13,000–12,000 cal B.P.) levels at Abu Hureyra in the northern Levant (Hillman 2000). The domestic status of these rye remains is controversial (see Nesbitt 2002), but even if domestic rye were present at Abu Hureyra, this potential domesticate appears to have had an ephemeral existence, since domestic rye is not seen again in Near Eastern assemblages for another 2,000 years when it appears at the site of Can Hasan III in southeastern Anatolia (Hillman 1978). Modern domestic rye appears to have had a European origin (Zohary and Hopf 2000).

Barley is another possible candidate for the earliest Near Eastern plant domesticate based on the non-shattering, tough rachises found in small numbers among wild, brittle rachis barley at PPNA Nativ Hagdud (Bar-Yosef and Kislev 1989). The small percentage of tough rachis grains in this assemblage (about 4%), however, is within the range of occurrence of this domestic morphotype in modern wild strands of barley, raising questions whether these grains represent true domesticates or the precursors of varieties eventually selected in the domestication process (Kislev 1989 1997; Zohary 1992). Another proposed PPNA domesticate (c. 11,400 and 11,200 cal. B.P.), the parthenocarpic figs (non-seed-bearing) found at Giral I in the lower Jordan Valley (Kislev et al. 2006a), have also been argued to have been the mutant forms known to occur in wild figs (Denham 2007; Lev-Yadin et al. 2006a; but see Kislev et al. 2006b.)

The earliest securely identified and dated evidence of the arrival of tough rachis domestic einkorn wheat in the Near East was not found until the Early PPNB (c. 10,500 cal. B.P.) at sites in southeastern Anatolia: Navali Çori, Cafer Höyük, and, possibly, Çayönü (Nesbitt 2002; Tanno and Wilcox 2006b). Firm evidence of tough rachis, domestic two-row barley is not found until the Middle PPNB (c. 10,000 cal B.P.) at which time it was recovered from sites throughout the Fertile Crescent and central Anatolia (Nesbitt 2002). The Middle and Late PPNB also saw the development of various forms of free threshing wheat and barley (Nesbitt 2002). The addition of domestic varieties seems to have been very gradual, with tough rachis varieties comprising only 10% of the einkorn recovered from Early PPNB levels at Navali Çori and domestic morphotype barley only 35% of the barley recovered from Middle PPNB levels at Aswad, and 50% of the Late PPNB barley at Ramad (Tanno and Wilcox 2006).

Evidence for initial domestication of non-cereal crop plants like pulses is less clear since morphological markers of pulse domestication are either absent or not

yet identified. However, based on the habits of wild pulses (their high rate of seed dormancy, low yield, and the tendency of their seed pods to shatter when ripe) it has been argued that large quantities of lentils recovered from sites like Jerf el Ahmar and Netiv Hagdud make it likely that lentils were under cultivation and well on their way to full domestication in both the northern and southern Levant by the PPNA (Weiss et al. 2006). Early PPNB (c. 10,200 cal. B.P.) chickpeas and fava beans recovered in northwestern Syria at the Tel Kerkh are also thought to represent an early stage of domestication of these staples of the modern Near Eastern diet (Tanno and Wilcox 2006b).

The possibility that cereal and pulse crop plants were subjected to a prolonged period of intensive cultivation prior to displaying characteristic morphological markers of domestication is becoming increasingly more likely. A variety of methods are now being used to monitor this process, including the presence of weed complexes characteristic of cultivation (Colledge 1998, 2002), the likely movement of plants outside their preferred habitats, the progressive decrease of other gathered plants in archaeobotanical assemblages, and increases in the breadth (but not the length) of seeds (Wilcox et al. 2008), all which are taken to be signs of human management of morphologically wild cereals and pulses. These markers have been used to argue that intensive cultivation of wild cereals and pulses stretches back perhaps as far the Late Natufian at sites like Mureybit and Abu Hureyra (Colledge 2002) and was certainly practiced by the PPNA in both the southern and northern Levant (Tanno and Wilcox 2006a; Wilcox 2005; Wilcox et al. 2008). The delay between intensive cultivation of future crop plants and the display of morphological change may, in fact, be as much as several millennia (Weiss et al. 2006; Wilcox et al. 2008). The timing of the leading edge of this process is still uncertain, but both macro- and micro-botanical evidence from Early Epipaleolithic Ohalo II definitively demonstrates the utilization of wild cereals in the southern Levant reaches back at least 24,000 years ago (Piperno et al. 2004; Weiss et al. 2004).

Dogs with characteristic shortened jaws and crowded teeth found in burial contexts at Ain Mallaha (c. 13,000 cal B.P.) in the southern Levant (Davis and Valla 1978; Tchernov and Valla 1997) and a dog jaw found in roughly contemporary levels at Palegawra cave in the Zagros (Turnbull and Reed 1974) provide the earliest evidence of animal domestication in the Near East. Believed to have been a nonfood domesticate in the Near East, dogs probably entered into association with humans through the same commensal relationship as mice, rats, and sparrows drawn to human habitations to feed off refuse (Zeder in press).

Evidence for the appearance of morphologically altered domestic livestock species is much less clear. For more than 30 years, the industry standard for documenting initial livestock domestication has been a marked and sudden reduction in overall body size said to occur in all livestock species including sheep and goats, pigs, and cattle (Grigson 1969; Helmer 1992. Hongo and Meadow 2000; Legge 1996; Meadow 1989; Peters et al. 1999 2005; Uerpmann 1978, 1979). Based on this marker, goat domestication was set at about 10,000 B.P. with sheep domestication occurring a bit later between about 10,000 to 9,750 cal. B.P. (Bar-Yosef and Meadow 1995: 89). This size reduction marker put both cattle and pig domestication

somewhat later still at about 9,500-9,000 cal. B.P. (Bar-Yosef and Meadow 1995:90). Thus the domestication of animals was thought to postdate the appearance of plant domesticates in the region (at that point dated to between about 11,000–10,500 cal. B.P.) by as much as millennia or more.

Recent work, however, has called the utility of this marker into question. A study assessing the impact of various factors on body size in modern wild and domestic caprines from the Zagros (sex, regional variation, age, and domestic status) has demonstrated that the signature reduction in the size of goat bones detected in the archaeofaunal assemblage from Ganj Dareh around 10,000 cal. B.P. was not a reflection of body size reduction in these animals as originally argued (Bar-Yosef and Meadow 1995:87; Uerpmann 1979) but was instead attributable to a shift in the demographic composition of the adult portion of managed herds (Zeder 2001, 2005, 2006c; Zeder and Hesse 2000). This demographic change has been linked to a change in harvest patterns from a hunter's strategy that maximizes immediate off-take (thus focusing on large adult males) to a herder's interest in the growth of herds which dictates the early harvest of young males and the delayed slaughter of females until they have passed peak reproductive males—a harvest pattern clearly evident in sex-specific harvest profiles constructed for goat assemblages from the Zagros region (Zeder 2001, 2005, 2006c, 2008b). A similar demographic shift is also responsible for the apparent reduction in the size of sheep skeletal elements in the Zagros at about 9,000 years ago (Zeder 2008b). Morphological change that can unequivocally be tied to domestication is not seen in goats until at least 500 years later, once managed herds were moved out of the natural habitat of wild goats. As seen in the goat remains from Ali Kosh in lowland Iran (Hole et al. 1969), the horns of these animals demonstrate changes in size and shape indicative of the relaxation of pressure for large horns in mate competition which seems to have come into play once these animals were genetically isolated from wild herds and humans assumed complete control over their breeding (Zeder 2001, 2005 2006c, 2008b).

Although archaeozoologists have been slow to adopt methods for the construction of high-resolution sex-specific harvest profiles, lower resolution demographic data from southeastern Anatolia suggests that the management of morphologically wild sheep and goats dates back at least as far as the end the Early PPNB (c. 10,500 cal. B.P.) (Peters et al. 1999, 2005). Similar patterns are seen among sheep specimens from Aşikli Höyük in central Anatolia at about 10,400–9,400 cal. B.P. (Buitenhuis 1997; Vigne et al. 1999) and among Middle PPNB (10,000–9,200 cal. B.P.) goats in the northern Levant (Legge 1996) and in the southern Levant (Horwitz 1993, 2003). These data suggest that sheep and goat were brought under human control, possibly independently of one another, in the region stretching from southeastern Anatolia into northwestern Iran by at least 10,500 cal. B.P. if not earlier (Zeder 2008a). Clear-cut morphological markers of caprine domestication are not seen then for at least a millennia after the initial management of caprine herds. Demographic data from Late Epipaleolithic (ca. 12,500 cal. B.P.) contexts at Halalan Çemi and Zawi Chemi Shanidar may capture the leading edge of this process, initiated by the development of hunting strategies geared at enhancing the availabil-

ity of local stock of wild sheep under increasing hunting pressure from increasingly sedentary communities (Redding 2005; Zeder 2008b).

A similar extended process is also becoming increasingly likely for pigs, the leading edge of which may also be seen in archaeofaunal data from Hallan Çemi during the Late Epipaleolithic (Rosenberg et al. 1998). More definitive evidence of the process of pig domestication can be found in the modifications in molar lengths and the change in demographic profiles first detected in Early PPNB levels (c. 10,300 cal. B.P.) at Çayönü (Ervvnc et al. 2001). Demographic shifts detected among cattle remains from the Upper Euphrates Valley (Helmer et al. 2005) suggest that cattle were coming under management between 11,000–10,000 cal. B.P.

Thus for both plant and animal domesticates we are beginning to be able to detect a prolonged process of increasingly intensive human management that precedes the appearance of traditional morphological markers of domestication by a 1,000 years or more. This long delay between intensive human management and subsequent morphological change in both plants and animals raises real questions about when the threshold from wild to domestic was crossed—or even if it is worthwhile to try to determine a specific turning point in what is in effect a gradual, continuous process (Zeder 2006a). It is interesting to note, however, that early pioneers who colonized Cyprus at about 10,500 cal. B.P. arrived with morphologically domesticated wheat and barley, as well as morphologically wild but likely managed sheep, goats, cattle, and pigs (along with other game animals like fallow deer and foxes that were never domesticated) (Colledge 2004; Murray 2003; Vigne et al. 1999, 2000, 2003). The wholesale exportation of this domestic subsistence base, as well as mainland wild resources, strongly suggests that the process of domestication on the mainland was well along by this date. A more concerted effort at applying the new suite of non-morphological markers of plant and animal domestication in the Near East will likely detect that the leading edge of this process was much earlier than currently thought (Zeder 2008a).

Genetic data from modern wild and domestic crops plants and animals is providing further important insight into this process. Recent genetic studies suggest that wild einkorn was brought under domestication (perhaps multiple times) in the north-central Fertile Crescent (Kilian et al. 2007, though see Heun et al. 1997, 2008), the region where, as we have seen, archaeological evidence has produced the earliest domestic einkorn. Genetic evidence also points to barley domestication occurring both in the western (Badr et al. 2000) and the eastern arms (Morrell and Clegg 2007) of the Fertile Crescent, again a finding that corresponds to archaeological evidence from these regions (Wilcox 2002:137). Emmer wheat domestication seems to have been concentrated in the northern Levant according to genetic data (Ozkan et al. 2002; Salamini et al. 2002), although archaeological evidence points to there being another center of emmer domestication in the southern Levant which may have no living descendents (Wilcox 2002). The wild variety of lentil most closely related to modern domestic lentils is found in southeastern Turkey and northern Syria (Ladizinsky 1989), pointing perhaps to the early spread of cultivated lentils from the northern to the southern Levant in the PPNA (Weiss et al. 2006). The variety of wild chickpea most closely related to modern domestic chickpeas (Sudupak

et al. 2004) is the most westerly variety sampled and the closest to the site of Tel Kerkh where Wilcox believes he has evidence of chickpea cultivation at 10,200 cal. B.P. (Tanno and Wilcox 2006b).

