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QUANTIFYING FITNESS IN A PUBLIC GOODS GAME

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The conditions favouring co-operation is one of the central problems in evolutionary biology. Hamiltonian framework is often used to explain when co-operation might or might not be favoured. However due to the difficulty associated with calculating the relevant parameters, it is difficult to use this approach to make quantitative predictions. Given advances in systems biology in yeast we propose that a next-generation quantitative modelling approach for studying evolution of cooperation may now be feasible. Here we put forward a model approach that brings together systems biology and population genetics. Then we ask whether this model can make accurate quantitative predictions of fitness in a public goods game. Our system consist of two yeast strains, with only one strain secreting the enzyme invertase to catalyze the hydrolysis of the sucrose into glucose, the prefer carbon source of yeast. We use prior data on the biochemistry of the two yeast strains to parametrise the mathematical model and make numerous predictions regarding both absolute and relative fitness of invertase producers and non-producers under a variety of spatially structured experimental environments. Subsequently by performing experiments we show that the model has both strong qualitative and quantitative accuracy. While Hamilton's rule has enormous impact in enabling predictions of general trends, we here show that an alternative framework can provide a next generation model that is suitable for quantitation of co-operation.