

Evolving the human niche

Erle C. Ellis^{a,1}, Peter J. Richerson^b, Alex Mesoudi^c, Jens-Christian Svenning^d, John Odling-Smee^e, and William R. Burnside^f

Boivin et al.'s (1) article profoundly deepens scientific understanding of anthropogenic global ecological change from Pleistocene to present by offering robust new evidence of early human transformation of the biosphere that should influence discussions on Anthropocene formalization (2, 3). As ecologists and evolutionary theorists, we applaud this work. However, we are also concerned that this paper represents a missed opportunity to bring archaeology, ecology, and evolutionary theory closer together.

Boivin et al. (1) characterize the ecological consequences of "human niche construction" without linking this directly with evolutionary processes (4–8). "Evolutionary pressures" and "evolutionary trajectories" are noted, yet ecological inheritances, the basis for niche construction theory (9), are not included, nor are cultural inheritances or processes of natural, artificial, or cultural selection. Although "cultural niche construction" appears, cultural evolution (6, 7) is neither mentioned nor linked with niche construction, leaving "human niche construction" without its essential evolutionary

context, to mean only "human alterations of ecology"—or ecosystem engineering by humans.

A human niche cannot be understood without integrating niche construction with cultural evolution and social change. Human alteration of ecology is inherently social: socially learned and socially enacted (4). Long-term changes in the human niche are produced by evolutionary processes acting on both ecological and cultural inheritances (4, 5). Complex cultural packages such as agriculture emerged and spread through long-term processes of cumulative cultural evolution (6, 7), facilitated by such factors as high-fidelity social learning, large populations, within-group cooperation, and multilevel selection.

The spread of *Homo sapiens* across the continents, the emergence of larger-scale societies, and human transformation of the biosphere are the consequences of these evolutionary processes (4, 7). Working together across disciplines in a common evolutionary framework based on niche construction theory might yet guide human societies toward a better Anthropocene (10).

- 1 Boivin NL, et al. (2016) Ecological consequences of human niche construction: Examining long-term anthropogenic shaping of global species distributions. *Proc Natl Acad Sci USA* 113(23):6388–6396.
- 2 Ruddiman WF, Ellis EC, Kaplan JO, Fuller DQ (2015) Defining the epoch we live in. *Science* 348(6230):38–39.
- 3 Waters CN, et al. (2016) The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science* 351(6269):aad2622.
- 4 Ellis EC (2015) Ecology in an Anthropogenic biosphere. *Ecol Monogr* 85(3):287–331.
- 5 Laland KN, et al. (2015) The extended evolutionary synthesis: Its structure, assumptions and predictions. *Proc Biol Sci* 282(1813):20151019.
- 6 Mesoudi A, Whiten A, Laland KN (2006) Towards a unified science of cultural evolution. *Behav Brain Sci* 29(4):329–347, and discussion (2006) 29(4):347–383.
- 7 Boyd R, Richerson PJ, Henrich J (2011) The cultural niche: Why social learning is essential for human adaptation. *Proc Natl Acad Sci USA* 108(Suppl 2):10918–10925.
- 8 Odling-Smee J, Laland KN (2012) Ecological inheritance and cultural inheritance: What are they and how do they differ? *Biol Theory* 6(3):220–230.
- 9 Odling-Smee FJ, Laland KN, Feldman MW (2003) *Niche Construction: The Neglected Process in Evolution* (Princeton Univ Press, Princeton), pp 472.
- 10 Sarrazin F, Lecomte J (2016) Evolution in the Anthropocene. *Science* 351(6276):922–923.

^aDepartment of Geography and Environmental Systems, University of Maryland Baltimore County, Baltimore, MD 21250; ^bDepartment of Environmental Science and Policy, University of California, Davis, CA 95616; ^cHuman Biological and Cultural Evolution Group, Department of Biosciences, University of Exeter, Penryn TR10 9FE, United Kingdom; ^dSection for Ecoinformatics & Biodiversity, Department of Bioscience, Aarhus University, DK-8000 Aarhus C, Denmark; ^eMansfield College, University of Oxford, Oxford OX1 3TF, United Kingdom; and ^fNational Socio-Environmental Synthesis Center, Annapolis, MD 21401

Author contributions: E.C.E., P.J.R., A.M., J.-C.S., J.O.-S., and W.R.B. wrote the paper.

The authors declare no conflict of interest.

¹To whom correspondence should be addressed. Email: ece@umbc.edu.