Genetic analyses of livestock species domesticated in the Near East provide a similar picture of multiple lineages of domesticates having been brought under domestication in different places across the region. A remarkable recent study of genetic variability among modern wild bezoar goats (Naderi et al. 2007, 2008) indicates that all six currently known lineages of domestic goat were brought under domestication in the Zagros/Taurus region. Genetic signatures of the wild goats belonging to at least two of these domestic lineages (the A and the C lineages) suggest a process of rapid population growth and geographic translocation which may represent the imprint of human mitigated reproductive isolation and movement of these animals within the natural habitat of wild goats during the early phases of goat domestication—a genetic signature perhaps of the long period of human management detected in the harvest profiles of archaeological assemblages of morphologically wild goats in this region. These same two lineages appear to have moved out of this natural habitat domestication incubator together somewhere in southeastern Anatolia (Naderi et al. 2008), traveling together as far as the coast of southern France where animals belonging to these lineages have been detected among archaeological goat bone assemblages dating back to about 7,000 cal. B.P. (Fernández et al. 2006). While still lacking the geographical precision of the goat genetic data, at least two of the three domestic lineages of sheep are likely to have been domesticated in this region (Bruford and Townsend 2006; Guo et al. 2005). Three and perhaps four of the five lineages of domestic taurine cattle were also probably domesticated here (Bradley 2006), with one lineage (the T3 lineage) the major variety that spread throughout Europe and another (the T1 lineage) the variety that spread across North Africa (Achilli et al. 2008). Similarly, at least four of the many domestic lineages of pigs seem to have originated in the Near East (Larson et al. 2005, 2007).

Thus earlier scenarios that suggested a single center of plant domestication and a 1,000- year delay between the timing of plant and animal domestication can no longer be supported. The new picture that is emerging from these combined archaeological and genetic data point to a process in which people throughout the Fertile Crescent were actively experimenting with various plant and animal resources (including some, like gazelle, which never made it any further than the first tentative steps down the pathway to domestication [Zeder in press]). Over a period of several millennia beginning by at least 11,000 cal. B.P., these experiments resulted in a fully formed domestic Partnership between morphologically and genetically altered crop and livestock species and humans increasingly invested in their propagation. These different managed crops and livestock species, however, did not coalesce into fully developed agricultural economies in which domesticates are the dominant source of calories (after Smith 2001) until the Middle PPNB (Helmer et al. 1998; Nesbitt 2002), where they first emerge in the central Fertile Crescent at about 10,000 cal. B.P., taking another 1,500–2,000 years to reach the farthest extremities of its eastern and western arms. Even long after the emergence of agricultural economies based

on herding and farming, we still see a great deal of variability in the mix of wild and domestic resources at different sites in different social and environmental contexts in the region (Zeder 1994, 2006d:140).

The Utility of Co-opted Evolutionary Models in Explaining Agricultural Emergence in the Near East

The Near Eastern archaeological record has enough detail and chronological control to evaluate how well each of the earlier considered co-opted evolutionary models (neo-Darwinian selectionism, macroevolution, and human behavioral ecology) account for this keystone case study example of agricultural emergence. It is especially useful to consider this record in terms of four fundamental areas where these models differ most from one another - (1) on the scale of change (macro vs. micro-evolutionary); (2) on the tempo of change (punctuated vs. gradual); (3) on the degree of directedness of change (directed vs. undirected); and (4) on the role of human intent in culture change (major vs. none).

Locus of Change (Macro vs. Micro)

Both selectionist and human behavioral ecological approaches to culture change stress the micro-level forces that operate on the level of individual actors, whether shaped by Darwinian forces of selection, drift, and transmission in the selectionist approaches or by the rules that govern human decision making in the human behavioral ecology approach. In contrast, macroevolutionary approaches stress the importance of forces that work at larger scales, above the level of individuals, operating simultaneously in a hierarchical fashion within and across different levels of the society. The Near Eastern case study has elements that lend support to both a macro and a micro view of evolutionary change.

The increasing resolution of our understanding of the archaeological record of agricultural origins in the Near East has made it increasingly difficult to accommodate one-size-fits-all explanatory models for agricultural emergence that spotlight single macroscale forces as the causal agents of agricultural emergence (Zeder 2006a, 2009; Zeder and Smith in press)—whether it be climate change (Richerson et al. 2001), demographic pressure (Rosenberg 1990 1998), social aggrandizement (Hayden 1992 1995 2003, in press), or religious conversion (Cauvin 2000a, b). However, the record does support a model which characterizes agricultural emergence in terms of a series of mutually reinforcing macro-level economic, environmental, social, and ideological factors operating in concert across multiple levels of Near Eastern society—a model which we have seen is very much in line with a macroevolutionary approach to the study of culture change.

Following this model, the climatic amelioration after the Late Glacial Maximum that resulted in a spread of plant and animal resources out of protected refugia can be seen as creating conditions that made it possible for larger groups of people to con-

gregate together for longer periods of the year. An elaboration of social mechanisms and ritual practices that helps to preserve bonds of community in these more sedentary Early Natufian settlements was accompanied by a broadening resource base that allowed people to continue living in these more permanent base camps despite any localized pressures on resources incurred by reduced mobility. The powerful bonds of community forged in these first sedentary settlements may account for their use as cemeteries by Late Natufian people in the southern Levant who continued to exploit the same range of resources, though in a more mobile way, during the climatic downturn of the Younger Dryas (Munro 2003, 2004). In the northern Levant and in the central and Eastern Fertile Crescent, which may not have been as profoundly affected by these climatic conditions (Wilcox 2005), sedentary communities were able to weather the impact of climate change and localized resource depression through the intensification of resource strategies, which may have involved cultivation of plants and game management strategies to promote the stocks of prey animals. With stabilization of climate in the Early Holocene, the pull of these social bonds is again seen in the proliferation of sedentary communities throughout the western and central Fertile Crescent whose continued viability required the increasingly active manipulation of resources that, in the case of certain species, moved them farther along the pathway to full domestication. At the same time, this process resulted in the creation of resources amenable to ownership, surplus production, and restricted access, concepts that threatened the egalitarian ethos that drew these communities together in the first place. Forces that worked to divide households in these communities were countered with an increasing number of measures directed at leveling economic and social differences and promoting community cohesion. New views of the relationship between humans and the cosmos helped people rationalize their place in this new social and economic order. Increased channels of interaction among communities forged expanded economic and social bonds that provided additional buffers against resource shortfalls. Under the combined pressures of human-induced degradation of local landscapes and the climatic downturn of the mid-ninth millennium cal. B.P., the Late PPNB mega villages in the southern Levant were no longer able to maintain the delicate balance between these competing centrifugal and centripetal social forces and fragmented into an array of sedentary and more mobile groups following mixed agro-pastoral and hunter-gatherer strategies (Kuijt and Goring-Morris 2002). The nucleated villages that followed the 8.2 kya climate pulse in the Pottery Neolithic were reconstituted along very different rules of social ranking and leadership (Gopher and Gophna 1993).

There is no way that a selectionist approach which restricts one's focus to the level of individual actors and the forces of selection, drift, and transmission operating on randomly generated discrete human behaviors (monitored through their artifact trait proxies) could account for these highly interrelated developments that clearly operate at the level of groups of individuals—from households to communities to whole regional interaction spheres. Even if one had all the data (and the several generations of archaeologists) needed to piece together cladogenetic trees tracking material culture lineages over the more than 10 millennia encompassed by this transition, this myopic focus on the smallest level of culture change could never

begin to capture the complex hierarchy of interacting forces responsible for agricultural emergence in the Near East. Moreover, even with the remarkably robust Near Eastern archaeological record of resources and resource strategies, the human behavioral ecology playbook of rules for decision making does not seem up to the task of accounting for the range and complexity of collective decisions made during this long transitional period over this large region, especially if these rules are structured solely around energy optimization.

At the broadest most macro-level, the process of Neolithic emergence in the Near East seems to have been driven by very general economic goals oriented toward promoting a predictable and secure resource base, as well as social goals oriented toward binding groups of people together, both operating in concert within a framework of environmental variability and climate change—forces that cannot be easily accommodated under either a selectionist or a human behavioral ecology approach.

And yet these macro-level forces in and of themselves do not provide a full account of the course of agricultural emergence in the Near East. The increasing resolution of the archaeological record for agricultural emergence in the Near East makes it clear that although there are general similarities that cut across the region, there is still a tremendous amount of variability in the ways in which people responded to these larger forces in the southern Levant, northern Levant, south-eastern Anatolia, central Anatolia, the Zagros, and on Cyprus. A wide variety of more microscale, localized forces operating at the level of individuals and small groups of individuals clearly played pivotal roles in shaping the way in which the process played out in each of these subregions. The solutions that people across the region found to meet overarching economic and social goals within the context of global climate change were shaped by local parameters and constraints. The variable responses to climate change of regions at different latitudes with different topographies and weather patterns, the differential density and diversity of different plant and animal resources in different parts of the region, the range of raw materials present, the demographic history of colonization and population growth, the localized human pressures on landscapes, the degree communities engaged in a broader sphere of interaction, and the ways in which they incorporated borrowed elements into their highly localized way of life; all of these localized factors helped lend a highly regional flavor to the emergence of agricultural economies in different parts of the Fertile Crescent.

Consideration of both the general macroscale forces that set the basic parameters of change and the microscale highly localized factors that determined how these higher-level trends played out at the local level are needed, if one is to understand the process of agricultural emergence in the Near East. Looking beyond the Near East, these same higher level macroscale forces were also likely at play in other world regions where agriculture emerged, as were a wide range of microscale factors particular to each case. Identifying the locus of culture change, and by so doing identifying the causes of change, cannot, then, stop at defining the single or even the multiple macrolevel forces that set the general parameters of change. Nor can it focus entirely on the particular histories of instances of change within single cultural

lineages. Instead, a comparative approach is required which seeks to identify both the unique factors that shape the trajectories of different instances of agricultural emergence, while also identifying the most macroscale forces that pertain to all cases as well as the microscale forces that explain how these forces played out in each instance (Spencer 1990:6, 1997:233–234).

Tempo of Change (Punctuated vs. Gradual)

The admittedly oversimplified diagram of the chronological occurrence of Childe’s ten key components of the Neolithic Revolution in the Near East shown in Figure 6.3 does not seem, at first glance, to be consistent with a model of punctuated process in which change happens in a rapid burst, occurring on a centenary or even decadal scale (following Rosenberg 1994a:314). Instead, the first stirrings of Childe’s revolution can be traced back to the evidence of ground stone tools and plant processing in the Late Glacial Maximum, while the final fading away of foraging ways of life and their replacement by fully formed agricultural economies does not happen for another ten plus millennia. This extended time frame would seem more consistent

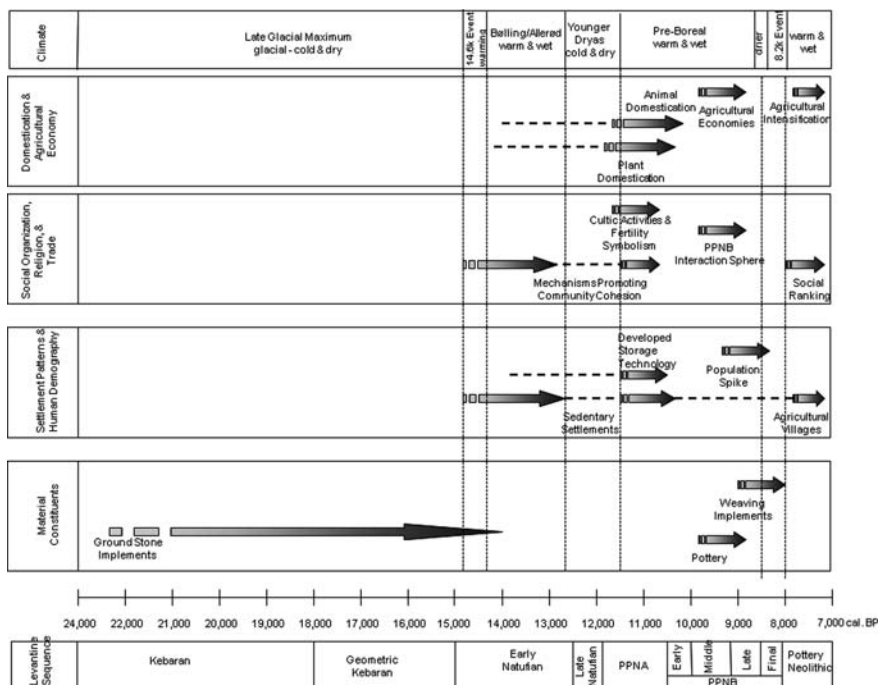


Fig. 6.3 Time line of the appearance of major components of the 10 key components of Childe’s Neolithic society in the Near East

with the gradual model of incremental change favored by selectionist archaeologists and human behavioral ecologists.

