Biol 3306 Lecture 14 supplement to Quantitative Trait Evolution

Calculations of average offspring phenotypic values (for explanation only—you will not be asked to do these on the homework or on the test)

General considerations. Mating is random--the probability of mating with a particular genotype is equal to its frequency in the population. The distribution of offspring phenotypes conforms to mendelian expectations (e.g., a mating between a heterozygote and an homozygote will produce a 1:1 ratio of homozygous: heterozygous offspring). The average offspring phenotype is the average phenotype from each mating multiplied by the frequency with which that mating occurs, summed over all matings (this is the same way that one calculates mean relative fitness or mean phenotype value in a population).

Additive case. Assume $f(A_1) = f(A_2) = 0.5$, population is in HWE. Each genotype has a single phenotype value, PV of $A_1A_1 = 1.0$, PV of $A_1A_2 = 0.5$, PV of $A_2A_2 = 0$.

A_1A_1:

probability of mating with A_1A_1 = 0.25

expected offspring distribution is: all A_1A_1

average offspring phenotype = 1 x 1 = 1

probability of mating with A1A2 = 0.5

expected offspring distribution is: ½ A_1A_1 ½ A_1A_2

average offspring phenotype = (½ x 1) + (½ x 0.5) = 0.75

probability of mating with A_2A_2 = 0.25

expected offspring distribution is: all A_1A_2

average offspring phenotype = 1 x 0.5 = 0.5

average offspring = (0.25 x 1) + (0.5 x 0.75) + (0.25 x 0.5) = 0.75

A_1A_2:

probability of mating with A_1A_1 = 0.25

expected offspring distribution is: ½ A_1A_1 ½ A_1A_2

average offspring phenotype = (½ x 1) + (½ x 0.5) = 0.75

probability of mating with A_1A_2 = 0.5

expected offspring distribution is: ¼ A_1A_1 ½ A_1A_2 ¼ A_2A_2

average offspring phenotype = (¼ x 1) + (½ x 0.5) + (¼ x 0) = 0.5

probability of mating with A_2A_2 = 0.25

expected offspring distribution is: ½ A_1A_2 ½ A_2A_2

average offspring phenotype = (½ x 0.5) + (½ x 0) = 0.25

average offspring = (0.25 x 0.75) + (0.5 x 0.5) + (0.25 x 0.25) = 0.5

A_2A_2:

probability of mating with A_1A_1 = 0.25

expected offspring distribution is: all A_1A_2

average offspring phenotype = 1 x 0.5 = 0.5

probability of mating with A_1A_2 = 0.5

expected offspring distribution is: ½ A_1A_2 ½ A_2A_2

average offspring phenotype = (½ x 0.5) + (½ x 0) = 0.25

probability of mating with A_2A_2 = 0.25

expected offspring distribution is: all A_2A_2

average offspring phenotype = 1 x 0 = 0

average offspring = (0.25 x 0.5) + (0.5 x 0.25) + (0.25 x 0) = 0.25

Dominance case. Assume $f(A_1) = f(A_2) = 0.5$, population is in HWE. Each genotype has a single phenotype value, PV of A_1A_1 = 1.0, PV of A_1A_2 = 1.0, PV of A_2A_2 = 0.

A_1A_1:

probability of mating with A_1A_1 = 0.25

expected offspring distribution is: all A_1A_1

average offspring phenotype = 1 x 1 = 1

probability of mating with A1A2 = 0.5

expected offspring distribution is: ½ A_1A_1 ½ A_1A_2

average offspring phenotype = (½ x 1) + (½ x 1) = 1

probability of mating with A_2A_2 = 0.25

expected offspring distribution is: all A_1A_2

average offspring phenotype = 1 x 1.0 = 0.5

average offspring = (0.25 x 1) + (0.5 x 1) + (0.25 x 1) = 1

A_1A_2:

probability of mating with A_1A_1 = 0.25

expected offspring distribution is: ½ A_1A_1 ½ A_1A_2

average offspring phenotype = (½ x 1) + (½ x 1) = 1

probability of mating with A_1A_2 = 0.5

expected offspring distribution is: ¼ A_1A_1 ½ A_1A_2 ¼ A_2A_2

average offspring phenotype = (¼ x 1) + (½ x 1) + (¼ x 0) = 0.75

probability of mating with A_2A_2 = 0.25

expected offspring distribution is: ½ A_1A_2 ½ A_2A_2

average offspring phenotype = (½ x 1) + (½ x 0) = 0.5

average offspring = (0.25 x 1) + (0.5 x 0.75) + (0.25 x 0.5) = 0.75

A_2A_2:

probability of mating with A_1A_1 = 0.25

expected offspring distribution is: all A_1A_2

average offspring phenotype = 1 x 1 = 1

probability of mating with A_1A_2 = 0.5

expected offspring distribution is: ½ A_1A_2 ½ A_2A_2

average offspring phenotype = (½ x 1) + (½ x 0) = 0.5

probability of mating with A_2A_2 = 0.25

expected offspring distribution is: all A_2A_2

average offspring phenotype = 1 x 0 = 0

average offspring = (0.25 x 1) + (0.5 x 0.5) + (0.25 x 0) = 0.5