

Ecological significance of imperfectly synchronized collective behaviors

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How the coexistence of many species is maintained is a fundamental and unanswered question in ecology. Coexistence is a puzzle because we lack a quantitative understanding of the variation in species presence and abundance. Whether variation in ecological communities is driven by deterministic or random processes is one of the most controversial issues in ecology. I will consider the variation of species presence and abundance in microbial communities from a macroecological standpoint. We identify three novel, fundamental, and universal macroecological laws that characterize the fluctuation of species abundance across communities and over time. These three laws — in addition to predicting the presence and absence of species, diversity and other commonly studied macroecological patterns — allow testing mechanistic models and general theories aiming at describing the fundamental processes shaping microbial community composition and dynamics. I will conclude by showing that a mathematical model based on environmental stochasticity quantitatively predicts the three macroecological laws, as well as non-stationary properties of community dynamics.