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Environmental quality modulates the cooperative and competitive nature of a microbial cross-feeding mutualism TIM HOEK, CSnD Master Program, University Utrecht, Utrecht, The Netherlands, KEVIN AXELROD, Biophysics PhD Program, Harvard University, Cambridge, MA, EUGENE YURTSEV, JEFF GORE, Physics of Living Systems, Department of Physics, Massachusetts Institute of Technology, Cambridge, MA — Mutualisms are essential for ecosystem function and stability. However, in some environments the competitive aspects of an interaction may dominate the mutualistic aspects. Although these transitions could have far-reaching implications, it has been difficult to study the causes and consequences of this mutualistic-competitive transition in experimentally tractable systems. Here we experimentally study a microbial cross-feeding mutualism in which each yeast strain supplies an essential amino acid for its partner strain. We find that, depending upon the amino acid concentration, this pair of strains can exhibit any of: obligatory mutualism, facultative mutualism, competition, parasitism, competitive exclusion, or failed mutualism leading to extinction of the population. A simple model capturing the essential features of this interaction predicts that environmental quality specifies the outcome and provides a "phase diagram" of net interactions in this mutualism. In addition, the model accurately predicts that changes in the dynamics of the mutualism in deteriorating environments can predict that population collapse is imminent. Our results provide a general framework for how mutualisms may transition between qualitatively different regimes of interaction.

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