

# Privatisation of public goods can cause population collapse

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Microbes have evolved to deploy a risky strategy to acquire nutrients from their environment. It involves the production of public goods that are costly to produce but can be exploited by neighbouring individuals that share the environment. Why has this metabolic strategy evolved and persisted when a failsafe, exploitation-free alternative is readily available whereby public goods are kept private? We addressed this question by examining metabolism of the yeast *Saccharomyces cerevisiae*, both in its native form and with a three-strain synthetic community deploying different strategies to metabolise sucrose. Public-metabolisers digest resources externally by secreting invertase, private-metabolisers internalise resources through sucrose transporters before digestion, and cheats avoid the metabolic costs of digestion and exploit the external products that are generated by other competitors. Using a combination of mathematical modelling and eco-evolutionary experiments, we found that private-metabolisers can invade and takeover an otherwise stable community of public-metabolisers and cheats. However, private-metabolisers experience a reduced growth rate, which when coupled with population bottlenecks, that are frequently associated with microbial communities, meant that privatising public goods can become unsustainable and resulted in population collapse. We, therefore, identified that the evolution of either of the opposing metabolic strategies can be promoted depending on the environmental conditions and interactions between members of the population.