

Reply to Smith: On distinguishing between models, hypotheses, and theoretical frameworks

We are pleased to learn that our paper has stimulated further discussion of these important issues. However, we wish to clarify our position on several of the points mentioned in Smith's letter (1).

- i) We do not apply the label "particularism" as broadly as Smith claims, nor do we find fault with the "vast majority" of recent work on agricultural origins (OA) (1). We used the term particularism not as an exercise in taxonomy, but to acknowledge parallels with earlier trends in anthropology. We make no claim that optimal foraging theory (OFT) is the only alternative to particularism, and we explicitly identify other useful theoretical frameworks (2).
- ii) We disagree with Smith's claim that OFT and the diet breadth model (DBM) have "failed to produce any compelling regional-scale explanations of OA." We contend that Southwest Asia is just such an example. When empirical archaeological and paleoecological data are seriously considered (2), it becomes clear that the "deconstruction" of the DBM in Southwest Asia (3) falls far short of being "devastating." We also disagree that failure of the DBM to generate accurate predictions in a given case (such as eastern North America) is evidence that the model is without value. On the contrary, it performed well in guiding research away from an efficiency-maximizing explanation for OA in this region.
- iii) Smith's use of terminology (OFT/DBM) indicates that he incorrectly conflates two distinct phenomena. The DBM is one

model developed within OFT, and the two should not be lumped together. Neither is "explicitly antithetical" to niche construction theory (NCT) and neither is an explanation on its own. OFT and NCT are complementary frameworks for understanding behavior in an evolutionary context.

- iv) It makes little sense to claim that, compared with OFT, NCT is a "better match to empirical data sets." Even if this generalization was correct, it would mean that NCT was a more useful framework for a specific case, not that OFT is in some way incorrect. We suggest, however, that many evolutionary processes (including many OA case studies) might be best understood by integrating the logic of OFT and NCT rather than viewing them as independent and opposing pillars of theory (see ref. 4 for a relevant example).
- v) We agree that NCT does make an explicit connection between environmental modification and "evolutionary advantage" as described by Smith (5). We do not, however, think that NCT will reach its full potential without developing and testing hypotheses that spell out the nature of this evolutionary advantage in specific cases. Doing so will entail defining terms such as "resource rich," specifying why certain ecological interventions are fitness-enhancing, attempting to understand why some practices are retained and others abandoned, and acknowledging that NC can have negative consequences for resource reliability and predictability. Only

then will NCT be based on a "solid general theory for human behavior" (1).

Smith's prediction of OFT's demise is at best premature. In all likelihood, OFT will continue to contribute to OA research, as well as to diverse disciplinary efforts outside of archaeology (see ref. 2).

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- 1** Smith BD (2014) Failure of optimal foraging theory to appeal to researchers working on the origins of agriculture worldwide. *Proc Natl Acad Sci USA* 111:E2829.
 - 2** Gremillion KJ, Barton L, Piperno DR (2014) Particularism and the retreat from theory in the archaeology of agricultural origins. *Proc Natl Acad Sci USA* 111(17):6171–6177.
 - 3** Zeder MA (2012) The broad spectrum revolution at 40: Resource diversity, intensification, and an alternative to optimal foraging explanations. *J Anthropol Archaeol* 31(3):241–264.
 - 4** Broughton JM, Cannon MD, Bartelink EJ (2010) Evolutionary ecology, resource depression, and niche construction theory: Applications to central California hunter-gatherers and Mimbres-Mogollon agriculturalists. *J Archaeol Method Theory* 17(4): 371–421.
 - 5** Smith BD (2011) A cultural niche construction theory of initial domestication. *Biol Theory* 6(3):260–271.

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The authors declare no conflict of interest.

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