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Degree of interactions essentially change relative species abundance

In community ecology, the relation between diversity, stability and species abundance patterns (SAP) has been discussed as one of the “unanswered questions in ecology in the last century” [1]. In special, theoretical understanding of SAP for a system in a single trophic level has been greatly progressed in the last decade, based on Hubbell’s neutral theory [2, 3]. Meanwhile, for more complex systems occurring on multiple trophic levels and including non-neutral species with various types of interspecies interactions among them, a pioneering work by May [4], which triggered a controversial debate between the diversity and stability [5], has demonstrated efficacy of a linear analysis and the theory of random matrices. Beyond the linear model, statistical mechanics have been employed for analyzing nonlinear models and have provided global and quantitative information for diversity, stability and SAP [6, 7, 8, 9, 10]. While we have clarified relationships among the strength of the intraspecific competition, asymmetry of interspecies interactions and SAP for a system with fully-connected interactions [9]; we present that sparse interactions essentially change SAP and it reveals multiple peaks which have been observed in several experimental data [11, 12, 13] but was not demonstrated theoretically. Sparseness of the interspecies interactions, moreover, gives novel non-monotonic dependence of diversity on the ratio of mutualistic interactions, suggesting that the mutualism is not a simple factor for species coexistence in a system with sparse interactions. Since the present theory is based on the general replicator dynamics [14], the theoretical prediction can be verified not only in ecology but also in population genetics, game theory, chemical reaction networks, gene regulatory networks and evolution of grammar, etc., and the significance of sparse and mutualistic interactions may give a broad impact on those areas.

REFERENCES