And yet a closer examination of this chart (as well as those found in Kuijt and Prentiss' contribution to this volume and in Byrd 2005: Figure 6) suggests a different story. The timing of the appearance of various components of Childe's model relative to the history of climatic mood swings that marks the Late Pleistocene/Early Holocene in the region shows a developmental staircase consisting of short periods of rapid change often coinciding with these hot and cold flashes separated by periods of more gradual incremental change, if not stasis. Over time, the tempo of these changes quickens, and the number of Childean components that crystallize at any one time increases. The long period of expansion of the niches exploited by foraging Kebaran and Geometric Kebaran peoples in the waning days of the Late Glacial Maximum is interrupted by the rapid adoption of sedentary lifestyles in the Early Natufian coinciding with the 14.6 warming event (Byrd 2005). Over the next 2,000–3,000 years these communities were supported by an increasingly broad utilization of wild resources and bound together by emergent mechanisms of social cohesion. The climatic downturn of the Younger Dryas is followed by another 1000 years of, in the southern Levant, more mobile foraging strategies focused on the same range of resources as in the Early Natufian and, in the northern Levant, the establishment of sedentary settlements supported by increasingly intense manipulation of wild plant and animal resources. The advent of stable Holocene climates in the following PPNA sees a large number of rapid revolutionary changes in the incorporation of emergent domesticates into subsistence bases, in household and community organization, and in cosmology. The continued more gradual elaboration of all these emergent cultural components over the next 2,000–3,000 years culminates in a spike in population growth, expanding regional trade networks, and the coalescence of the different component elements into fully formed agricultural communities. In the southern Levant, Late PPNB mega communities seem to collapse under their own weight during another climatic downturn, only to re-form again some 500 or so years later in a socially much changed configuration of agricultural village life.

Throughout this sequence, each period of change builds on previous evolutionary events, with the overall process of agricultural emergence unfolding in stepwise fashion of innovation and consolidation as different components of the Neolithic package are established. It would seem then that the initial apparent lack of fit between Neolithic emergence in the Near East and a macro-evolutionary model of punctuated equilibrium results from a conflation of Childe's ten components into a single Neolithic blueprint or *Bauplan*. Instead of a single massive revolutionary upheaval, what is coming into focus is a transition comprising a sequence of smaller episodes of restructuring whose cumulative impact over the millennia leads to the establishment of fully formed agricultural economies in the region (an incremental process of culture change also seen in Chatters' and Eldredge's contributions to this volume).

Moreover, if one steps back from this close-grained view and examines these developments in terms of a broader perspective of human cultural evolution, the

stepwise revolutionary events that took place over this time span mark a real departure from the preceding 30,000 years during which modern humans in this region had been hunting and collecting wild resources whose availability they could influence but never really control. It becomes, from this vantage point, an interval of profound change in essentially every aspect of social, economic, ideological, and political life in this region that gave birth to the increasingly sophisticated agropastoral societies based on an expanding array of genetically controlled domestic breeds and governed by increasingly stratified social and political arrangements that people in this region have lived under ever since.

Directedness of Change (Directed vs. Undirected)

As we have seen both human behavioral ecologists and, especially, selectionists go to great pains to disavow the role of directed change in cultural evolution. To selectionists, any appearance of direction in the course of change is likely a chimera, and even if real says nothing about how that change came about, which, according to their model, is solely attributable to the mechanism of either selection or transmission operating on randomly generated behavioral variability (Leonard and Jones 1987; Lyman and O'Brien 1998:621). And while human behavioral ecology advocates hold that basic optimizing covering laws provide direction to human decisions that govern the innovation and emulation of behaviors, they are steadfast in their rejection of models of culture change that bear any taint of progressive evolutionary viewpoints (Layton et al. 1991). Instead, they prefer to focus on the day-to-day localized and immediate decisions and their consequences (Winterhalder and Goland 1997; Winterhalder and Kennett 2006:8) and are made uncomfortable by the prospects of there being any degree of long-term directionality to culture change. Macroevolutionary archaeologists, like their biological brethren, also reject progressivist, unilineal frameworks of evolutionary development (Gould 1988; Rosenberg 1994a; Spencer 1997). But they hold that factors like historical contingency, exaptation, and the hierarchical nature of macroevolutionary change all provide a large measure of directionality of change over time (Rosenberg 1994a:329; Spencer 1997:231–232; Spencer and Redmond 2001:201).

As we have seen, the emergence of agriculture in the Near East comprised of a number of highly localized stories in which people living within particular environmental settings were working to meet overall social and economic goals with the resources (natural and cultural) at hand. However, the record from the region clearly does not support a view which sees the individual paths taken as the product of random variation filtered by selection, drift, and transmission. Nor can this record be interpreted solely as the cumulative effect of decisions made by hundreds of individuals coping with proximate cost-benefit considerations that just happen to follow similar trajectories across this broad region. Instead, what emerges from a review of the Near Eastern record is a more directional process, shaped by the mutually reinforcing macro-level economic, environmental, social, and ideological factors working across multiple levels within and between regions, by the legacy of

past ways of coping that are carried over into new strategies for dealing with changing conditions, and by the continual retooling of technology, subsistence strategies, and ritual practice to meet new challenges. This is not to say that the pathway to agriculture was a one-way expressway that once embarked upon could not be exited (Smith 2001). There are plenty of examples of U-turns (the return to more mobile strategies in both the Late Natufian and the Terminal PPNB, for example), dead-ends (the early experiments with rye in the Late Natufian northern Levant), detours (the retention of round houses and, presumably, associated household-level social mechanisms, on Cyprus), and decisions to take more scenic alternate routes (exemplified by the different, sometimes quite circuitous, trajectories of agricultural emergence taken in different parts of the Fertile Crescent arc). And yet there also seem to have been a certain set of shared constraints and a limited number of general solutions, plus the important element of connectivity and sharing of solutions among populations across the Fertile Crescent, that resulted in striking similarities in the ways in which localized groups responded to economic goals through intensification of resource management and to social goals through community coping measures that, in the end, imparted a very real direction to the course of culture change in the Near East over this major transition.

Human Intent in Culture Change (Lots vs. None)

Disagreement over the role of human intent, of deliberate conscious decision making, in cultural evolution is the major schism between these different co-opted models of cultural evolution. To selectionists human intent is an anathema not to be allowed in any conception of culture change, with any acknowledgment of the role of human sentience in culture change a heresy of significant magnitude to warrant expulsion from this particular sect of evolutionary archaeology (Leonard and Jones 1987; Lyman and O'Brien 1998). And while they subscribe to many tenets of the neo-Darwinian approach to the study of culture change, human behavioral ecologists differ with selectionists in their central focus on the rules that govern decision making and their general acknowledgement of the role of conscious human intent in making these decisions (Bettinger 2006; Piperno 2006). Here, they are in agreement with macroevolutionary archaeologists for whom human agency is a central attribute of culture change. Indeed, to macroevolutionary archaeologists, human intent is the major agent responsible for directionality in cultural evolution and the primary way in which cultural evolution differs from biological evolution (Spencer 1997).

Any objective reading of the record of agricultural emergence in the Near East cannot escape the central role of intentional human action in the transition. Nowhere is this more evident than in the core process of plant and animal domestication. While it is true that the co-evolutionary interaction between humans and target plant and animal populations which lies at the heart of the domestication process shares certain commonalities with biological mutualisms between farmer ants and their fungal crops (Zeder 2006a), even the entomologists who study these relationships readily admit that the fundamental difference between these two processes

lies in the element of human intent (Schultz et al. 2005). These biologists know what apparently selectionist archaeologists do not—that mutualisms in nature are driven by natural selection operating on mutation-induced behavioral and morphological variation in both partners, while the relationships between humans and target domesticates are largely driven by humans who are able to spontaneously and with deliberate intent modify their behaviors toward plant and animal partners through observation, imitation, and innovation based on a conscious and deliberative evaluation of the effects of previous actions. This element of deliberation, decision, and transmission of behaviors that arise through conscious human innovation ramps up the emerging mutualism between humans and target domesticates, imbuing the process with greater speed and magnitude than any mutualism found in nature. And while selectionists admit that the transmission of behaviors through social learning is a major difference between biological and cultural evolution, their unwillingness to let go of the anti-intent doctrine so central to the selectionist credo, to admit that the innovation and transmission of behaviors involves sentient human actions, makes it impossible for them to effectively explain domestication, or, I submit, any other aspect of human cultural evolution (though see a potential softening of this hard line position in Mesoudi and O'Brien 2008; O'Brien 2008).

Human intent is a central driving feature throughout the process of domestication. Inveterate tinkerers, humans had likely been deliberately manipulating environments to encourage the availability of plant and animal resources of interest (niche construction or ecosystem engineering *sensu* Odling-Smee et al. 2003; Smith 2007a, b) for thousands of years before the first morphologically altered domesticates appeared on the scene. This process involved a series of conscious and deliberate decisions to try out different things that might enhance productivity of these resources—to move wild einkorn plants to soils where they were more likely to flourish, to water and weed wild stands of cereals and pulses, to transplant branches from trees that produced tastier figs, and to selectively cull wild herds of animals in ways that provided sustainable long-term returns. The responses of certain plants and animals to these ministrations, both plastic and genetically driven, further encouraged human focus and elaboration of the behaviors and tools that helped these responsive partners prosper. And while it is highly unlikely that humans did these things with the goal of starting their own agro-businesses several millennia down the line, they were guided in these deliberate actions by proximate and quite consciously recognized goals of securing a predicable resource base to support their family and their community of families. To deny humans this quintessentially human attribute is to strip cultural evolution of its primary distinguishing feature and so doom the viability of any co-opted model of evolution that discounts human intent in the process of culture change.

And yet while macroevolutionary archaeologists readily embrace the element of human intent in their models of culture change (Spencer 1997), the macroscale of their models makes it difficult for them to monitor the impact of human agency on the course of cultural evolution. Macroevolutionary approaches simply do not allow for the detection or explanation of the motivations behind the actions of individual actors. Here, the human behavioral ecology focus on human decision making

would seem to offer a particularly powerful tool, providing real possibility of linkage between the micro- and the macro-level forces that so clearly work together to drive evolutionary developments. And yet, the effectiveness of HBE models in providing the rules that guide human intentionality is open to debate.

Two basic elements of HBE optimizing models seem particularly hard to reconcile with the Near Eastern record: (1) the fundamental principle that lower ranked resources (based on net energetic returns) will only be utilized if high-ranked alternatives are not available and (2) that immediate returns are preferred over deferred returns. These essentially axiomatic HBE assumptions define a context of agricultural origins in which substantial conceptual obstacles lie in the way of a shift to an emphasis on plant resources or a willingness to accept the discounting costs of deferred harvest of plants and animals. Some combination of depression of higher ranked resources and enhancement of the density or desirability of lower ranked resources has to have occurred in order for humans to decide to focus on plants like cereals and pulses with their higher handling costs and lower returns and to suppress their blood-lust instinct to kill and consume any sizable meat package that comes along. And yet the improving archaeobotanical record from the Near East shows that plants were a prominent part of the resource menu from the very beginning of the sequence, well before any likely hunting depression on game animals could have manifested itself (Piperno et al. 2004; Weiss et al. 2004). In fact, there is increasing evidence for the importance of plant resources in Near Eastern diets stretching well into the Middle Paleolithic (Albert et al. 2003; Lev et al. 2005). Moreover, the notion that farming and herding requires a mind-set willing to risk waiting for deferred returns, while foraging and hunting confers immediate returns, cannot be supported. The increasing insights afforded by new markers of human manipulation of wild plant and animal resources show that people were making long-term investments in landscapes and associated plant communities in order to enhance down-the-line returns on their investments well before plants and animals were co-opted into domestic partnerships. People may also have been altering hunting strategies in such a way as to assure long-term availability of wild game. Moreover, the notion that herding involves deferring slaughter of animals until a certain sustainable herd size is reached (Alvard and Kuzner 2001) fails to acknowledge the fact that animals are continually culled from managed herds. The difference between hunting and herding is that the hunter kills to maximize immediate return while the herder kills in way that promotes herd growth. The herder is, however, still killing and eating animals, which are now perhaps a little bit more handy and more tractable than their unmanaged forbearers.

Sedentism and the associated broadening of the resource base in the Near East does not seem to be born out of necessity, arising either from human or climate induced environmental change. Nor can it be viewed as resulting from a microeconomic cost/benefit analysis weighing energetic returns against search and handling costs. Instead, as argued here, there seems to have been compelling social pulls that brought people together for longer periods of time and in greater numbers whenever conditions permitted, even if the net energetic returns of the resource strategies that permitted coalescence were less than optimal from an energetics point of view.

These same social ties can also be seen as a major motivating factor driving the progressive intensification of subsistence strategies aimed at sustaining aggregations of people for as long as prevalent ecological constraints, technological capacities, and mechanisms for social cohesion would allow.

