Interplay of structured and random interactions in many-species ecological dynamics

Juan Giral Martinez[1], Jean-François Arnoldi[2], Silvia De Monte[1], and Matthieu Barbier*[3]

[1]Institut de biologie de l'ENS Paris – Département de Biologie - ENS Paris, Institut National de la Santé et de la Recherche Médicale, Centre National de la Recherche Scientifique – France
[2]CNRS – CNRS, CNRS : UMR8568, CNRS, CNRS : UMR6074, CNRS, CNRS : UMR5593, CNRS : ERL3189, CNRS : UMR7104, CNRS : UMR5244, CNRS : UMR2205, CNRS : UPR8241, CNRS, CNRS : UMR5554, CNRS : UMR5274, CNRS : UMR5493, CNRS : UMR7199, CNRS : UMR8184, CNRS : UMR7141, CNRS : UMR5251, CNRS : UMRTemps8066, CNRS : FR550, CNRS : UMR5127, CNRS : UMRSETEMoulis, CNRS : UMR9189 – France
[3]CIRAD – CIRAD, CIRAD, CIRAD – France

Résumé

A growing body of 'disordered systems' theory investigates minimal ecosystem models with random interactions, where simple statistics suffice to predict dynamical outcomes and macroecological patterns. However, interaction networks commonly possess large-scale structures, such as hierarchies or functional groups, that have also been used to explain community-level patterns. Here, we ask which results from random interaction models can be expected to be fragile or robust to the presence of such large-scale network structures. We consider a simple superposition of structured and random interactions in a classic population dynamics model, and study its impact on macroscopic observables, abundance distributions and dynamical regimes. Randomness and structure combine in a surprisingly yet deceptively straightforward way: the studied patterns can almost be partitioned into contributions from each of these two components, and yet even this minimal interplay can lead to non-trivial effects, such as randomness stabilizing dynamical fluctuations that would have arisen from fully structured interactions. We conclude that whether interaction structure matters or not depends on which patterns we are testing for its consequences: we expect the phenomenology associated with random interactions to be less robust in static patterns of species presence and abundance, and more robust in the nature of dynamical regimes.

Mots-Clés: community assembly, dynamical regimes, statistical mechanics, disordered systems, network structures

*Intervenant