Communicative & Integrative Biology 2:6, 1-2; November/December 2009; © 2009 Landes Bioscience

Core conceptual flaws in human behavioral ecology

Bruce D. Smith

Archaeobiology Program; National Museum of Natural History; Smithsonian Institution; Washington DC, USA

Key words: domestication, human behavioral ecology, diet breadth, movement ecology paradigm, niche construction theory, foraging, resource selection, origins of agriculture, food production

Submitted: 07/23/09

Accepted: 07/24/09

Previously published online: www.landesbioscience.com/journals/cib/article/9613

Correspondence to:
Bruce D. Smith; Email: smithb@si.edu

Addendum to: Smith BD, Yarnell RI. Initial formation of an indigenous crop complex in eastern North America at 3800 B.P. Proc Natl Acad Sci USA 2009; 106:6561–6.

The recent emergence of movement ecology and niche construction paradigms in evolutionary ecology bring into clear focus the conceptual shortcomings of older foraging models currently employed in Human Behavioral Ecology. Along with increasing archaeological evidence, these new perspectives call into question the basic utility of HBE as a framework of understanding for complex human evolutionary processes, including the transition from hunting and gathering to agriculture.

Under the general label of Human Behavioral Ecology (HBE), two foraging models developed in evolutionary ecology over 30 years ago—diet breadth and patch choice, have been employed in proposed universal frameworks of explanation for a major transitions in human history—the initial domestication of plants and animals by human societies world-wide.[1] Growing empirical evidence and newly emerging approaches in evolutionary ecology, however, have isolated three basic assumptions of HBE that constitute core conceptual flaws that substantially compromise it's explanatory potential: (1) that forager movements across a landscape are random,[2] (2) that as foragers encounter resources, a stringent assessment of their net energy value is the solitary criteria for ranking and selection (any dietary addition of low-ranked resources is invariably due to a scarcity of higher ranked food items);[1-3] and (3) that foragers are dependent and passive consumers of resources, with no capacity for environmental manipulation.[2]

HBE classifies small-seeded annual plants (a major class of domesticates—e.g., wheat, maize, rice) as low-ranking resources that are incorporated into human diets and subsequently domesticated only when better food sources become scarce. Two recent articles that document the independent domestication and coalescence of local seed-bearing plants into a crop complex in resource-rich river valleys in eastern North America in the absence of resource scarcity provide empirical evidence that contradicts this expectation of HBE.[4,5] Recent archaeological studies in other world areas also indicate the utilization and/or domestication of small-seeded annuals and other "low-quality" resources by hunter-gatherer and early farming societies occupying resource-rich environments in the absence of evidence of resource scarcity,[6-11] indicating that resource selection is not based solely on a single criteria—the net energy value of randomly encountered food items.[12,13]

Forager movement patterns (human and non-human), which contrary to a basic tenet of HBE are almost always knowledge-based rather than random, are increasingly recognized as playing a central role in resource selection under the Movement Ecology Paradigm (MEP).[14-18] Resource selection is not exclusively determined by net-energy values, but by complex and situation-specific sets of drivers, some of which come into play long before foragers encounter food items.

While MEP addresses the "random foraging/net-energy-only" conceptual flaw in HBE, Niche Construction Theory (NCT), addresses the "passive-resource-consumer" flaw of HBE by recognizing the active role of foragers in modifying their environments.[19] As the "ultimate ecosystem engineers,"[19-21] human societies have been actively modifying a wide range of environments in ways that enhance their resource base[22-25] for ca. 40,000 years.[26] In contrast to HBE, which "explains" domestication as a response to resource scarcity, NCT instead situates it within end-Pleistocene

human efforts to manipulate and enrich their resource base that involved broad-spectrum "auditioning" of a wide range of different species of plants and animals for potential larger roles in increasingly human-influenced ecosystems. When viewed from a NCT perspective, the process of domestication thus did not begin as a human response to resource scarcity, but rather emerged within the developmental context of increasingly more coherent and integrated overall strategies of ecosystem engineering by human societies.[27]