The problem, then, may not lie in the HBE focus on human decision making, but on the basic optimizing premise and the cost/benefit assumptions that HBE archaeologists maintain guide these decisions. Recognition that human decision making may be guided by “something other than economic self-interest” is not new to human behavioral ecology (Bettinger 2006; Boyd and Richerson 1988; Winterhalder 1986;) and represents, perhaps, a willingness to embrace a more catholic approach that looks beyond optimizing as a central governing attribute of human behavior—a development that augers well for the utility of a human behavioral approach to understanding the role of human agency in the course of culture change.

Conclusions

This review of the Near Eastern record of agricultural origins suggests that all three co-opted evolutionary models considered here has something to offer in understanding the long sequence of events that unfolded over the transition from foraging to farming. Microevolutionary forces played an important role in shaping the trajectories taken in various parts of the region and in the incremental adjustments people made to accommodate changing environmental and social conditions. And yet there were also clearly macroscale linkages between individuals, communities, and regions that, often in rapid revolutionary bursts, lent this process a clear directionality. At the same time, the role of daily human decisions in how to best organize their lives and their activities to meet proximate goals of economic and social sustainability also played a part in this process, especially in the domestication of plants and animals and the development of agricultural economies based on them, which is the central element of this transition.

Where these models fall short, especially the microevolutionary and human behavioral ecology models, is when their proponents give too much deference to their biological underpinnings and attempt the wholesale application of models developed to explain biological evolution to the very different process of cultural evolution. This is especially a trap for selectionist archaeologists in their rejection of human intent as a factor in cultural evolution. Moreover, while selectionists may give lip service to group-level evolutionary forces, punctuated change, and hierarchy as possible components of cultural evolution, their dogged pursuit of trait-level cladogenesis of cultural lineages is an explanatory dead end. Deferring dealing with process until patterns are thoroughly mapped has not worked too well in biology, and it is even more doubtful that such an alpha-taxonomy approach to culture change will serve the study of cultural evolution any better. Moreover, the tendency of HBE advocates to treat optimizing principles drawn from behavioral ecology as immutable covering laws rather than testable hypotheses (Smith 2006) affords these principles more power than even biologists are willing to grant them.

Instead of being directly applicable to cultural evolution, these different approaches to biological evolution are best used as heuristic devices providing general models of evolutionary change that can be loosely applied to the study of culture change. The key role of human intentionality and the transmission of behaviors through social learning and the resultant capacity for Lamarckian change unique to human culture requires that archaeologists broaden their search for epistemological inspiration beyond biology to include theoretical frameworks grounded in the social and cognitive sciences (Boyd and Richerson 1985; Richerson and Boyd 2005; Spencer 1997:247).

None of these efforts, however, makes much sense in the absence of empirical data that can be used to both test and strengthen evolutionary models designed to explain the course of culture change. Too often, it seems, archaeologists working within these evolutionary frameworks focus more on the elegance of their models and their ability to come up with some cogent explanation or model addenda that accounts for the failure of the empirical record to conform to their predictions, while still showing that their general premise was right all along. As the record for agricultural emergence clearly shows (and as seen in many of the contributions to this volume), the growing precision with which we are able to monitor culture process through archaeological analysis makes model spinning in the absence of empirical reality check less and less justifiable. In fact, our increasing control of the empirical record and our ability to frame nuanced, multivariable explanatory scenarios to account for this record may be bringing us, at long last, to a tipping point where we may be able to actually contribute to the development of higher order theories of culture change rather than continuing to look to other disciplines for epistemological validation.

References

- Achilli, A., Olivieri, A., Pellecchia, M., Uboldi, C., Colli, L., Al-Zahery, N., Accetturo, M., Pala, M., Kashani, B., Perego, U.A., Battaglia, V., et al. (2008). Mitochondrial genomes of extinct aurochs survive in domestic cattle. *Current Biology* 18, 157–158.
- Albert, R., Bar-Yosef, O., Meignen, L. (2003). Quantitative phytolith study of hearths from the Natufian and Middle Paleolithic levels of Hayonim Cave (Galilee, Israel). *Journal of Archaeological Sciences* 30, 461–480.
- Aldenderfer, M. (2006). Costly signaling, the sexual division of labor and animal domestication in the Andean highlands. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 167–196). Berkeley: University of California Press.
- Alvard, M.S., Kunzner, I. (2001). Deferred harvests: The transition from hunting to animal husbandry. *American Anthropologist* 103, 295–311.
- Arnold, S.J., Pfrender, M.E., Jones, A.G. (2001). The adaptive landscape as a conceptual bridge between micro- and macroevolution. *Genetica* 112–113, 9–32.
- Aurenche, O., Cauvin, J., Sanlaville, P. (Eds.). (1988). Préhistoire du Levant II (1^{re} Partie). *Paléorient* 14(2), 5–345.
- Aurenche, O., Cauvin, J., Sanlaville, P. (Eds.). (1989). Préhistoire du Levant II (2^e Partie). *Paléorient* 15(1), 1–179.
- Aurenche, O., Galet, P., Régagnon-Caroline, E., Évin, J. (2001). Proto-neolithic and neolithic cultures in the Middle East. The birth of agriculture, livestock raising and ceramics 12,500–5,500 cal. B.C. *Radiocarbon* 43, 1191–1202.

- Asouti, E. (2006). Group identity and the politics of dwelling at Neolithic Çatalhöyük. In I. Hodder (Ed.), *Çatalhöyük Perspectives: Themes from the 1995-99 Seasons* (pp. 75–79). Çatalhöyük Research Project 6, Cambridge: British Institute of Archaeology at Ankara & McDonald Institute for Archaeological Research.
- Badr, A., Müller, K., Schäfer-Pregl, R., El Rabey, H., Effgen, S., Ibrahim, H.H., Pozzi, C., Rohde, W., Salamini, F. (2000). On the origin and domestication history of barley (*Hordeum vulgare*). *Molecular Biology and Evolution* 17, 499–510.
- Barlow, K.R. (2006). A formal model for predicting agriculture among the Fremont. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 87–102). Berkeley: University of California Press.
- Bar-Yosef, O. (1982). The Natufian of the southern Levant. In T.C. Young, P.E.L. Smith, and P. Mortensen (Eds.), *The Hilly Flanks. Essays on the Prehistory of Southwest Asia* (pp. 11–42). Studies in Ancient Oriental Civilization, No. 36, Oriental Institute, Chicago: University of Chicago.
- Bar-Yosef, O. (1986). The walls of Jericho: An alternative interpretation. *Current Anthropology* 27, 157–162.
- Bar-Yosef, O. (1990). The last glacial maximum in the mediterranean levant. In C. Gamble and O. Soffer (Eds.), *The World at 18,000 BP, vol. 2: Low Latitudes* (pp. 58–72). London: Unwin Hyman.
- Bar-Yosef, O. (1992). From foraging to farming in the Mediterranean Levant. In T.D. Price and A.-B. Gebauer (Eds.), *Transitions to Agriculture in Prehistory* (pp. 21–48). Madison: Prehistory Press.
- Bar-Yosef, O. (2001b). PPNB interaction sphere. *Cambridge Archaeological Journal* 11, 114–120.
- Bar-Yosef, O., and Belfer-Cohen, A. (1989). The Levantine “PPNB” interaction sphere. In I. Hershkovitz (Ed.), *People and Culture in Change: Proceedings of the Second Symposium on Upper Paleolithic, Mesolithic and Neolithic Populations of Europe and the Mediterranean Basin* (pp. 59–72), British Archaeological Reports International Series, No. 508. Oxford: Archaeopress.
- Bar-Yosef, O., and Kislev, M. (1989). Early farming communities in the Jordan valley. In D. Harris and G. Hillman (Eds.), *Foraging and Farming: The Evolution of Plant Exploitation* (pp. 632–642), London: Unwin Hyman.
- Bar-Yosef, O., and Meadow, R.H. (1995). The origins of agriculture in the Near East. In T.D. Price and A.-B. Gebauer (Eds.), *Last Hunters, First Farmers: New Perspectives on the Transition to Agriculture* (pp. 39–94). Santa Fe: School of American Research Press.
- Bar-Yosef, O., Gopher, A., Tchernov, E., Kislev, M. (1991). Netiv Hagdud: An early Neolithic village site in the Jordan valley. *Journal of Field Archaeology* 18, 405–424.
- Bar-Yosef Mayer, D.E. (2000). The economic importance of mollusks in the Levant. In M. Mashkour, A.-M. Choyke, H. Buitenhuis, and F. Poplin (Eds.), *Archaeozoology of the Near East 4A* (pp. 218–227). Arc-Publicatie 32, The Netherlands: Centre for Archaeological Research and Consultancy, Groningen.
- Bettinger, R. (1991). *Hunter-gatherers: Archaeological and Evolutionary Theory*. New York: Plenum Press.
- Bettinger, R. (2006). Agriculture, archaeology, and human behavioral ecology. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 304–322). Berkeley: University of California Press.
- Binford, L.R. (2001). *Constructing frames of reference: an analytical method for archaeological theory building using ethnographic and environmental data sets*. Berkeley: University of California Press.
- Bökönyi, S. (1977). *Animal remains from the Kermanshah Valley, Iran*. British Archaeological Reports Supplementary Series, No. 34, Oxford: Archaeopress.
- Boyd, R., Richerson, P.J. (1985). *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

- Bradley, D.G. (2006). Genetics and the origins of domestic cattle. In M.A. Zeder, E. Emshwiller, B.D. Smith, and D.G. Bradley (Eds.), *Documenting Domestication: New Genetic and Archaeological Paradigms* (pp. 317–328). Berkeley: University of California Press.
- Braidwood, R.J., and Howe, B. (1960). *Prehistoric Investigations in Iraqi Kurdistan*. The Oriental Institute of the University of Chicago Studies in Ancient Oriental Civilization, No. 31. Chicago: University of Chicago Press.
- Braidwood, L.R., Braidwood, B., Howe, B., Reed, C.A., and Watson, P.J. (1983). *Prehistoric archaeology along the Zagros flanks*. The Oriental Institute of the University of Chicago Studies in Ancient Oriental Civilization, No. 105, Chicago: University of Chicago Press.
- Bruford, M., and Townsend, S.J. (2006). Mitochondrial DNA diversity in modern sheep: Implications for domestication. In M.A. Zeder, E. Emshwiller, B.D. Smith, and D.G. Bradley (Eds.), *Documenting Domestication: New Genetic and Archaeological Paradigms* (pp. 306–316). Berkeley: University of California Press.
- Buitenhuis, H. (1997). Aşikli Höyük: A “protodomestication” site. *Anthropozoologica* 25–26, 655–662.
- Byrd, B.F. (1994). Public and private, domestic and corporate: The emergence of the Southwest Asian village. *American Antiquity* 56, 639–666.
- Byrd, B.F. (2000). Households in transition: Neolithic social organization within Southwest Asia. In Kuijt, I. (Ed.), *Life in Neolithic Farming Communities: Social Organization, Identity, and Differentiation* (pp. 63–98). New York: Academic/Plenum Press.
- Byrd, B. (2005). Reassessing the emergence of village life in the Near East, *Journal of Archaeological Research* 13, 231–290.
- Byrd, B., Monahan, C. (1995). Death, mortuary ritual, and natufian social structure. *Journal of Anthropological Archaeology* 14, 251–287.
- Cauvin, J. (1978). *Les premiers villages de Syrie-Palestine du IX^{eme} au VI^{eme} millenaires avant J.C.* Paris: CNRS.
- Cauvin, J. (2000a). The symbolic foundations of the Neolithic Revolution in the Near East. In Kuijt, I. (ed.), *Life in Neolithic farming communities, social organization, identity and differentiation* (pp. 235–254). London: Kluwer Academic/Plenum.
- Cauvin, J. (2000b). *The birth of the Gods and the origins of agriculture*. Cambridge: Cambridge University Press.
- Çelik, B. (2005). A new Early Neolithic settlement: Karahik Tepe. Neo-lithics 2–3/00, 6–8.
- Charnov, E.L. (1976). Optimal foraging, the marginal value theorem. *Theoretical Population Biology* 9(2), 129–136.
- Charnov, E.L., and Orians, G. (1973). *Optimal foraging: Some theoretical explorations*. Salt Lake City: Department of Biology, University of Utah.
- Chatters, J.C., Prentiss, W.C. (2005). A Darwinian macro-evolutionary perspective on the development of hunter-gatherer systems in northwestern North America. *World Archaeology* 37, 46–65.
- Childe, V.G. (1951). *Man makes himself*. New York: The New American Library of World Literature, LTD.
- Colledge, S. (1998). Identifying pre-domestication cultivation using multivariate analysis. In A. Damania, J. Valkoun, G. Willcox, and C. Quallset (Eds.), *The origins of agriculture and plant domestication* (pp. 121–131). Aleppo: ICARDA, Aleppo.
- Colledge, S. (2002). Identifying pre-domestication cultivation using multivariate analysis: Presenting the case for quantification. In R.T.J. Cappers and S. Bottema (Eds.), *The Dawn of Farming in the Near East* (pp. 141–152). Studies in Near Eastern Production, Subsistence, and Environment, No. 6, Berlin: Ex Oriente.
- Colledge, S. (2004). Reappraisal of the archaeobotanical evidence for the emergence and dispersal of the “founder crops”. In E. Peltenburg and A. Wasse (Eds.), *Neolithic Revolution. New perspectives on Southwest Asia in light of recent discoveries in Cyprus* (pp. 49–60). Levant Supplementary Series 1, Oxford: Oxbow.

