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# Multiscale metapopulation modeling sheds new light on a basic law of island biogeography

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## Abstract

A major pattern in macroecology and biogeography is the power-law relationship between species richness and sampled area. In the context of island biogeography, where the area represent the island sizes in an archipelago, this relationship can be explained by a balance between immigration from a continent and extinction of species within the island. However, the rationale to explain the relationship has remained quite conceptual, and there is no actual mathematical model of population and metapopulation dynamics supporting the pattern. Furthermore, there is still a debate about the actual shape of the relationship, as some data appeared to be not supportive of a power-law.

Here we propose a multiscale metapopulation model with two components: long-distance dispersal from a source continent (where species never go extinct), and within-island colonization-extinction dynamics, depending on the amount of available habitat within the island. We generalize this model to investigate the dynamics of multiple species, and we derive analytical and numerical patterns of species richness and frequency within the islands. We show that the power law emerges as a consequence of these dynamics, yet for a limited range of the model parameter values. We explore the diversity of species-area relationships with this model, and discuss which novel insights can be derived for both theoretical and applied ecology.

**Keywords:** Island biogeography, species richness

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