Evolutionary adaptation of regulation in variable environments

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DEMONSTRATING the evolutionary adaptation of cellular regulation is a challenge as it depends on environmental variability, the molecular processes that underlie regulation and fitness, and genetic constraints. To disentangle these diverse factors, we engineered a minimal synthetic microbial system and systematically mapped the relations between plasticity, fitness, and environmental variability. We found that at higher amplitudes of the environmental variations, the fitness of non-plastic generalists decreased sharply resulting in an increased selective advantage of plasticity. We demonstrated the adaptation towards novel responses in accordance with the predicted fitness landscape, and identified local genetic constraints and epistasis that determined the evolutionary dynamics. These results provide a step toward understanding the generic mechanisms of evolution in complex environments throughout all levels of biological organization.