Evolution of Cooperation towards higher Complexity

Francisco Dionísio[1] and Isabel Gordo[2]
[1]Departamento de Biologia Vegetal da Faculdade de Ciências da Universidade de Lisboa, 1149-016 Portugal
[2]Instituto Gulbenkian de Ciência, 2781-901 Portugal

Abstract

Background: A tragedy of the commons arises if individuals cannot protect their future use of a depletable resource and individual fitness rises if individuals exploit the resource at rates beyond sustainability. Natural selection then forces the individuals to diminish, perhaps even to destroy, their resource. One way to protect future use is privatization, i.e., locally excluding rivals from the resource. Another is to reduce rivalry among individuals by restricting exploitation rates.

Questions: Under what conditions will natural selection increase excludability? If relatedness among individuals is high, will kin selection be enough to eliminate or weaken the evolution of privatization?

Mathematical Method: We use a simple model that captures the tension between individual and group success. Then, we calculate the evolutionarily stable strategy using the standard optimization techniques of evolutionary game theory.

Conclusions: Selection for privatization occurs at low values of relatedness. The conditions for this to occur resemble those previously obtained for the reduction of rivalry because non-excludability of damage, and not rivalry per se, is the fundamental cause of the tragedy of the commons.