Evolution of Recombination on an HIV-1 Derived Fitness Landscape

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Abstract

The maintenance of recombination is among the most important unsolved problems of evolutionary biology. The Hill-Robertson effect, which states that the interaction between genetic drift and selection generates unfavorable linkage disequilibria (hence favoring recombination), offers one of the most promising hypotheses to solve this problem. In particular, it has been argued that this hypothesis works independently of epistatic interactions. However, this result has been derived on the basis of smooth fitness landscapes, which may be unrealistic (Otto and Feldman (1997)). We estimated the fitness effects of 1'857 single mutations and of 257'536 pairs of mutations found in a 60'000 HIV-1 B pol-genotypes assayed for in vitro replication capacity (Hinkley et al. (2010)) to develop a reasonably realistic model of a fitness landscape on which we run a genetic algorithm to mimic the evolution of HIV populations. By adding a recombination rate modifier to the genome, we address the question of whether genetic drift outweighs epistasis as a factor for the evolutionary maintenance of recombination in the case of the fitness landscape of our model. Despite the fairly rugged nature of the fitness landscape, which could be characterized by the presence of a large number of local optima, we find that recombination is robustly favored in finite populations. This result suggests that the Hill-Robertson effect provides a powerful explanation for the evolutionary maintenance of recombination even if fitness landscapes are rugged.

References

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