- Davis, S.J.M., Valla, F. (1978). Evidence for domestication of the dog 12,000 years ago in the Natufian of Israel. *Nature* 276, 608–610.
- Dawkins, R. (1986). *The blind watchmaker*. New York: W. W. Norton & Company, Inc.
- Dawkins, R. (1986). *The Blind Watchmaker*. London: Harlow, Longman.
- Denham, T. (2007). Debate. Early fig-domestication, or gathering of wild parthenocarpic figs? *Antiquity* 81, 457–461.
- Denham, T., and Barton, H. (2006). The emergence of agriculture in New Guinea: A model of continuity from pre-existing foraging practices. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 237–264). Berkeley: University of California Press.
- Diehl, M.W., and Waters, J.A. (2006). Aspects of optimization and risk during the early agricultural period in southeastern Arizona. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 63–86). Berkeley: University of California Press.
- Dunnell, R. (1978). Style and function: A fundamental dichotomy. *American Antiquity* 43, 192–202.
- Dunnell, R. (1980). Evolutionary theory and archaeology. *Advances in Method and Theory* 3: 35–99.
- Dunnell, R. (1987). Comment on “Sedentism, population growth, and resource selection in the Woodland Midwest: A review of coevolutionary developments. *Current Anthropology* 28, 191–192.
- Dunnell, R. (1988). The concept of progress in cultural evolution. In M.H. Nitecki (Ed.), *Evolutionary Progress* (pp. 169–194). Chicago: University of Chicago Press.
- Dunnell, R. (1989). Aspects of the application of evolutionary theory in archaeology. In C.C. Lamberg-Karlovsky (Ed.), *Archaeological thought in America*, (pp. 35–49). Cambridge: Cambridge University Press.
- Eerkens, J.W., Bettinger, R.L., and McElreath, R. (2006). Cultural transmission, phylogenetics, and the archaeological record. In C.P. Lipo, M.J. O’Brien, M. Collard, and S.J. Shennan (Eds.), *Mapping Our Ancestors: Phylogenetic Approaches in Anthropology and Prehistory* (pp. 169–183). New Brunswick: Aldine Transaction.
- Elredge, N. (1989a). *Macro-evolutionary dynamics: species, niches, and adaptive picks*, New York: McGraw Hill.
- Elredge, N., and Gould, S.J. (1972). Punctuated equilibria: An alternative to phyletic gradualism. In T.J.M. Schopf (Ed.), *Models in Paleobiology* (pp. 82–115). San Francisco: Cooper.
- Emlen, J. (1966). The role of time and energy in food preference. *American Naturalist* 100, 611–617.
- Ervynck, A., Dobney, K., Hongo, H., Meadow, R.H. (2001). Born free!: New evidence for the status of pigs from Çayönü Tepesi, Eastern Anatolia. *Paléorient* 27(2), 47–73.
- Esin, U. (1998). The aceramic site of Aşikli Höyük and its ecological conditions based on its floral and faunal remains. *Tüba-Ar* 1, 95–104.
- Esin, U., and Harmankya, S. (1999). Aşikli. In M. Özdoğan and N. Başgelen (Eds.), *Neolithic Turkey, the Cradle of Civilization New Discoveries* (pp. 115–132). Istanbul: Arkeoloji ve Sanat Yayınları.
- Fernández, H., Hughes, S., Vigne, J.-D., Helmer, D., Hodgins, G., Miquel, C., Hanni, C., Luikart, G., Taberlet, P. (2006). Divergent mtDNA of goats in an Early Neolithic site, far from the initial domestication areas. *Proceedings of the National Academy of Sciences, U.S.A.* 103, 15375–15379.
- Flannery, K.V. (1972). The cultural evolution of civilizations. *Annual Review of Ecology and Systematics* 3, 399–426.
- Flannery, K.V. (1993). Will the real model please stand up: Comments on Saidel’s round House or square? *Journal of Mediterranean Archaeology* 6(1), 109–117.
- Flannery, K.V. (2002). The origins of the village revisited: From nuclear to extended households. *American Antiquity* 67, 417–433.

- Foley, R. (1982). A reconsideration of the role of large mammal predation in tropical hunter-gatherer adaptation. *Man* 17, 393–403.
- Fried, M. (1967). *The Evolution of Political Society*. New York: Random House.
- Gebel, H.G.K. (2002). The Neolithic of the Near East. An essay on a “polycentric evolution” and other current research problems. In A. Hausleiter, S. Kerner, and B. Müller-Neuhof (Eds.), *Material Culture and Mental Spheres. Rezeption archäologischer Denkrichtungen in der Vorderasiatischen Altertumskunde. Internationales symposium für Hans J. Nissen* (pp. 214–324). Berlin 23–24 Juni 2000, Münster: Alter Orient und Altes Testament 293, Ugarit-Verlag.
- Gebel, H.G.K. (2004). There was no centre: the polycentric evolution of the Near Eastern Neolithic. *Neo-Lithics* 1, 28–32
- Gopher, A., Gophna, R. (1993). Culture of the eighth and seventh millennia BP in the southern Levant: A review for the 1990s. *Journal of World Prehistory* 7, 297–353.
- Goring-Morris, A.N. (1987). *At the Edge: Terminal Pleistocene Hunter-Gatherers in the Negev and Sinai*. British Archaeological Reports International Series 361, Oxford: Archaeopress.
- Gould, S.J. (1988). On replacing the idea of progress with an operational notion of directionality. In H. Nitecki, (Ed.), *Evolutionary Progress* (pp. 319–338). Chicago: University of Chicago Press.
- Gould, S.J. (1989). Punctuated equilibrium in fact and theory. *Journal of Biological and Social Structures* 12, 117–136.
- Gould, S.J. (2002). *The Structure of Evolutionary Theory*. Cambridge: Belknap.
- Gould, S.J., Eldredge, N. (1993). Punctuated equilibrium comes of age. *Nature* 366, 223–227.
- Gould, S.J., Lewontin, R.C. (1979). The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationalist programme. *Proceedings of the Royal Society London Series B* 205, 581–598.
- Gremillion, K.J. (1996). Diffusion and adoption of crops in evolutionary perspective. *Journal of Anthropological Archaeology* 15, 183–204.
- Gremillion, K.J. (1998). Changing roles of wild and cultivated plant resources among early farmers of eastern Kentucky. *Southeastern Archaeology* 17, 140–157.
- Gremillion, K.J. (2006). Central place foraging and food production on the Cumberland Plateau, Eastern Kentucky. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 41–62). Berkeley: University of California Press.
- Gremillion, K.J., and Piperno, D.R. (in press). Human behavioral ecology, phenotypic plasticity, and agricultural origins: insights from the emerging evolutionary synthesis. *Current Anthropology*.
- Grigson, C. (1969). The uses and limitations of differences in absolute size in the distinction between the bones of aurochs (*Bos primigenius*) and domestic cattle (*Bos Taurus*). In P.J. Ucko, and G.W. Dimbleby (Eds.), *The Domestication and Exploitation of Plants and Animals I* (pp. 277–294). Chicago: Aldine-Atherton, Inc.
- Guilaine, J., and Briois, F. (2001). Parekkilisha Shillourokambos. An early Neolithic site in Cyprus. In E. Swiny (Ed.), *The Earliest Prehistory of Cyprus: From Colonization to Exploitation* (pp. 37–53). Cyprus American Archaeological Research Institute Monograph Series 12, Boston: American Schools of Oriental Research.
- Guo, J., Du, L.-X., Ma, Y.-H., Guan, W.J., Li, H.-B., Zhao, Q.-J., Li, X., Rao, S.-Q. (2005) A novel maternal lineage revealed in sheep (*Ovis aries*). *Animal Genetics* 36, 331–336.
- Hall, B.K. (1996). *Baupläne*, phylotypic stages, and constraint: Why there are so few types of animals. *Evolutionary Biology* 29, 215–261.
- Hauptmann, H. (1993). Ein Kultgegebäude in Nevalı Çori. In M. Frangipane, H. Hauptmann, M. Liverani, P. Matthiae, and M. Mellink (Eds.), *Between the Rivers and over the Mountains* (pp. 37–69). *Archaeologica Anatolica et Mesopotamica Alba Palmieri Dedicata*, Rome: Università di Roma “La Sapienza”.
- Hauptmann, H. (1999). The Urfa region. In M. Özdoğan and N. Başgelen (Eds.), *Neolithic in Turkey*, vol. 1 (pp. 65–86). Istanbul: Arkeoloji ve Sanat Yay.

- Hawkes, K., Bliege-Bird, R. (2002). Showing off, handicap signaling, and the evolution of Men's work. *Evolutionary Anthropology* 11, 58–67.
- Hawkes, K., O'Connell, J.F. (1992). On optimal foraging models and subsistence transitions. *Current Anthropology* 33, 63–66.
- Hawkes, K., Hill, K., O'Connell, J.F. (1982). Why hunters gather: Optimal foraging and the Aché of eastern Paraguay. *American Ethnologist* 9, 379–398.
- Hawkes, K., O'Connell, J.F., Rogers, L. (1997). The behavioral ecology of modern hunter-gatherers and human evolution. *Trends in Ecology and Evolution* 12, 29–32.
- Hayden, B. (1992). Models of domestication. In A.-B. Gebauer and T.D. Price (Eds.), *Transition to Agriculture in Prehistory* (pp. 11–19). Madison: Prehistory Press.
- Hayden, B. (1995). A new overview of domestication. In T.D. Price and A.-B. Gebauer (Eds.), *Last Hunters, First Farmers: New Perspectives on the Transition to Agriculture* (pp. 273–300), Santa Fe: School of American Research Press.
- Hayden, B. (2003). Were luxury foods the first domesticates? Ethnoarchaeological perspectives from Southeast Asia. *Journal of World Prehistory* 34, 458–469.
- Hayden, B. (in press). Is the proof in the pudding?: Feasting and the origins of domestication. *Current Anthropology*.
- Helmer, D. (1992). *La Domestication des Animaux par Les Hommes Préhistoriques*. Paris: Masson.
- Helmer, D., Roitel, V., Sana, M., and Wilcox, G. (1998). Interprétations environnementales des données archaéozoologiques et archéobotanique en Syrie du Nord de 16,000 BP à 7000 BP, et les débuts de la domestication de plantes et des animaux. In M. Fortin and O. Aurenche (Eds.), *Natural Space. Inhabited Space in Northern Syria (10th–2nd mill. BC)* (pp. 9–33). Lyon and Toronto: Maison de l'Orient and Canadian Society for Mesopotamian Studies.
- Helmer, D., Gourichon, L., Monchot, H., Peters, J., and Saña Seguí, M. (2005). Identifying Early Domestic Cattle from Pre-Pottery Neolithic Sites on the middle Euphrates using Sexual Dimorphism. In J.-D. Vigne, J. Peters and D. Helmer (Eds.), *The First Steps of Animal Domestication* (pp. 86–95). Oxford: Oxbow Books.
- Hemmer, H. (1988). *Domestication: The Decline of Environmental Appreciation*. Cambridge: Cambridge University Press.
- Henry, D.O. (1989). *From Foraging to Agriculture: The Levant at the End of the Ice Age*, Philadelphia: University of Pennsylvania Press.
- Henry, D.O. (2002). Models of agricultural origins and proxy measures of prehistoric demographics. In R.T.J. Cappers, and S. Bottema (Eds.), *The Dawn of Farming in the Near East* (pp. 15–26). Studies in Early Near Eastern Productions, Subsistence, and Environment 6, Berlin: ex orient2.
- Heun, M., Schafer-Pregl, R., Klawan, D., Castagna, R., Accerbi, M., Borghi, B., Salamini, F. (1997). Site of einkorn wheat domestication identified by DNA fingerprinting. *Science* 278, 1312–1314.
- Heun, M., Haldorsen, S., Vollan, K. (2008). Reassessing domestication events in the Near East: Einkorn and *Triticum urartu*. *Genome* 51, 444–451.
- Hillman, G.C. (1978). On the origins of domestic rye – *Secale cereale*: The finds from Aceramic Can Hasan III in Turkey. *Anatolian Studies* 28, 157–174.
- Hillman, G.C. (2000). Abu Hureyra I: The Epipaleolithic. In A.T.M. Moore, G.C. Hillman, and A.J. Legge (Eds.), *Village on the Euphrates: From Foraging to Farming at Abu Hureyra* (pp. 327–398). Oxford: Oxford University Press.
- Hole, F. (1990a). Archaeology of the village period. In F. Hole (Ed.), *The Archaeology of Western Iran: Settlement and Society from Prehistory to the Islamic Conquest* (pp. 29–78). Washington, D.C.: Smithsonian Institution Press.
- Hole, F. (1990b). Settlement and society in the village period. In F. Hole (Ed.), *The Archaeology of Western Iran: Settlement and Society from Prehistory to the Islamic Conquest* (pp. 78–106). Washington, D.C.: Smithsonian Institution Press.
- Hole, F. (2000). Is size important? Function and hierarchy in Neolithic settlements. In I. Kuijt (Ed.), *Life in Neolithic Farming Communities. Social Organization, Identity and Differentiation* (pp. 192–209). London: Kluwer Academic/Plenum.

