Dynamical kinds and ecological theory

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Abstract

Ecology has a theory problem. On the one hand, fine-scale models that attempt to capture detailed causal interactions tend to be analytically intractable and sui generis. On the other, tractable theories with broad scope are viewed with suspicion. This is a consequence both of the assumption that a model should be tested by checking whether time-series data can be fit to one of its solutions and the fact that a typical experimental trajectory is statistically indistinguishable from the solutions of multiple candidate models which assert very different things about ecological dynamics. I argue for an ontological view with methodological consequences that circumvents this intolerable underdetermination. When we assert that behavior of a biological system is governed by a particular set of equations, we are asserting the existence of a dynamical kind-a class of causal systems bearing a characteristic set of features. In this paper, I sketch an account in which dynamical kinds are defined via sets of dynamical symmetries-transformations of the variables that leave intact the way in which states unfold through time-and the algebraic structure connecting them. I then demonstrate the immediate methodological gains that arise from adopting this view of model identification. In particular, I show how models of population growth which are statistically indistinguishable under the old approach can be readily discerned by their behavior under applied dynamical symmetries. In the case of growth models, this can be done with strictly observational data of the sort we already possess for a number of organisms.

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