Natural Selection

In order for evolution by natural selection to occur...

1.) More offspring must be produced then can survive.

2.) Individuals must differ in fitness.

3.) Differences must be heritable; ie. offspring resemble their parents.

Predicting allele frequencies in the next generation when natural selection is operating.

Generation 1. Zygotes have a frequency for the *A* allele of *p*.

Selection acts between the zygote stage and the adult stage.

At the adult stage the new frequency of the *A* allele is p^*.

Question: what will be the frequency, p', of the *A* allele in generation 2.

Answer: assuming that selection only operates on the *A* allele between the zygote and adult stage, $p' = p^*$.

What will the allele frequencies be after selection?

Let w_{11} = the fraction of *AA* individuals that survive to adulthood.

Let w_{12} = the fraction of *Aa* individuals that survive to adulthood.

Let w_{22} = the fraction of *aa* individuals that survive to adulthood.

$\overline{w}$ = mean fitness; $w_{11}p^2 + w_{12}2pq + w_{22}q^2$

then the allele frequency of *A* allele in the next generation, p', is

$$p' = \frac{w_{11}p^2 + w_{12}pq}{\overline{w}}$$

and the frequency of the *a* allele in the next generation, q', is just

$$q' = 1 - p'$$

Important: Fisher's Fundamental theorem of Natural Selection states: $\overline{w}' \geq \overline{w}$

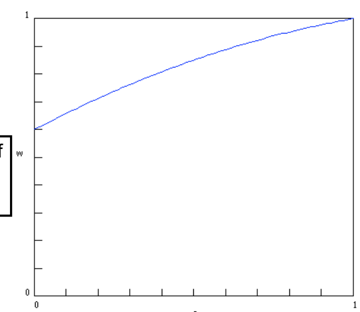
Patterns of Selection

Directional selection: $w_{11}>w_{12}>w_{22}$

or

$w_{11}<w_{12}<w_{22}$

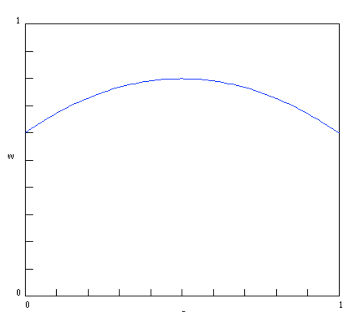
In this case we can expect fixation of the *A* allele if $w_{11}>w_{12}>w_{22}$ or fixation of the *a* allele if $w_{11}<w_{12}<w_{22}$.



Patterns of Selection

Stabilizing selection: $w_{11}<w_{12}>w_{22}$

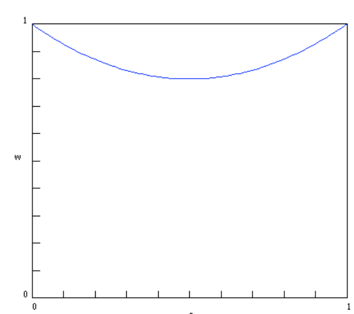
In this case we can expect a stable polymorphism in regards to the *A* and *a* alleles.



Patterns of Selection

Disruptive selection: $w_{11}> w_{12}<w_{22}$

In this case we can expect either the *A* allele or the *a* allele to go to fixation depending on the initial allele frequencies and fitnesses of the homozygotes.



Quantitative Genetics and Continuous Traits

Consequences of polygenic inheritance:

1.) Continuous Variation

2.) Enormous number of genotypes, many with the same phenotypes.

3.) Environmental modification of phenotypes; ie. plasticity.

Quantitative genetics is the approach used to study the evolution of traits that are determined by many genes and the environment; ie. height, weight, IQ, etc.

The phenotypic variance (V_P) of a continuous trait in a population can be attributed to variance caused by genetic differences (V_G) and variance caused by environmental differences (V_E).

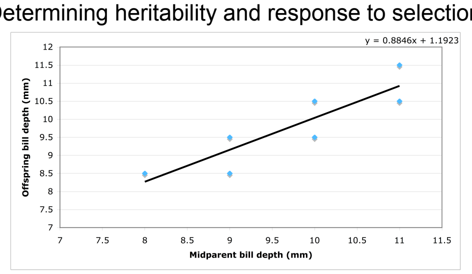
$$V_p = V_G + V_E$$

The heritability of a trait is the proportion of the phenotypic variance due to genotypic differences.

$$h^2 = V_G / (V_G + V_E)$$

Remember, in order for evolution by natural selection to occur, there must be a genetic component to the variation expressed for a trait in a population.

Determining heritability and response to selection



h^2 is equal to the slope of the regression line, in this case 0.8846. So, an estimated 88.46% of the variation can be attributed to genetic differences.

The selection differential (S) is the difference in the mean trait value before and after selection.

So the response to selection (R) is: $R = h^2S$