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Coral disease dynamics under environmental change

Reef-building corals have experienced significant declines in recent years due to temperature-induced bleaching events and disease outbreaks. Here, we use a series of spatially-implicit mathematical models to understand how coral-microbial interactions mediate the effects of such environmental change. First, we show the existence of reciprocal feedbacks between coral genetic diversity and disease outbreaks when a tradeoff exists between growth and susceptibility to infection. Under low disease-induced mortality (virulence), genetic diversity amplifies (dilutes) disease outbreaks when transmission is high (low). Amplification occurs when high transmission and low virulence allow the fixation of susceptible but fast-growing genotypes because infected corals occupy patches for a long time and thus make it harder for resistant but slow-growing genotypes to colonize empty patches. Conversely, dilution occurs when low transmission and virulence lead to the fixation of resistant but slow-growing genotypes because there are fewer infected corals and thus more empty patches available.

Next, we show that coral-microbial systems can persist in the face of environmental change via a form of 'extended evolutionary rescue'. Under this scenario, environmental change both decreases coral abundance and destabilizes the dynamics of coral-microbial (meta)communities by inducing high-amplitude limit cycles, which increase the risk of stochastic extinction. However, microbial competition within diverse communities leads to a form of 'ecological rescue' whereby corals maintain higher abundances and experience stable dynamics under environmental change.

Overall, these results suggest that coral-microbial interactions are critical for predicting the effects of environmental change and devising management strategies to ensure the persistence of these important ecosystems.