- Hole, F., and Flannery, K.V. (1967). The prehistory of southwestern Iran: A preliminary report. *Proceedings of the Prehistoric Society* 33, 147–206.
- Hole, F., Flannery, K.V., and Neely, J.A. (1969). *Prehistory and Human Ecology on the Deh Luran Plain*. Memoirs of the Museum of Anthropology, No. 1. Ann Arbor: The University of Michigan Press.
- Hongo, H., and Meadow, R.H. (2000). Faunal remains from pre-pottery levels at Çayönü, southeastern Turkey: a preliminary report focusing on pigs (*Sus* sp.). In M. Mashkour, A.M. Choyke, H. Buitenhuis, and F. Poplin (Eds.), *Archaeozoology of the Near East 4A* (pp. 121–139). Arc-Publicatie 32, Groningen, The Netherlands: Centre for Archaeological Research and Consultancy.
- Horwitz, L.K. (1993). The development of ovicaprine domestication during the PPNB of the southern Levant. In H. Buitenhuis and A.T. Clason (Eds.), *Archaeozoology of the Near East I* (pp. 27–36), Leiden: Universal Book Service.
- Horwitz, L.K. (2003). Temporal and spatial variation in Neolithic caprine exploitation strategies: a case study of fauna from the site of Yiftah'el (Israel). *Paléorient* 29(1), 19–58.
- Hours, F., and Copeland, L. (1983). Les rapports entre l'Anatolie et la Syrie du Nord à l'époque des premières communautés villageoise de bergers et de paysans, 7600-5000 B.C. In T.C. Young Jr., P. Smith, and P. Mortensen (Eds.), *The Hilly Flanks. Essays on the Prehistory of Southwest Asia* (pp. 75–90), Studies in Ancient Oriental Civilization, No. 36, Oriental Institute, Chicago: University of Chicago Press.
- Huxley, J.S. (1942). *Evolution: The Modern Synthesis*. London: Allen and Unwin.
- Jones, G.T., Leonard, R.D., and Abbott, A.L. (1995). The structure of selectionist explanations in archaeology. In P.A. Tesler (Ed.), *Evolutionary archaeology: Methodological issues* (pp. 13–32). Tuscon: University of Arizona Press.
- Kelly, R.L. (1995). *Foraging spectrum: Diversity in hunter-gatherer lifeways*. Washington D.C.: Smithsonian Institution Press.
- Kelly, R.L. (2000). Elements of a behavioral ecological paradigm for the study of prehistoric hunter-gatherers. In M.B. Schiffer (Ed.), *Social theory in archaeology* (pp. 63–78). Salt Lake City: University of Utah Press.
- Kennett, D.J., and Winterhalder, B. (Eds.) (2006). *Behavioral ecology and the transition to agriculture*. Berkeley: University of California Press.
- Kennett, D.J., Voorhies, B., and Martorana, D. (2006a). An ecological model for the origins of maize-based food production on the Pacific coast of southern Mexico. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 103–136). Berkeley: University of California Press.
- Kennett, D.J., Andersen, A., and Winterhalder, B. (2006b). The ideal free distribution, food production, and the colonization of Oceania. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 265–288). Berkeley: University of California Press.
- Kenyon, K. (1981). *Excavations at Jericho, Vol 3: The Architecture and Stratigraphy of the Tell*. London: British School of Archaeology in Jerusalem.
- Kilian, B., Özkan, H., Walther, A., Kohl, J., Dagan, T., Salamini, F., Martin, W. (2007). Molecular diversity at 18 loci in 321 wild and 92 domesticate lines reveal no reduction of nucleotide diversity during *Triticum monococcum* (einkorn) domestication: Implications for the Origin of Agriculture. *Molecular Biology and Evolution* 24, 2657–2688.
- Kislev, M.E. (1989). Pre-domesticated cereals in the Pre-Pottery Neolithic A period. In I. Hershkovitz (Ed.), *People and Culture in Change* (pp.147–152). British Archaeological Reports International Series 508, Oxford: Archaeopress.
- Kislev, M.E. (1997). Early agriculture and paleoecology of Netiv Hagdud. In O. Bar-Yosef and A. Gopher (Eds.), *An early Neolithic village in the Jordan Valley* (pp. 209–236). Peabody Museum of Archaeology and Ethnology, Cambridge: Harvard University.
- Kislev, M.E., Hartmann, A., Bar-Yosef, O. (2006a). Early domesticated fig in the Jordan Valley, *Science* 312, 1374–1375.
- Kislev, M.E., Hartmann, A., Bar-Yosef, O. (2006b). Response to Comment on “Early Domesticated Fig in the Jordan Valley”. *Science* 314, 1683b.

- Kozłowski, S.K. (1999). *The Eastern Wing of the Fertile Crescent*, British Archaeological Reports, International Series 760, Oxford: Archaeopress.
- Kozłowski, S.K., and Aurenche, O. (2005). *Territories, Boundaries and Cultures in the Neolithic Near East*, Lyon: Maison de l'Orient et de la Méditerranée Jean Pouilloux.
- Krebs, J.R. and Davies, N.B. (1978). Decision-making. In J.R. Krebs and N.B. Davies (Eds.), *Behavioral Ecology: An Evolutionary Approach* (3rd edition) (pp. 105–136). Oxford: Blackwell Scientific Publications.
- Kuijt, I. (2000). People and space in early agricultural villages: Exploring daily lives, community size, and architecture in the late Pre-Pottery Neolithic. *Journal of Anthropological Archaeology* 19, 75–102.
- Kuijt, I. (2009). Inventing Storage: Evidence for the Earliest Pre-Domestication Granaries 11,000 years ago in the Jordan Valley. *Proceedings of the National Academy of Sciences, U.S.A.* 106, 10966–10970
- Kuijt, I. (in press). What do we really know about food storage, surplus, and feasting in pre-agricultural communities? *Current Anthropology*.
- Kuijt, I., Goring-Morris, A.N. (2002). Foraging, farming, and social complexity in the Pre-Pottery Neolithic of the southern Levant: a review and synthesis. *Journal of World Prehistory* 16, 361–440.
- Ladizinsky, G. (1989). Origin and domestication of the Southwest Asian grain legumes. In D.R. Harris and G.C. Hillman (Eds.), *Foraging and Farming: The Evolution of Plant Exploitation* (pp. 374–389). London: Unwin Hyman.
- Legge, A.J. (1996). The beginning of caprine domestication in Southwest Asia. In D.R. Harris (Ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia* (pp. 238–263). Washington D. C.: Smithsonian Institution Press.
- Larson, G., Dobney, K., Albarella, U., Fang, M., Matisoo-Smith, E., Robins, J., Lowden, S., Finlayson, H., Brand, T., Willerslev, E., Rowley-Conwy, P., Andersson, L., Cooper, A. (2005). Worldwide phylogeography of wild boar reveals multiple centers of pig domestication. *Science* 307, 1618–1621.
- Larson, G., Albarella, U., Dobney, K., Rowley-Conwy, P., Schibler, J., Tresset, A., Vigne, J.-D., Edwards, C., Schlumbaum, A., Dinu, A., Balasescu, A., Dolman, G., Tagliacozzo, A., Manasseryan, N., Miravle, P., Van Wijngaarden-Bakker, L., Masseti, M., Bradley, D.G., Cooper, A. (2007). Ancient DNA, pig domestication, and the spread of the Neolithic into Europe. *Proceedings of the National Academy of Sciences U.S.A.* 104, 15276–15281.
- Layton, R.R., Foley, R. (1992). On subsistence transitions: Response to Hawkes and O'Connell. *Current Anthropology* 33, 218–219.
- Layton, R.R., Foley, R., Williams, E. (1991). The transition between hunting and gathering and the specialized husbandry of resources. *Current Anthropology* 32: 255–274.
- Leonard, R.D., Jones, G.T. (1987). Elements of an inclusive evolutionary model of archaeology. *Journal of Anthropological Archaeology* 6, 199–219.
- Lev, E., Kislev, M., Bar-Yosef, O. (2005). Mousterian vegetal food in Kebara Cave, Mt. Carmel. *Journal of Archaeological Science* 32, 475–484.
- Lev-Yadin, S., Ne'eman, G., Abbo, S., Flaishman, M.A. (2006a). Comment on "Early Domesticated Fig in the Jordan Valley". *Science* 314, 1683a.
- Lipo, C.P., O'Brien, M.J., Collard, M., and Shennan, S.J. (2006). *Mapping our ancestors: Phylogenetic Approaches in Anthropology and Prehistory*. New Brunswick: Aldine Transaction.
- Lyman, R.L., O'Brien, M.J. (1998). The goals of evolutionary archaeology: History and explanation. *Current Anthropology* 39, 615–652.
- Lyman, R.L., O'Brien, M.J. (2000). Measuring and explaining change in artifact variation with clade-diversity diagrams. *Journal of Anthropological Archaeology* 19, 39–74.
- Lyman, R.L., O'Brien, M.J. (2001). On misconceptions of evolutionary archaeology: Confusing macroevolution and microevolution. *Current Anthropology* 42, 408–409.
- MacArthur, R.H., Pianka, E.R. (1966). On optimal use of a patchy environment. *The American Naturalist* 100, 603–609.

