Rare Genotype Advantage Encyclopedia Article

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Rare **genotype** advantage is the evolutionary theory that genotypes (e.g., the genes of a bacterium or parasite) that have been rare in the recent past should have particular advantages over common genotypes under certain conditions.

Rare genotype advantage can be best illustrated by a host-parasite interaction. Successful **parasites** are those carrying genotypes that allow them to infect the most common host genotype in a population. Thus, hosts with rare genotypes, those that do not allow for infection by the pathogen, have an advantage because they are less likely to become infected by the common-host pathogen genotypes. This advantage is transient, as the numbers of this genotype will increase along with the numbers of pathogens that infect this formerly rare host. The pattern then repeats. This idea is tightly linked to the so-called Red Queen Hypothesis first suggested in 1982 by evolutionary biologist Graham Bell (1949-) (so named after the Red Queen's famous remark to Alice in Lewis Carroll's *Through the Looking Glass:* "Now here, you see, you have to run as fast as you can to stay in the same place."). In other words, genetic variation represents an opportunity for hosts to produce offspring to which pathogens are not adapted. Then, sex, mutation, and genetic **recombination** provide a moving target for the **evolution** of virulence by pathogens. Thus, hosts continually change to stay one step ahead of their pathogens, likened to the Red Queen's quote.

This reasoning also works in favor of pathogens. An example can be derived from the use of **antibiotics** on bacterial populations. Bacterial genomes harbor genes conferring resistance to particular antibiotics. Bacterial populations tend to maintain a high level of variation of these genes, even when they seem to offer no particular advantage. The variation becomes critical, however, when the **bacteria** are first exposed to an antibiotic. Under those conditions, the high amount of variation increases the likelihood that there will be one rare genotype that will confer resistance to the new antibiotic. That genotype then offers a great advantage to those individuals. As a result, the bacteria with the rare genotype will survive and reproduce, and their genotype will become more common in future generations. Thus, the rare genotype had an advantage over the most common bacterial genotype, which was susceptible to the drug.