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Mixed Strategies, Evolution and the Tragedy of the Commons in Heterogeneous Populations

The question of sustainability and prevention of the tragedy of the commons, also known as evolutionary suicide, which occurs when extremely efficient consumers exhaust the common resource and eventually harm themselves, is becoming of vital importance in the modern world. In order to investigate it we consider a situation, when consumers can choose different strategies for resource consumption in different proportion, investing primarily in consumption or in sustaining the resource. This is modeled by an infinitely-dimensional system of ODEs, which is then reduced to a finitely-dimensional system using parameter distribution. The population of consumers is then allowed to evolve over time, and the changes in the frequency of different strategies are tracked through changes in the expected value of the parameter that describes the choice of a strategy. We demonstrate that under different parameter values different strategies predominate, leading to either sustained interaction with the resources, or to population extinction, which occurs after a series of transitional regimes.