ANTHROPOLOGY

From Foraging to Planting

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Behavioral Ecology and the Transition to Agriculture

Douglas J. Kennett and Bruce Winterhalder, Eds.

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Plant and animal domestication and the transition to agriculture are topics of intense interest in archaeology. The early Holocene transformation of human societies around the globe from foraging to agriculture constitutes the most important development for our species since the emergence of modern humans. The transition spurred population growth, affected (often negatively) the health of individuals, and led to changes in how people related to each other and to their world.

Three seminal works (*1*–*3*) from the long history of research on agricultural origins have shaped my perception that agriculture is an outgrowth of normal plant-people relationships—i.e., is fundamentally ethnobiological—and that our understanding of this transformation requires systematic recovery of the remains of the plants and animals used by humans.

Behavioral Ecology and the Transition to Agriculture is poised to become a similar work for scholars who are part of an emerging consensus that plant domestication and agriculture are outgrowths of foraging behavior. As Robert Bettinger notes, "This volume marks a turning point in the development of human behavioral ecology…, whose past efforts have spoken to a research agenda largely crafted in the biological sciences by individuals interested in nonhuman species." The volume's chapters reflect a maturing of human behavioral ecology; their approach to the landmark transformation of agricultural origins illustrates the increasing sophistication in modeling.

At the core of human behavioral ecology, as Douglas Kennett and Bruce Winterhalder note, is optimization: "As a result of natural and cultural evolutionary processes, behavior will tend toward constrained optimization." Foraging efficiency enhances fitness by providing adequate food and freeing the forager to undertake nonsubsistence activities that may enhance fitness, such as acquiring prestige. A central feature of diet breadth, the most commonly used model, is that individuals make rational decisions about whether to take an encountered animal or plant (from a set of ranked resources) based on the costs and benefits of doing so (measured in the "currency" of food energy) within the constraints of a goal, such as maximizing energy return or minimizing risk. Changes in costs or benefits—e.g., environmental change that alters resource abundances—cause changes in diet breadth, such as widening to include lower ranked resources. In Renee Barlow's formulation, "The model predicts that foragers will farm when the expected marginal energetic return for a particular farming activity (kcal/hr) is greater than the immediate return rate for foraging (kcal/hr)…." Applying human behavioral ecology requires that the archaeological record, which captures the actions of groups and rarely individuals, is adequate to model such a process.

Human behavioral ecology models differ from coevolutionary approaches, which do not rely on decision-making as outlined above. From a coevolutionary perspective, foraging is characterized by mutualism (*2*). Through foraging, humans contribute to plant propagation—some seeds survive digestion and form new populations; root tips left in the ground multiply. Plants that respond in these ways increase in abundance and therefore are increasingly foraged. Over time, the cycle of planting (inadvertent or deliberate) and harvesting leads to morphological changes that mark domestication (*3*).

What coevolution contributes to the "how" of agricultural origins is the notion that people's routine interactions with plants and animals have the potential to change those species. What we know from ethnobiological studies of contemporary foragers is that humans are active manipulators of environments, not passive responders. Management practices that increase stands of desirable wild resources, such as controlled burning and replanting, demonstrate that foragers control a suite of skills that could lead to agriculture. Human behavioral ecology provides a framework for understanding which resources would be targeted for management.

One theme running through the volume is that human behavioral ecology approaches are useful regardless of whether specific models can be tested. Kristen Gremillion puts it well: "The goal of this exercise is neither to test the predictions of central place foraging theory against the archaeological record, nor to assess the validity of the models themselves. The theoretical model is used to provide a framework for analysis and to identify variables relevant to decision making…." Nonetheless, Gremillion demonstrates the usefulness of central place foraging theory (that foragers or farmers will select residential base locations that maximize net foraging or farming return) through a simulation that predicts return rates of different cultivation strategies and generates testable hypotheses. Ideal free distribution modeling (that individuals will select habitats that maximize net foraging or farming return), such as that presented by Kennett, Atholl Anderson, and Winterhalder for the dispersal of people across the Pacific, also generates testable hypotheses on site locations, pace of colonization, and habitat change. Central place foraging and ideal free distribution are powerful approaches in part because they generate predictions that can be tested with archaeological site distribution and paleoenvironmental data.

Artifacts from a flexible culture. Although they cultivated maize, the people who produced Fremont assemblages (Utah, CE 600 to 1300) continued to rely on hunting and foraging.

CREDIT: PHOTO BY K. RENEE BARLOW; ARTIFACTS COURTESY OF THE UTAH MUSEUM OF NATURAL HISTORY

Diet-breadth models are more challenging to evaluate. Ideally, testing would rely on temporal sequences of quantitative data on utilized plant and animal species. Problems include the differential preservation of different species and tissues and the difficulties of both species-level identifications and determination of which recovered species were foods.

Using ubiquity (the percentage of observations in which a species is found) as a proxy for energy returns and richness (the number of species recovered) may facilitate evaluation of models, as in the study of early agriculture in Arizona by Michael Diehl and Jennifer Waters. Furthermore, using ubiquity and richness allows a single ranking of both plants and animals based on disparate data, such as seeds preserved by charring and tubers preserved as

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starch or phytolith residues on tools. These proxy indicators are not divorced from sample size effects, however, and do not help the analyst interpret absence: Is this lack of use of a resource? Or extreme preservation bias? Such issues are important in evaluating temporal sequences of data.

