
Variability and structural stability of ecosystems: two sides of the same coin

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Abstract

A community of interacting species can reach an equilibrium only if the latter is stable, implying that it can sustain small perturbations. Different measures of stability exist relating to the response of ecosystems to different types of perturbations. Dynamical stability deals with external perturbations. For instance, invariability, commonly used in empirical studies, quantifies the response to persistent environmental fluctuations. On the other hand, structural stability answers "how far is the ecosystem from instability?", and quantifies the intensity of internal perturbations (e.g. of interaction rates) that can render the equilibrium unstable. Here, using linear stochastic differential equations, we show that structural stability coincides with invariability, revealing a fundamental link between empirical approaches to stability and the abstract notion of structural stability. For comparable intensity of environmental fluctuations, the less variable the community, the more robust it must be to stochastic fluctuations of its internal structure.

Keywords: community dynamics, equilibrium, external perturbations, internal perturbations, white noise

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