Interacting mutations promote diversity

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Genetic diversity arises through the interplay of mutation, selection and genetic drift. In most scientific models, mutants have a fitness value which remains constant throughout. Based on this value, they compete with other types in the population and either die out or become established. However, evolutionary game theory considers constant fitness values to be a special case. It holds that the fitness of a mutation also depends on the frequency of the mutation.

Scientists from the Max Planck Institute for Evolutionary Biology in Plön and the University of British Columbia in Vancouver developed a model to address the scenario of mutations being frequency-dependent but having random fitness parameters. The results demonstrate that the dynamics that arise in random mutants increase the genetic diversity within a population. Fitness, though, may even decline.

Population geneticists generally study mutations with constant fitness values. However, frequency-dependent selection is a recurrent theme in evolution: it enables the evolution of new species without geographical separation (sympatric speciation) or a relatively rapid change in the immune system of a population.

A mutation may be advantageous for low frequencies, for instance, but the fitness of the mutant decreases with rising frequency. A reverse trend in the fitness value is also conceivable. "Our computer model combines aspects of population genetics and evolutionary game theory in order to obtain a new perspective on genetic evolution," says Arne Traulsen from the Max Planck Institute for Evolutionary Biology.

Whereas mutations have a random yet fixed fitness value in many mathematical models, this new model also enables a change in random fitness values with the frequency of the different types.

The results of the simulations show that frequency-dependent selection leads to higher genetic diversity within a population of individuals even though diversity per se is not favoured. The interaction of different mutations and the emergence of new mutants support the development of dynamic diversity in the population. One mutant does not always need to replace all other mutations or the original population. "It is possible for different mutations to exist in parallel such that a new mutant does not to completely replace the residents," says Weini Huang, lead author of the study. What is particularly interesting is the fact that diversity in this model remains naturally limited.

Fitness, on the other hand, does not necessarily rise with frequency-dependent selection in contrast to constant selection. By way of example, a mutation may arise within cells which halts the production of substances that are passed on to other cells. This can initially be advantageous; however, if it reaches fixation, the average fitness of the cell population declines. Advantageous mutations can thereby be lost and deleterious ones become established.

More information: Huang, Haubold, Hauert & Traulsen, Emergence of stable polymorphisms driven by evolutionary games between mutants, *Nature Communications*, June 26, 2012, DOI:10.1038/ncomms1930

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