# Lab 2: Natural selection

**Basic instructions:**

The module of Populus that we will be using in today's lab is 'Selection on a diallelic locus.' To get to this module, click on 'model' then on 'natural selection' then on 'selection on a diallelic locus.' At least initially, set your 'plot options' to *p* vs. *t*.

**Mathematical background:**

See page 68 of the Populus help file (Adobe acrobat). The mathematical background for today's lab was covered in the lecture on natural selection. It might be helpful to review that material before arriving.

**Questions:**

1. *Culex pipiens* is a mosquito that acts as a vector of West Nile Virus. For obvious reasons efforts are underway in many areas to control the population density of this mosquito. It has been estimated that use of the insecticide OP-Ace.1 generates a selection coefficient equal to .3 (meaning resistant mosquitoes have a fitness of 1, while susceptible mosquitoes have a fitness of .7). Assuming insecticide resistance is completely dominant, and that the initial frequency of the resistance allele is .01, how long will it take until the allele frequency of the resistance allele exceeds .9? At this point, what proportion of the population will be resistant to the insecticide?

2. *Anopheles stephensi* is a mosquito that also acts as vector of human diseases, although in this case, the disease being vectored is human Malaria. Much as with *Culex pipiens*, efforts to control this mosquito with insecticides have been underway for some time. It has been estimated that use of the insecticide Permethrin generates a selection coefficient equal to .95 (meaning resistant mosquitoes have a fitness of 1, while susceptible mosquitoes have a fitness of .05). Assuming insecticide resistance is completely dominant, and that the initial frequency of the resistance allele is .01, how long will it take until the allele frequency of the resistance allele exceeds .9? How does this compare to the rate of insecticide resistance evolution in *Culex pipiens*? What explains the difference in the rate of evolution?

3. The two examples above assumed that insecticide resistance was a dominant trait. If resistance were instead, completely recessive, how would your results to the questions above change? Why? What, in general, does this suggest about the role dominance plays in shaping the rate of spread of new mutations?

4. Fisher's 'Fundamental theorem of natural selection' states that natural selection always acts to increase the mean fitness of a population. By changing 'plot options' to '$\overline{w}$ vs. $p$', you can determine which allele frequency would maximize the population mean fitness for any set of parameter values. Can you find sets of parameters for which the population does not reach the global maximum value of mean fitness? (Hint: Try asymmetrical underdominance: $W_{AA}$ = 1.0, $W_{Aa}$ = .90, $W_{aa}$ = .95 and a variety of initial allele frequencies. Does this result disprove Fisher's fundamental theorem? What does this result suggest about the power of natural selection to reach 'global' vs. 'local' optima?