References

1. Kennett DJ, Winterhalder B. eds. Behavioral Ecology and the Transition to Agriculture. Berkeley, CA: Univ Calif Press 2006.
2. Winterhalder B, Kennett D. Behavorial ecology and the transition from hunting and gathering to agriculture. In: Kennett D, Winterhalder B, eds. Behavioral Ecology and the Transition to Agriculture. Berkeley, CA: Univ Calif Press 1-21.
3. Winterhalder B, Goland C. An evolutionary ecology perspective on diet choice, risk and plant domestication. In: Gremillion K, ed. People, plants and landscapes studies in paleoethnobotany. Gremillion K, ed. Tuscaloosa AL: Univ Ala Press 1997; 123-60.
4. Smith BD. Eastern North America as an independent center of plant domestication. Proc Natl Acad Sci USA 2006; 103:2223-8.
5. Smith BD, Yarnell RA. Initial formation of an indigenous crop complex in eastern North America at 3800 B.P. Proc Natl Acad Sci USA 2009; 106:6561-6.
6. Nadel D. Wild barley harvesting, fishing and year-round occupation at Ohalo II (19.5 KY, Jordan Valley, Israel). British Archaeo Rep International Series Oxford, Archaeopress 2004; 1240:135-43.
7. Piperno DR, Weiss E, Holst I, Nadel D. Processing of wild cereal grains in the Upper Paleolithic revealed by starch grain analysis. Nature 2004; 407:894-7.
8. Bar Yosef O, Gopher A. eds. An early Neolithic village in the Jordan Valley. Cambridge, MA: Harvard Univ Peabody Mus Archaeol and Ethno 1997.
9. Kislev ME. Plant remains. Early agriculture and paleoecology of Netiv Hagdud. In Bar Yosef O, Gopher A, eds. An early Neolithic village in the Jordan Valley. Cambridge, MA: Harvard Univ Peabody Mus Archaeol and Ethno 1997; 209-36.
10. Ranere AJ, Piperno DR, Holst I, Dickau R, Iriarte J. The cultural and chronological context of early Holocene maize and squash domestication in the central Balsas River Valley, Mexico. Proc Natl Acad Sci USA 2009; 106:5014-8.
11. Piperno DR, Ranere AJ, Holst I, Iriarte J, Dickau R. Starch grain and phytolith evidence for early ninth millennium B.P. maize from the central Balsas River Valley, Mexico. Proc Natl Acad Sci USA 2009; 106:5019-24.
12. Zeder MA. The Neolithic macro-(r)evolution: macroevolutionary theory and the study of culture change. J Archaeol Res 2007; 17:1-64.
13. Zeder MA. Evolutionary biology and the emergence of agriculture: the value of co-opted models of evolution in the study of culture change. In: Prentiss A, Chatters J, Kuijt I, eds. Macroevolution in human prehistory. New York, NY: Springer 2009; 157-210.
14. Nathan R, Getz WM, Revilla E, Holyoak M, Kadmon R, Saltz D, Smouse PE. A movement ecology paradigm for unifying organismal research. Proc Natl Acad Sci USA 2008; 49:19052-9.
15. Getz W, Saltz D. A framework for generating and analyzing movement paths on ecological landscapes. Proc Natl Acad Sci USA 2008; 49:19066-71.
16. Benhamou S. How many animals really do the Levy walk? Ecology 2007; 88:1962-99.
17. Dalziel BD, Morales JM, Fryxell JM. Fitting probability distributions to animal movement trajectories: using artifical neural networks to link distance, resources and memory. Am Nat 2008; 172:248-58.
18. Edwards AM, Phillips RA, Watkins NW, Freeman MP, Murphy MP, Afanasyev V, et al. Revisiting L'evy flight search patterns of wandering albatrosses, bumblebees and deer. Nature 2007; 499:1044-8.
19. Odling-Smee J, Laland KN, Feldman MW. Niche construction. Monographs in Population Biology 37. Princeton, NJ: Princeton University Press 2003.
20. Laland KN, Odling-Smee J, Feldman MW. Cultural niche construction and human evolution. J Evol Biol 2001; 14:22-33.
21. Smith BD. The ultimate ecosystem engineers. Science 2007; 315:1797-8.
22. Deur DD, Turner NJ. eds. Keeping it living, traditions of plant use and cultivation on the Northwest Coast of North America. Seattle, WA: Univ Wash Press 2005.
23. Anderson MK. Tending the wild. Berkeley, CA: Univ Calif Press 2005.
24. Gremillion KJ. Forest opening, habitat use and food production on the Cumberland Plateau, Kentucky: adaptive flexibility in marginal settings. Am Antiq 2008; 387-411.
25. Delcourt PA, Delcourt HR. Prehistoric Native Americans and ecological change. Cambridge, UK: Camb Univ Press 2002.
26. Groube L. In Harris DR, Hillman GC, eds., Foraging and Farming. London, UK: Unwinn and Hyman 1989; 292-304.
27. Smith BD. Niche construction and the behavioral context of plant and animal domestication. Evol Anthro 2007; 16:188-99.