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Dynamics of within-population structure stabilise complex ecological communities

While ecological communities are diverse and complex, what mechanisms underly their stability and persistence has been a theoretical enigma for almost half a century. Theory predicts that complex communities are only stable when most species are limited by strong self-regulation, such that an increase in species abundance translates into an immediate decrease in its own growth rate. This diversity-stability paradox emerges from ecological theory that focuses on the topology of the interaction network between species and the strength of their population-level interactions, while neglecting any within-population differences among individuals. Here I show using simulations of model food webs that differences in foraging efficiency and vulnerability to predation between juvenile and adult individuals of the same species result in diverse communities persisting on a single basal species. The juvenile-adult asymmetry in foraging and vulnerability results in highly connected ecological networks, including 10 times more species than networks resulting from simulations without within-population structure or without juvenile-adult asymmetry. Even the most diverse communities are stable or exhibit abundance fluctuations with limited amplitude, despite that only the basal species is self-regulated. Eigenvalue analysis reveals that community stability results from dynamic changes in within-population stage-structure with changes in food availability rather than the within-population structure per se. These dynamics even override destabilising effects induced by the topological aspects of the species interaction network. Differences between juvenile and adult individuals and fluctuations in their relative abundance are therefore a natural and ubiquitous mechanism stabilising complex ecological communities and promoting their persistence.