

Muller's ratchet in multigene families with gene conversion

Proposer: Alison Etheridge and Jay Taylor

Muller's ratchet is a model for the progressive loss of fitness in populations in which recombination is either absent or ineffective (e.g., because of inbreeding). Because mutations are more likely to be harmful than beneficial, most individuals will carry some number of deleterious mutations. Whereas recombination between individuals carrying different sets of harmful mutations can regenerate highly fit genomes in outcrossing populations, loss of the most fit classes of genomes will be effectively irreversible in a population in which recombination is suppressed. If unchecked, this process may facilitate genome deterioration, as observed in non-recombining sex chromosomes, organelle genomes, and some bacterial endosymbionts and parasites, and might ultimately lead to extinction.

It has recently been proposed that intergenic gene conversion may rescue gene families from the degenerative effects of the ratchet. Gene conversion is a process closely related to recombination which allows parts of one sequence to be copied to a second, similar sequence. Although meiotic conversion will be suppressed in inbreeding populations, conversion between similar genes which are present in multiple copies within the same genome can still occur and may repair 'broken' members of the family. Of course, because gene conversion can also increase the number of copies of a deleterious mutation, it has also been suggested that conversion may have no effect on, or even accelerate, Muller's ratchet.

The aim of this project will be to test these verbal accounts of the effect of the gene conversion on Muller's ratchet with explicit models. The initial step will be to simulate the ratchet in a two gene family with different rates of gene conversion and different modes of selection. We will also attempt to interpret these empirical results using simple heuristic models of the ratchet in a multigene family. This project would best suit a student with a keen interest in evolutionary genetics and good programming skills.

References:

- Graves, J. A. M. (2004) The degenerate Y chromosome - can conversion save it? *Reprod. Fertil. Dev.* 16: 527-534.
- Haigh, J. (1978) The Accumulation of Deleterious Genes in a Population - Muller's Ratchet. *Theor. Pop. Biol.* 14: 251-267.
- Khakhlova, O. and Bock, R. (2006) Elimination of deleterious mutations in plastid genomes by gene conversion. *The Plant Journal* 46: 85-94.
- Rispe, C. and Moran, N. A. (2000) Accumulation of Deleterious Mutations in Endosymbionts: Muller's Ratchet with Two Levels of Selection. *Am. Nat.* 156: 425-441.
- Rozen, S. et al. (2003) Abundant gene conversion between arms of palindromes in human and ape Y chromosomes. *Nature* 423: 873-876.