- Mayr, E. (1942). *Systematics and the Origin of Species*. New York: Columbia University Press.
- Mead, E. (1963). *Animal Species and Evolution*, Cambridge: Harvard University Press.
- Meadow, R.H. (1989). Osteological evidence for the process of animal domestication. In J. Clutton-Brock (Ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation* (pp. 80–90). London:Unwin Hyman.
- Mesoudi, A., O'Brien, M.J. (2008). The learning and transmission of hierarchical cultural recipes. *Biological Theory* 3, 63–72.
- McClure, S.B., Jochim, M.A., and Barton, C.M. (2006). Human behavioral ecology, domestic animals, and land use during the transition to agriculture in Valencia, eastern Spain. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 197–216). Berkeley: University of California Press.
- Morrell, P.L., Clegg, M.T. (2007). Genetic evidence for a second domestication of barley (*Hordeum vulgare*) east of the Fertile Crescent. *Proceedings of the National Academy of Sciences U.S.A.* 104, 3289–3294.
- Moore, A.T.M. (1991). Abu Hureyra I and the antecedents of agriculture on the middle Euphrates. In O. Bar-Yosef and F.R. Valla (Eds.), *The Natufian Culture in the Levant* (pp. 277–294). Ann Arbor: International Monographs in Prehistory.
- Moore, A.M.T., Hillman, G.C., and Legge, A.J. (2000). *Village on the Euphrates: from Foraging to Farming at Abu Hureyra*, Oxford: Oxford University Press.
- Morensen, P. (1974). A survey of Prehistoric settlements in Northern Luristan. *Acta Archaeologica* 45, 1–47.
- Morensen, P. (1975). Survey and soundings in the Holailan Valley 1974. In *Proceedings of the Third Annual Symposium on Archaeological Research in Iran* (pp. 1–2). Iranian Centre for Archaeological Research, Tehran.
- Munro, N. (2003). *Small game, the Younger Dryas, and the transition to agriculture in the southern Levant*. *Mitteilungen der Gesellschaft für Urgeschichte* 12, 47–71.
- Munro, N. (2004). Zooarchaeological measures of hunting pressure and occupation intensity in the Natufian implications for agricultural origins. *Current Anthropology* 45, S6–S33.
- Murray, M.A. (2003). The plant remains. In E. Peltenburg (Ed.), *The colonization and settlement of Cyprus. Investigations at Kissonerga-Mylouthkia, 1976–1996. Lemba Archaeological Project, Cyprus III.1* (pp. 59–71). *Studies in Mediterranean Archaeology* 70: 4, Sweden: Åströms Förlag.
- Nadel, D. (2004). Wild barley harvesting, fishing, and year-round occupation at Ohalo II (19.5 KY, Jordan Valley, Israel). In Le Secrétariat du Congrès (Ed.), *Section 6: The Upper Paleolithic (General Sessions and Posters), Acts of the XIVth UISSP Congress, University of Liege (September 2001)* (pp. 135–143). British Archaeological Reports International Series No. 1240, Oxford: Archaeopress.
- Naderi, S., Rezaei, H.-R., Taberlet, P., Zundel, S., Rafat, S.-A., Nagash, H.-R., El-Barody, M.A.A., Ertugrul, O, Pompanon, F., (2007). Large-scale mitochondrial DNA analysis of the domestic goat reveals six haplogroups with high diversity. *Plos One* 2(10): e1012.
- Naderi, S., Rezaei, H.R., Pompanon, F., Blum, M.G., Negrini, R., Naghash, H.R., Balkiz, O., Mashkour, M., Gaggiotti, O.E., Ajmone-Marsan, P., Kence, A., Vigne, J.D., Taberlet, P. (2008). The goat domestication process inferred from large-scale mitochondrial DNA analysis of wild and domestic individuals. *Proceedings of the National Academy of Sciences USA* 105, 17659–17664.
- Nesbitt, M. (2002). When and where did domesticated cereals first occur in Southwest Asia? In R.T.J. Cappers and S. Bottema (Ed.), *The Dawn of Farming in the Near East* (pp. 113–132). *Studies in Early Near Eastern Productions, Subsistence, and Environment* 6, Berlin: ex Orient 2.
- O'Brien, M.J. (1987). Sedentism, population growth, and resource selection in the Woodland Midwest: A review of coevolutionary developments. *Current Anthropology* 28, 177–197.
- O'Brien, M.J. (Ed.), (2008). *Cultural Transmission and Archaeology: Issues and Case Studies*. Washington, D.C.: Society for American Archaeology Press.

- O'Brien, M.J., Holland, T.D. (1992). The role of adaptation in archaeological explanation. *Archaeological Method and Theory* 2, 31–79.
- O'Brien, M.J., Lyman, R.L. (2000). *Applying Evolutionary Archaeology*, New York: Kluwer Academic/Plenum.
- O'Brien, M.J., Lyman, L., Leonard, R.D. (1998). Basic incompatibilities between evolutionary and behavioral archaeology. *American Antiquity* 63, 485–498.
- O'Connell, J.F., Hawkes, K., Lupo, K.D., Blurton Jones, N.G. (2002). Male strategies and Plio-Pleistocene archaeology. *Journal of Human Evolution* 43, 831–872.
- Odling-Smee, F.J., Laland, K.N., and Feldman, W. (2003). *Niche Construction*, Monographs in Population Biology, No. 37. Princeton: Princeton University Press.
- Özbaşaran, M. (2000). The Neolithic Site of Musular – Central Anatolia. *Anatolica* 26, 129–151.
- Özbaşaran, M., and Buitenhuis, H. (2002). Proposal for a regional terminology for central Anatolia. In F. Gérard and L. Thissen (Eds.), *The Neolithic of Central Anatolia. Internal Developments and External Relations during the 9th-6th Millennia cal BC* (pp. 67–78). Istanbul: Ege Yayınları.
- Özdoğan, M. (1997). Çayönü. *The Oxford Encyclopedia of archaeology in the Near East* 1, 444–446.
- Özdoğan, M. (1997). Anatolia from the Last Glacial maximum to the Holocene climatic optimum. Cultural formations and the impact of the environmental setting. *Paléorient* 23(1), 25–38.
- Özdoğan, M. (2002). Redefining the Neolithic in Anatolia. A critical overview. In Cappers, R.T.J. Bottema, S., (Eds.), *The Dawn of Farming in the Near East* (pp. 153–158). Studies in Near Eastern Production, Subsistence, and Environment, No. 6, Berlin: Ex Oriente.
- Özdoğan, M., Özdoğan, A. (1989). Çayönü, a conspectus of recent work. *Paléorient* 15(1), 65–74.
- Ozkan, H., Brandolini, A., Schafer-Pregl, R., Salamini, F. (2002). AFLP analysis of a collection of tetraploid wheats indicates the origin of emmer and hard wheat domestication in southeast Turkey. *Molecular Biology and Evolution* 19, 1797–1801.
- Peltenburg, E. (Ed.) (2003). *The Colonization and Settlement of Cyprus. Investigations at Kissonerga-Mylothkia, 1976–1996. Lemba Archaeological Project, Cyprus III.1*. Studies in Mediterranean Archaeology 70: 4, Sweden: Åströms Förlag.
- Peltenburg, E. (2004). Social space in early sedentary communities of Southwest Asia and Cyprus. In Peltenburg, E. and Wasse, A. (Eds.), *Neolithic Revolution. New Perspectives on Southwest Asia in Light of Recent Discoveries in Cyprus* (pp. 71–90). Levant Supplementary Series 1, Oxford: Oxbow.
- Perrot, J. (1983). Terminologie et cadre de la préhistoire récents de Palestine. In T.C. Young, Jr., P.E.L. Smith, and P. Mortensen (Eds.), *The Hilly Flanks. Essays on the Prehistory of Southwest Asia* (pp. 113–122). Studies in Ancient Oriental Civilization, No. 36, Oriental Institute, Chicago: University of Chicago.
- Peters, J., Helmer, D., von den Driesch, A., Segui, S. (1999). Animal Husbandry in the northern Levant. *Paléorient* 25(2), 27–48.
- Peters, J., Von Den Driesch A., and Helmer, D. (2005). The upper Euphrates-Tigris Basin, cradle of agro-pastoralism? In Vigne, J.-D., Peters, J. and Helmer, D. (Eds.), *The First Steps of Animal Domestication*, Oxford: Oxbow Books, pp. 96–124.
- Piperno, D.R. (2006). The origins of plant cultivation and domestication in the Neotropics: A behavioral ecology perspective. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 137–166). Berkeley: University of California Press.
- Piperno, D.R., Pearsall, D.M. (1998). *The Origins of Agriculture in the Lowland Neotropics*. San Diego: Academic Press.
- Piperno, D.R., Weiss, E., Holst, I., and Nadel, D. (2004). Processing of wild cereal grains in the Upper Paleolithic revealed by starch grain analysis. *Nature* 407, 894–897.
- Prentiss, W.C., Chatters, J.C. (2003). Cultural diversification and decimation in the prehistoric record. *Current Anthropology* 44, 33–58.

- Redding, R.W. (2005). Breaking the mold, a consideration of variation in the evolution of animal domestication. In J.-D. Vigne, J. Peters and D. Helmer (Eds.), *The First Steps of Animal Domestication* (pp. 41–48). Oxford: Oxbow Books.
- Richerson, P.J., Boyd, R. (2005). *Not by Genes Alone: How Culture Transformed Human Evolution*. Chicago: University of Chicago Press.
- Richerson, P.J., Boyd, R., Bettinger, R.L. (2001). Was agriculture impossible during the Pleistocene by mandatory during the Holocene? A climate change hypothesis. *American Antiquity* 66, 387–412.
- Rindos, D. (1984). *The Origins of Agriculture: An Evolutionary Perspective*. Orlando: Academic Press.
- Rindos, D. (1985). Darwinian selection, symbolic variation, and the evolution of culture. *Current Anthropology* 26, 65–77.
- Rindos, D. (1987). Comment on O'Brien "Sedentism, population growth, and resource selection in the Woodland Midwest: A review of coevolutionary developments". *Current Anthropology* 28, 192–193.
- Rindos, D. (1989a). Diversity, variation, and selection. In R.D. Leonard and G.T. Jones, (Eds.), *Quantifying Diversity in Archaeology* (pp. 13–23). Cambridge: Cambridge University Press.
- Rindos, D. (1989b). Undirected variation and the Darwinian explanation of culture change. *Archaeological Method and Theory* 1, 1–45.
- Rollefson, G. (2000). Ritual and social structure at Neolithic 'Ain Ghazal. In I. Kuijt (Ed.), *Life in Neolithic Farming Communities. Social Organization, Identity and Differentiation* (pp. 165–190). London: Kluwer Academic/Plenum.
- Rollefson, G.O. (2004). A reconsideration of the PPN koine: cultural diversity and centralities. *Neo-Lithics* 1, 46–48
- Rollefson, G.O., Gebel, H. -G. (2004). Towards new frameworks: supra-regional concepts in Near Eastern neolithization. *Neo-Lithics* 1, 21–22.
- Rosenberg, M. (1990). The mother of invention: Evolutionary theory, territoriality, and the origins of agriculture. *American Anthropologist* 92, 399–415.
- Rosenberg, M. (1994a). Pattern, process, and hierarchy in the evolution of culture. *Journal of Anthropological Archaeology* 13, 307–340.
- Rosenberg, M. (1994b). Hallan Çemi Tepesi: Some further observations concerning stratigraphy and material culture. *Anatolica* 20, 121–140.
- Rosenberg, M. (1998). Cheating at musical chairs: territoriality and sedentism in an evolutionary context. *Current Anthropology* 39, 653–684.
- Rosenberg, M., Davis, M. (1992). Hallan Çemi Tepesi, and Early Aceramic Neolithic site in eastern Anatolia: Some preliminary observations concerning material culture. *Anatolica* 18, 1–18.
- Rosenberg, M., and Redding, R. (2000). Hallan Çemi and early village organization in eastern Anatolia. In: Kuijt, I. (Ed.). *Life in Neolithic Farming Communities: Social Organization, Identity, and Differentiation* (pp. 39–62). New York: Kluwer Academic /Plenum Press.
- Rosenberg, M., Nesbitt, M. Redding, R.W., Peasnell, B.L. (1998). Hallan Çemi. Pig husbandry, and post-Pleistocene adaptations along the Taurus-Zagros arc (Turkey). *Paléorient* 24(1), 25–41.
- Ryder, M.L. (1983). *Sheep and Man*. London: Duckworth.
- Salamini, F., Öakan, H., Brandolini, A., Schäfer-Pregl, R., Martin, W. (2002). Genetics and geography of wild cereal domestication in the Near East. *Nature Reviews/Genetics* 3, 429–441.
- Schmidt, K. (2005). "Ritual Centers" and the Neolithisation of Upper Mesopotamia. *Neo-Lithics* 2/05, 13–21.
- Schultz, T., Mueller, U.G., Currie, C.R., and Rehner, S. (2005). Reciprocal illumination: a comparison of agriculture in humans and in fungus-growing ants. In: F. Vega, M. Balckwell, (Eds.), *Ecological and Evolutionary Advances in Insect-Fungal Associations* (pp. 149–190). New York: Oxford University Press.
- Seilacher, A. (1972). Fabricational noise in adaptive morphology. *Systematic Zoology* 22, 451–465.
- Service, E.R. (1962). *Primitive Social Organization: An Evolutionary Perspective*. New York: Random House.

