Reciprocal sign epistasis and truncation selection: when is recombination favorable?

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Keywords: reciprocal sign epistasis, recombination, truncation selection, bistability

Abstract: In this study we sought to determine conditions in which a genotype of interest could be fixed when truncation selection is applied on an epistatic trait. This type of selection is especially used in varietal breeding; in nature, strict truncation is unlikely, but quasi-truncation may appear in resource-limited species. Previous works have shown that reciprocal sign epistasis with two fitness peaks of unequal height implies the existence of multiple stable stationary solutions. It means that above some critical values, one genotype may be fixed, and above them, another one may. Using a haploid bi-locus model in infinite populations, we could determine how recombination rate affects the evolution of a population selected by truncation for a phenotypic trait subject to reciprocal sign epistasis with unequal peak heights. These results were complemented by stochastic simulations in finite populations. For different initial states, we could determinate which genotype would be fixed, and how quickly, depending on two criteria: the recombination rate and the percentage of selected individuals. The critical parameters at which bistability sets in, were also calculated. Our results confirm that in the case of fitness displaying reciprocal sign epistasis, high recombination rates have a negative effect. Indeed, high rates of recombination induce getting stuck at the local optimum or reaching an equilibrium state between the two peaks. However if linkage disequilibrium is negative at departure, recombination is necessary to create the most favorable genotype. Thus, reciprocal sign epistasis therefore favors non null recombination rates when linkage disequilibrium is negative, in particularly if selection is intense.