ESA abstract

Title: What can spatial and phylogenetic patterns tell us about how ideas and technology spread through space and time?

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Intro/methods (200 words)

A long-standing debate continues between two competing hypotheses for how the domestication of plants and animals (agriculture) spread across the globe. Diffusion hypotheses suggest that the ideas and technology necessary for agriculture were shared between neighboring societies, while takeover hypotheses suggest agriculture spread through the forceful displacement of neighboring societies. The debate between these two hypotheses remains unsettled because previous efforts to disentangle these mechanisms have relied on subjective interpretations of historical texts and society specific archeological data alone. We go beyond those limited data and distinguish between these competing hypotheses using the quantitative tools of spatial ecology, phylogenetic methods, niche reconstruction, and machine learning.

We test these two hypotheses by comparing the spatial and phylogenetic distribution of known human cultures against 4 types of simulated spatial and phylogenetic models using different mechanisms of idea transmission: inheritance only, inheritance plus diffusion, inheritance plus takeover, or inheritance plus both diffusion and takeover. We calculated 11 highly-targeted phylogenetic and spatial statistics from more than 100k replicate simulations for each of those four models. A random forest machine-learning algorithm used those summary statistics to classify the one know human cultural history as coming from one of those modeled mechanisms. The output from these analyses is a frequency distribution of the number of times the random forest classified the know human history as each of the model types.

Results/conclusion (200 words)

Result show that diffusion was the most likely mode of transmission for the spread of agriculture with the inheritance only model as the most likely second choice. The random forest algorithm most frequently categorized the known human phylogeny as coming from a diffusion simulation and rarely categorized the known history as having come from a takeover or takeover plus diffusion model. The realized history was often categorized as inheritance only rather than diffusion but the difference between the inheritance only and the diffusion model were significant. Of the 11 summary statistics, both spatial and phylogenetic statistics were equally important to classifying the realized history.

The conclusions that can be drawn from this work are that (1) agriculture likely spread through sharing of information between neighbors rather than agriculturalists forcefully displacing their neighbors during expansion and that (2) it took both spatial and phylogenetic information to draw that conclusion. The similarity between the inheritance only model and the inheritance plus diffusion model demonstrates the subtlety between information and technology transmission modes; showing that a great deal of cultural information is transmitted by inheritance, and so the signal from horizontal transmission of ideas between neighbors must be strong to stand out against that background of inheritance.