

Ryan Chisholm

SMITHSONIAN TROPICAL RESEARCH INSTITUTE

e-mail: ryan.chis@gmail.com

A theoretical model linking interspecific variation in density dependence to species abundances

Understanding the factors that govern the commonness and rarity of individual species is a central challenge in community ecology. Empirical studies have often found that abundance is related to traits associated with competitive ability and suitability to the local environment, and more recently also to negative conspecific density dependence. Here, we construct a theoretical framework to show how a species abundance is in general expected to be dependent on its per-capita growth rate when rare and the rate at which its growth rate declines with increasing abundance (strength of stabilization). We argue that per-capita growth rate when rare can be interpreted as competitive ability and that strength of stabilization largely reflects negative conspecific inhibition. We then analyze a simple spatially implicit model in which each species is defined by three parameters that affect its juvenile survival: its generalized competitive effect on others, its generalized response to competition, and an additional negative effect on conspecifics. This model facilitates the stable coexistence of an arbitrarily large number of species and qualitatively reproduces empirical relationships between abundance, competitive ability and negative conspecific density dependence. Our results provide theoretical support for the combined roles of competitive ability and negative density dependence in the determination of species abundances in real ecosystems, and suggest new avenues of research for understanding abundance in models and in real communities.