

## A mechanism for metacommunity-scale biodiversity regulation

*Thursday, 12 July 2018 15:00 (30 minutes)*

There exists a growing body of empirical evidence that suggests biodiversity regulation – the emergence of dynamic equilibrium diversity – may be a common or even general feature of ecosystems. However a mechanistic understanding of what tends to constrain diversity in nature remains elusive. Here we introduce a metacommunity assembly model in which regional diversity converges on dynamic equilibria, despite continuous species turnover (temporal  $\beta$ -diversity). We build on previous theoretical studies of local biodiversity regulation by arguing that the mechanism controlling these temporal diversity patterns is the loss of Ecological Structural Stability – a diversity dependent measure of the sensitivity of an ecological assemblage to perturbation. As the limit of structural stability is approached, macroecological patterns characteristic of natural assemblages emerge in model metacommunities. In particular, the species abundance distribution, range size distribution, species co-occurrence profile, and species area relation all match patterns observed robustly in the field. These results suggest that structural instability is an important macroecological organising principle.

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**Session Classification:** Feasibility and stability properties of complex ecological networks: New perspectives

**Track Classification:** Minisymposium: Feasibility and stability properties of complex ecological networks: New perspectives