# HOMEWORK SET #3

*Due: Thursday, November 8*

1. Consider the following scenarios of one-locus selection with two alleles, $A$ and $a$ and selection coefficient $s = 0.1$ against $a$. The genetic basis of fitness is given for each scenario. In each case, compute $\Delta p$, the between-generation change in the frequency of $A$ for each of two initial frequencies: $p = 0.05$ and $p = 0.9$.
   (a) haploid ($w_A = 1$, $w_a = 1 - s$)
   (b) diploid; $A$ dominant advantageous
   (c) diploid; $A$ recessive advantageous
   (d) diploid; $A$ advantageous and partially dominant with $h = 0.4$
   (e) Using your results, briefly discuss how the individual and population genetic architectures of fitness affect rates of adaptive evolution.

2. Consider a locus with alleles $A$ and $a$ at frequencies $p = 0.7$ and $q = 0.3$ respectively. Assume that prior to selection (i.e., in the zygote stage) the population is in Hardy-Weinberg proportions.
   • First consider "additive" fitnesses, i.e., $w_{AA} : w_{Aa} : w_{aa} = 1 : 1 - (s/2) : 1 - s$ .
   (a) Assuming $s = 0.2$, compute $P^*_{AA}$, $P^*_{Aa}$, and $P^*_{aa}$, the genotype frequencies after selection but before reproduction. Carry out your calculations to 4 or 5 decimal places.
   (b) Show that $P^*_{AA}$, $P^*_{Aa}$, $P^*_{aa}$ are not in Hardy-Weinberg proportions.
   • Now consider "multiplicative" fitnesses, i.e., $w_{AA} : w_{Aa} : w_{aa} = 1 : 1 - s : (1 - s)^2$.
   (c) Redo part (a) using multiplicative fitnesses.
   (d) Show that the post-selection genotype frequencies ($P^*_{AA}$, $P^*_{Aa}$, $P^*_{aa}$) are *exactly* in Hardy-Weinberg proportions.
   (e) Explain why failure to reject the Hardy-Weinberg hypothesis statistically need not imply that a population satisfies the Hardy-Weinberg conditions.
   (f) Show that with multiplicative fitnesses the evolutionary rate of $p$ is, for any $s$,
   $\Delta p = pq\dfrac{s}{1 - sq}$. (Note: this is identical to $\Delta p$ for an advantageous allele in an *asexual* or *haploid* population with relative fitnesses $w_A = 1$; $w_a = 1 - s$.)

3. (a) How large does the selection coefficient $s$ need to be in order to change a dominant advantageous allele from an allele frequency of 0.5 to 0.51 in one generation?
   (b) Do the same calculation for a recessive advantageous allele.
   (c) Do the same calculation for a haploid advantageous allele.
   (d) What does this imply about the efficiency of selection in haploids vs. diploids?
   (*Optional*) Although this problem suggests that selection in haploids is more efficient than in diploids (Hint! Hint!), we know from problem 2 that selection in diploids can be equally efficient as haploids with multiplicative fitnesses (Triple Hint!). Are there any selection patterns in diploids that are more efficient than haploids for a given selection coefficient?

4. Hedrick, p. 362 #1

5. Hedrick, p. 362, #4