- Simpson, G.G. (1944). *Tempo and Mode in Evolution*. New York: Columbia University Press.
- Smith, B.D. (1998). *The Emergence of Agriculture*. New York: W. H. Freeman and Co.
- Smith, B.D. (2001). Low level food production. *Journal of Archaeological Research* 9, 1–43.
- Smith, B.D. (2006). Human behavioral ecology and the transition to food production. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 289–303). Berkeley: University of California Press.
- Smith, B.D. (2007a) The ultimate ecosystem engineers. *Science* 315, 1797–1798.
- Smith, B.D. (2007b). Niche construction and the behavioral context of plant and animal domestication, *Evolutionary Anthropology* 16, 189–199.
- Smith, P.E.L. (1972). Ganjdareh Tepe, *Iran* 10, 165–168.
- Smith, P.E.L. (1976). Reflections on four seasons of excavations at Tapeh Ganj Dareh. In Bagherzadeh, F. (Ed.), *Proceedings of the Fourth Annual Symposium on Archaeological Research in Iran* (pp. 11–22). Tehran: Iranian Centre for Archaeological Research.
- Solecki, R.L. (1981). *An Early Village Site at Zawi Chemi Shanidar*, Bibliotheca Mesopotamica, No. 13, Malibu: Undena Publications.
- Solecki, R.L., and McGovern, T. (1980). Predatory birds and prehistoric man, In S. Diamond (Ed.), *Theory and Practice. Essays Presented to Gene Weltfish* (pp. 79–95). The Hague: Mouton.
- Solecki, R.S. (1965). Prehistory in Shanidar valley, Northern Iraq, *Science* 139, 179–193.
- Spencer, C.S. (1990). On the tempo and mode of state formation: Neoevolutionism reconsidered, *Journal of Anthropological Archaeology* 9, 1–30.
- Spencer, C.S. (1993). Human agency, biased transmission, and the cultural evolution of chiefly authority, *Journal of Anthropological Archaeology* 12, 41–74.
- Spencer, C.S. (1997). Evolutionary approaches in archaeology. *Journal of Archaeological Research* 5, 209–264.
- Spencer, C.S., and Redmond, E. (2001). Multilevel selection and political evolution in the Valley of Oaxaca, 500–100 B.C. *Journal of Anthropological Archaeology* 20, 195–229.
- Stephens, D., and Krebs, J. (1986). *Foraging theory*. Princeton: Princeton University Press.
- Stordeur, D. (2004). New insights and concepts: Two themes of the Neolithic in Syria and south-east Anatolia, *Neolithics* 1, 49–51.
- Sudupak, M.A., Akkaya, M.S., Kence, A. (2004). Genetic relationships among perennial and annual *Cicer* species growing in Turkey assessed by AFLP fingerprinting. *Theoretical and Applied Genetics* 108, 937–944.
- Tanno, K., Wilcox, G. (2006a). How fast was wild wheat domesticated? *Science* 311, 1886.
- Tanno, K., Wilcox, G. (2006b). The origins of cultivation of *Cicer arietinum* L. and *Vicia faba* L.: early finds from tell el-Kerkh, north-west Syria, late 10th millennium B.P. *Vegetation History and Archaeobotany* 15, 197–204.
- Tchernov, E. (1991). Biological evidence for human sedentism in Southwest Asia during the Natufian. In O. Bar-Yosef and F.R. Valla, F.R. (Eds.), *The Natufian Culture in the Levant* (pp. 315–340). Ann Arbor: International Monographs in Prehistory.
- Tchernov, E., Valla, F.R. (1997). Two new dogs, and other Natufian dogs, from the southern Levant. *Journal of Archaeological Science* 24, 65–95.
- Tucker, B. (2006). A future discounting explanation for the persistence of a mixed foraging-horticulture strategy among the Mikea of Madagascar. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 22–40). Berkeley: University of California Press.
- Turnbull, P.F. and Reed, C.A. (1974). *The Fauna from the Terminal Pleistocene of Palegawra Cave, a Zarzian occupation site in the northeastern Iraq*. Fieldiana: Anthropology, vol. 63 (3), Chicago: Field Museum of Natural History.
- Ucko, P. (1968). *Anthropomorphic Figurines of Predynastic Egypt and Neolithic Crete with Comparative Material from the Prehistoric Near East and Mainland Greece*. Royal Anthropological Institute Occasional Paper, No 24, London: Andrew Szmidla.
- Uerpmann, H.-P. (1978). Metrical analysis of faunal remains from the Middle East. In R.H. Meadow and M.A. Zeder (Eds.), *Approaches to Faunal Analysis in the Middle East* (pp. 41–45). Peabody Museum Bulletin, No 2. Cambridge: Peabody Museum.

- Uerpmann, H.-P. (1979). *Probleme der Neolithisierung des Mittelmeerraumes*. Biehefte zum Tübingen Atlas des Vordern Orients, Reihe B, Nr. 28. Wiesbaden: Dr Ludwig Reichert.
- Vigne, J.-D., Buitenhuis, H., Davis, S. (1999). Les premiers pas de la domestication animal à l'Oest de l'Euphrate: Chypre et L'Anatolie centrale. *Paléorient* 25(2), 49–62.
- Vigne, J.-D., Carrère, I., Saliège, J.-F., Person, A., Bocherens, H., Guilaine, J., and Briois, F., (2000). Predomestic cattle, sheep, goat, and pig during the late 9th and the 8th millennium cal. B.C. on Cyprus: preliminary results of Shillourokambos (Parekklisha, Limassol). In Mashkour, M. Choyke, A.M., Buitenhuis, H., and Poplin, F. (Eds.), *Archaeozoology of the Near East, IVA* (pp. 83–106). ARC Publication No. 32, Groningen: ARC.
- Vigne, J.-D., Carrère I., and Guilaine, J (2003). Unstable status of early domestic ungulates in the Near East: The example of Shillourokambos (Cyprus, IX–VIIIth millennia cal. B.C.). In J. Guilaine et A. Le Brun éd.s., *Le Néolithique de Chypre* (pp. 239–251). Actes Coll. Int. Nicosie, 17–19 mai 2001, *Bulletin de Correspondance Hellénique*, suppl. 43.
- Voigt, M.M. (2000). Çatal Höyük in context: Ritual at early Neolithic sites in Central and Eastern Turkey. In Kuijt, I. (Ed.), *Life in Neolithic Farming Communities. Social Organization, Identity and Differentiation* (pp. 253–294). London: Kluwer Academic/Plenum.
- Vrba, E., Eldredge, N. (1984). Individuals, hierarchies, and processes: Towards a more complete evolutionary theory. *Paleobiology* 10, 146–171.
- Watkins, T. (1996). Excavations at Pinarbaşı: The early stages. In I. Hodder (Ed.), *On the surface: Çatalhöyük 1993–1995* (pp. 47–57). Cambridge and London: MacDonald Archaeological Institute and the British Institute at Ankara.
- Weiss, E., Wetterstrom, W., Nadel, D., Bar-Yosef, O. (2004). The broad spectrum revolution revisited: Evidence from plant remains. *Proceedings of the National Academy of Science, USA* 101, 9551–9555.
- Weiss, E., Kislav, M.E., Hartmann, A. (2006). Autonomous cultivation before domestication. *Science* 312, 1608–1610.
- Wilcox, G. (2002). Geographical variation in major cereal components and evidence for independent domestication events in Western Asia. In R.T.J. Cappers and S. Bottema (Eds.), *The Dawn of Farming in the Near East* (pp. 133–140). Studies in Near Eastern Production, Subsistence, and Environment, No. 6, Berlin: Ex Oriente.
- Wilcox, G. (2005). The distribution, natural habitats, and availability of wild cereals in relation to their domestication in the Near East: Multiple events, multiple centres. *Vegetative History and Archaeobotany* 14, 534–541.
- Wilcox, G., Fornite, S., Herveux, L. (2008). Early Holocene cultivation before domestication in northern Syria. *Vegetative History and Archaeobotany*. 17, 313–325.
- Winterhalder, B. (1986). Diet choice, risk, and food sharing in a stochastic environment. *Journal of Anthropological Archaeology* 5, 369–392.
- Winterhalder, B., Goland, C. (1993). On population, foraging efficiency, and plant domestication. *Current Anthropology* 34:710–715.
- Winterhalder, B., and Goland, C. (1997). An evolutionary ecology perspective on diet choice, risk, and plant domestication. In K.J. Gremillion (Ed.), *People, Plants, and Landscapes: Studies in Paleoethnobotany* (pp. 123–160). Tuscaloosa: University of Alabama Press.
- Winterhalder, D., and Kennett, D.J. (2006). Behavioral ecology and the transition from hunting and gathering to agriculture. In D.J. Kennett and B. Winterhalder (Eds.), *Behavioral ecology and the transition to agriculture* (pp. 1–21). Berkeley: University of California Press.
- Winterhalder, B., Kennett, D.J. (in press). Four neglected concepts with a role to play in explaining the origins of agriculture. *Current Anthropology*.
- Winterhalder, B., Smith, E.A. (1981). *Hunter-gatherer foraging strategies: Ethnographic and Archaeological Analyses*. Chicago: University of Chicago Press.
- Wright, S. (1931) Evolution in Mendelian populations. *Genetics* 16, 97–159.
- Wright, S. (1932). The roles of mutation, inbreeding, crossbreeding and selection in evolution. *Proceedings of the VI International Congress of Genetics* 1, 356–366.
- Zeder, M.A. (1994). After the revolution: Post-Neolithic subsistence strategies in Northern Mesopotamia. *American Anthropologist* 96, 97–126.

- Zeder, M.A. (2001). A metrical analysis of a collection of modern goats (*Capra hircus aegargus* and *Capra hircus hircus*) from Iran and Iraq: Implications for the study of caprine domestication. *Journal of Archaeological Science* 28, 61–79.
- Zeder, M.A. (2005). New Perspectives on Livestock Domestication in the Fertile Crescent as viewed from the Zagros Mountains. In J.-D. Vigne, J. Peters and D. Helmer (Eds.), *The First Steps of Animal Domestication* (pp. 125–147). Oxford: Oxbow Books.
- Zeder, M.A. (2006a). Central questions in the domestication of plants and animals. *Evolutionary Anthropology* 15, 105–117.
- Zeder, M.A. (2006b). Archaeological approaches to documenting animal domestication. In M.A. Zeder, E. Emshwiller, B.D. Smith, and D.G. Bradley (Eds.), *Documenting Domestication: New Genetic and Archaeological Paradigms* (pp. 171–180), Berkeley: University of California Press.
- Zeder, M.A. (2006c). A Critical Examination of Markers of Initial Domestication in Goats (*Capra hircus*). In M.A. Zeder, E. Emshwiller, B.D. Smith, and D.G. Bradley (Eds.), *Documenting Domestication: New Genetic and Archaeological Paradigms* (pp. 181–208). Berkeley: University of California Press.
- Zeder, M.A. (2006d). Archaeozoology in Southwest Asia: A status report based on the eighth meeting of the Archaeozoology of Southwest Asia and Adjacent Areas Working Group, *Paléorient* 32(1), 137–147.
- Zeder, M.A. (2008a). Domestication and early agriculture in the Mediterranean Basin: Origins, diffusion, and impact. *Proceedings of the National Academy of Sciences, USA* 105, 11597–11604.
- Zeder, M.A. (2008b). Animal domestication in the Zagros: An update and directions for future research. In E. Vila, L. Goucherin, A. Choyke, and H. Buitenhuis (Eds.), *Archaeozoology of the Near East VIII, Proceedings of the eight international symposium on the Archaeozoology of Southwestern Asia and Adjacent areas* (pp. 243–278). Lyon: Travaux de la Maison de l’Orient et de la Méditerranée (TMO).
- Zeder, M.A. (2009). The Neolithic macro-(r)evolution: Macroevolutionary theory and the study of culture change. *Journal of Archaeological Research* 17:1–63.
- Zeder, M.A. (in press). Pathways to animal domestication. In: P. Gepts (Ed.), *Biodiversity in Agriculture: Domestication, Evolution, & Sustainability*.
- Zeder, M.A., Hesse, B. (2000). The initial domestication of goats (*Capra hircus*) in the Zagros Mountains 10,000 years ago. *Science* 287, 2254–2257.
- Zeder, M.A. and Smith, B.D. (in press). A Conversation on Agricultural Origins: Talking Past Each Other in a Crowded Room. *Current Anthropology*.
- Zeder, M.A., Bradley, D.G., Emshwiller, E., and Smith, B.D. (Eds.). (2006a). *Documenting Domestication: New Genetic and Archaeological Paradigms*, University of California Press, Berkeley.
- Zeder, M.A., Emshwiller, E., Smith, B.D., Bradley, D.G. (2006b). Documenting domestication, the intersection of genetics and archaeology, *Trends in Genetics* 22, 139–155.
- Zohary, D. (1992). Domestication of the Neolithic Near Eastern crop assemblage. In Anderson, P.C. (Ed.), *Préhistoire de l’Agriculture* (pp. 81–86). Paris: Editions du CNRS.
- Zohary, D. and Hopf, M. (2000). *Domestication of Plants in the Old World*, ed. 3, Oxford: Oxford Science.