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## Frontiers of Biogeography

### Title

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### Permalink

<https://escholarship.org/uc/item/5346n7cj>

### Journal

Frontiers of Biogeography, 7(4)

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### Publication Date

2015

### DOI

10.21425/F5FBG28533

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## Range shifts are part of domestication

Domestication depends upon changes in geographic range. It typically includes the genetic separation of what will become a useful and dependent taxon from its ancestral species. Larson and Fuller (2014) summarized current knowledge about the timing of these events for 32 animal species, including accompanying behavioral changes. They utilized Zeder's (2012) three-way scheme, associating, for example, dogs and chicken with (1) a commensal pathway, whereby synanthropes become habituated and eventually domesticated; cattle and pigs with (2) a prey pathway wherein overexploited game are managed; and (3) directed domestication, for example with horses and various pets. They concluded that more than one independent initial domestication is rare, and that much of later diversification is due to what they label as "introgressive capture." However, by stressing the temporal dimensions and restricting attention to only the first stage of domestication, they exclude many processes from consideration that resulted in domesticated taxa. The origins of those taxa are of interest, but so also are the processes leading to their diversification and utilization. Here I suggest that the missing spatial dimensions may be usefully reincorporated into the study of domestication by clarifying the role of range shifts (e.g., Gaston 2003) in the historical events that happened, and in respect to the various processes involved. Doing so, could bring biogeography to the fore in the study of domestication.

Range shifts are arguably associated with every case of successful domestication. People carrying seeds or a few individuals of an animal deemed useful to a new environment allows for ecological release. Exposure to natural pests and predators is minimized, especially if the distance moved is outside the distributions of those other species. The human actions of gardening, weeding, and enclosing for plants or nursing and training for animals may provide the equivalent of ecological release even when actual physical displacement has not taken place. This sequence of events would then facilitate human-mediated manipula-

tions that result in the further taming of animals and the detoxification of plants. Because the range-shifted taxa are separated from the influence of native biota, it would be expected that mutualistic specialists would not be among potential domesticates.

Typically, the species range shifts would cause a human-induced genetic bottleneck, as only some of the genetic diversity of the original taxon is moved. There might then be strong directional selection acting upon the remaining alleles, resulting in ecotypic separation along environmental gradients. Depending on the degree to which continued introgression with the wild ancestor occurs, further genetic and physiological changes may be relatively rapid or prolonged over several centuries (Hufford et al. 2012, Hedrick 2015). This is the stage of domestication when artificial selection can be particularly effective, with humans making conscious decisions to select seeds or offspring with preferred traits, for example with increased productivity and edibility of plants (Abbo et al. 2012), and increased sociality and capacity for tolerating crowded conditions in animals (Wang et al. 2014). The end result has been hundreds of plant varieties and animal breeds, many of which are threatened by modernization and globalization.

This agrobiodiversity originates from the range shifting done by people, accompanied by artificial selection carried out at all life stages of the plants and animals. Overlooking this aspect of domestication results in a search for origins without an equal emphasis on the diversification processes that are crucial for both conservation and utilization of genetic resources.

The movement of humans around the world, their interactions with native biota, and the resulting transformation of Earth's land surfaces were all facilitated by the introductions of useful species. Humans transported their needed tools and materials during their various diaspora. The capacity for movement of themselves, their belongings, and their knowledge may be considered important parts of the human ecological niche,

which in turn makes domestication part of how humans act upon the biosphere. Niche construction theory (Smith 2015) proposes that the innate capacities of modern humans include acting as ecosystem engineers, changing Earth surface processes and altering evolutionary forces (Ellis 2015).

Range shifting can be intentional on the part of people, but can also be inadvertent, as seen in the widespread distributions of weeds and insect pests. It may be global in extent now, but many of the associated processes played out during earlier times at much smaller spatial extents, affecting individual plants within particular fields for example, or altering gene flows in relationship to decisions made by groups of neighboring farmers or pastoralists (Gepts et al. 2012). Nowadays there are many important cross-scale interactions also, for example with breeder and farmer decisions being shaped in response to information shared across the internet or through mass media (Young 2007).

Biogeography could be combined with domestication studies by connecting theory on species distributions with landscape genetics, as informed by the histories of movement of useful species. In some ways, this perspective harks back to historical syntheses (e.g., Sauer 1952) that emphasized the importance of dispersal in considering useful plants and animals. It adds additional questions about domestication to those suggested by Zeder (2015), broadening the ways that biogeographers could participate in related research. For example, it makes the spatial dimensions central to the examination of genetic and population processes that act through both natural and artificial selection, and that create used and useful biodiversity. The legacies of domestication include the environmental consequences of these changes in species distributions, which in turn allow for a better understanding of the processes involved in ecological and evolutionary diversification in the Anthropocene.

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## References

- Abbo, S., Lev-Yadun, S. & Gopher, A. (2012) Plant domestication and crop evolution in the Near East: on events and processes. *Critical Reviews in Plant Science*, 31, 241–257.
- Ellis, E.C. (2015) Ecology in an anthropogenic biosphere. *Ecological Monographs*, 85, 287–331.
- Gaston, K.J. (2003) The structure and dynamics of geographic ranges. Oxford University Press, Oxford.
- Gepts, P., Famula, T.R., Bettinger, R.L., Brush, S. B., Damania, A.B., McGuire, P.E. & Qualset, C.O., eds. (2012) Biodiversity in agriculture: domestication, evolution, and sustainability. Cambridge University Press, Cambridge.
- Hufford, M.B., Xu X., van Heerwaarden J., et al. (2012) Comparative population genomics of maize domestication and improvement. *Nature Genetics*, 44, 808–811.
- Hedrick, P.W. (2015) Heterozygote advantage: The effect of artificial selection in livestock and pets. *Journal of Heredity*, 106, 141–154.
- Larson, G. & Fuller, D.Q. (2014) The evolution of animal domestication. *Annual Review of Ecology, Evolution, and Systematics* 45, 115–136.
- Sauer, C.O. (1952) Agricultural origins and dispersals. American Geographical Society, New York.
- Smith, B.D. (2015) A comparison of niche construction theory and diet breadth models as explanatory frameworks for the initial domestication of plants and animals. *Journal of Archaeological Research*, 23, 215–262.
- Wang, G.-D., Xie, H.-B., Peng, M.-S., Irwin, D. & Zhang, Y.-P. (2014) Domestication genomics: Evidence from animals. *Annual Review of Animal Bioscience*, 2, 65–84.
- Young, K.R. (2007) Causality of current environmental change in tropical landscapes. *Geography Compass*, 1, 1299–1314.
- Zeder, M.A. (2012) Pathways to animal domestication. In: Biodiversity in agriculture: domestication, evolution, and sustainability (ed. by P. Gepts, T.R. Famula, R.L. Bettinger, S.B. Brush, A.B. Damania, P.E. McGuire & C.O. Qualset), pp. 227–259. Cambridge University Press, Cambridge.
- Zeder, M.A. (2015) Core questions in domestication research. *Proceedings of the National Academy of Sciences*, 112, 3191–3198.

Submitted: 28 August 2015

First decision: 14 October 2015

Accepted: 17 November 2015

Edited by Jessica Blois