Behavioral Ecology and the Transition to Agriculture illustrates the power and the limitations of human behavioral ecology as well as how it contributes to our understanding of that landmark transformation. Realizing the full potential of foraging theory modeling will, however, require more than good archaeology. One theme shared by many chapters is the difficulty of arriving at realistic estimates of costs and benefits of available resources. New ethnographic data, plant distribution studies, and paleoenvironmental data are needed to feed the models. Agricultural origins research is fundamentally interdisciplinary and, as such, among the most challenging topics we face.

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HUMAN EVOLUTION

Silverbacks and Their Satellites

Rebecca L. Cann

Nicholas Wade's latest book, *Before the Dawn*, extends many of the subjects he has previously written about (social evolution, gender roles, race, language, intelligence, migration, and genetic identity) for the *New York Times* to a full-length discussion of human evolution. Many American geneticists consider Wade to be the most important general science writer covering their field. The breadth of his writing allows him to include lice, sperm competition, microcephaly, proto-IndoEuropean, lactose intolerance, and cannibalism in a single chapter. As a graduate student, I was amazed by the number of books popularizing human paleontology that ignored human genetics, and I often wished that there were science writers energized to follow the new insights from geneticists as closely and rapidly as others reported interpretations of fragmentary fossils. Well, be careful what you wish for. The book also reveals some unpleasant truths about science writing that currently passes for objective and informed. Only smugness that one's sources must be correct because they represent a scientific elite group having new and exclusive truths about human evolution makes it possible to write, in 2006, sentences such as, "The Australian and New Guinean branch [of our phylogenetic tree] soon settled into a time warp of perpetual stagnation."

Wade's marketing of his non–politically correct views of human history as hard science with a genetic basis in modern molecular biology leads him to emphasize the role of warfare as the most critically important feature shaping human dispersal, mate choice, and competition—ideas that channel Richard Alexander's papers on conflicts between polygynous and monogamous societies. Napoleon Chagnon's Yanomamo work is also revisited, but without the alternative background previously exposed by Patrick Tierney's "Darkness in Eldorado" episode (*1*). Instead, Wade fleshes out Alexander's, William Hamilton's, Richard Wrangham's, and Robert Trivers's theses within a modern frame as the simple extension of chimpanzee social behaviors, because modern molecular genetics has now given us a comparative genome-wide basis for documenting recent shared, common ancestry. It is clear that Wade has chosen to focus on one species of chimpanzee (the common, rather than the bonobo) to supply data supporting claims of innate human male aggression, without considering the ecological box all African ape species find themselves driven into by expanding human encroachment. Instead, he dwells on the supposed stability of ape society and their conservatism in the face of ecological change, compared to innovative humans. His statements about conservatism of ape behavior jumped from the page as I viewed a PBS film about an orangutan sanctuary in Borneo, captivated by footage of a young female named Princess who knuckle-walks down a narrow dock, unmoors a canoe, loads her infant, lifts the paddle, and heads downstream to feed (*2*).

From Wade's perspective, archaeologist Richard Klein's claims that early modern humans were anatomically advanced but not behaviorally tempered (*3*) are completely in agreement with molecular genetics. Wade allows that others—notably Sally McBrearty, Alison Brooks, and Christopher Henshilwood (*4*, *5*)—see a different record, but he clearly champions Klein. Language genes are the reason, and the FoxP2 story is again recounted, without all the uncertainties and comparative carnivore information that make many inferences suspect. At the beginning of the book, Wade states that modern humans were confined to North Africa 50 thousand years ago (ka), a place and time at odds with the deep divergence of maternal genetic lineages within the Andamanese he notes elsewhere. The Toba volcanic eruption on Sumatra (73 ka), which would have destroyed previous evidence of an earlier African dispersal in this region, is consistent with the genetic data but gets no mention.

The author's consideration of competitive interactions between modern humans and archaic species is particularly problematic. According to Wade, modern humans carried out a continual campaign of active genetic cleansing against Neandertals that lasted at least 30,000 years. Considering that any human isolate bottled up with nonhuman primates on a separate, tropical continent for 500,000 years is likely to have brought some nasty pathogens when it arrived in habitats harboring appropriate insect vectors, some alternative explanations for the disappearance of Neandertals and *Homo floresiensis* are in order.

Before the Dawn
Recovering the Lost History of Our Ancestors
by Nicholas Wade
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Informed readers will find many other questionable interpretations. For example, instead of postulating agriculture as a condition to sedentism and the rise of the city state, Wade believes that affinity to place arose before a technology gave added value to place. New alleles for philopatry did not kick highborn European second sons out of kingships and into armies or the clergy; the stimulus was birth order. And, rather than characterize the inheritance of certain behavioral or disease traits as Mendelian versus complex, the appropriate distinction is simple Mendelian versus quantitative.

How many of our individual accomplishments are really due to hard work, dedication, and motivation, rather than the genetic lottery we may or may not have won? Many geneticists who probe such questions are uneasy, and journalists who know they are should understand the consequences of oversimplified answers. *Before the Dawn* will do little to cheer such scientists up. Accepted uncritically, it could even help shift the emphasis in popular culture and politics from individual values to group means and their stereotypes.

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