EEB2245: Evolutionary Biology
Spring 2009
Problem Set 3 answer key

1.) A scientist observed:

GENOTYPE →	**AA**	**Aa**	**aa**
# of eggs	**33**	**100**	**45**
Viability	**0.3**	**0.7**	**0.4**
# of adults	10	70	18

a) Calculate the number of adults that were observed. (See table above)

b) Using the data in the table calculate the genotype frequency of AA (before and after selection) and the allele frequency of A (before and after selection).

freq (AA) before:
33/(33+100+45) = 0.185

freq (AA) after:
10/(10+70+18) = 0.102

freq (A) before:
[2(33) + 100] / [2(33+100+45)] = 0.466

freq (A) after:
[2(10) + 70] / [2(10+70+18)] = 0.459

2.) Egg-to-adult survival rates in a laboratory population of Drosophila melanogaster is as follows: 90%, 70%, and 60% for genotypes A_1A_1, A_1A_2, and A_2A_2, respectively. The fecundity values for each genotype are 50, 55, and 70 eggs, respectively.

(a) Complete the table below

Genotype	**A_1A_1**	**A_1A_2**	**A_2A_2**
# eggs			
w_x			
# adults			

Genotype	A_1A_1	A_1A_2	A_2A_2
# eggs	50	55	70
w_x (viability)	0.90	0.70	0.6
# adults	45	38	42

(b) Calculated allele and genotype frequencies before and after selection

Allele Frequencies Before Selection:
freq (A_1) = 2(50)+55/(2*175) = 0.44
freq (A_2) = 2(70)+55/(2*175) = 0.56
Genotype Frequencies Before Selection:
freq (A_1A_1) = 50/(50+55+70) = 0.28
freq (A_1A_2) = 55/(50+55+70) = 0.31
freq (A_2A_2) = 70/(50+55+70) = 0.40

Allele Frequencies After Selection:
freq (A_1) = 2(45)+38/(2*125) = 0.51

$freq(A_2) = 2(42)+38/(2*125) = 0.49$

Genotype Frequencies After Selection:
$freq(A_1A_1) = 45/(45+38+42) = 0.36$
$freq(A_1A_2) = 38/(45+38+42) = 0.30$
$freq(A_2A_2) = 42/(45+38+42) = 0.34$

(c) After the selection event from egg-to-adult, the adults are bred randomly. Assuming Hardy-Weinberg equilibrium into the next generation, what are the allele and genotype frequencies of eggs in the next generation?

Allele freq in surviving adults of Generation 2:
$p = 0.36 + 0.30/2 = 0.51$
$q = 0.34 + 0.30/2 = 0.49$

Allele freq of eggs in Generation 2:
$p' = p = 0.51$
$q' = q = 0.49$
(because all of the assumptions of H-W apply, there's no change in allele frequency between surviving adults and their offspring)

Genotype Frequencies of eggs in Generation 2:
$freq(A_1A_1)' = p'^2 = (0.51)^2 = 0.26$
$freq(A_1A_2)' = 2p'q' = 2(0.51)(0.49) = 0.50$
$freq(A_2A_2)' = q'^2 = (0.49)^2 = 0.24$
(because all of the assumptions of H-W apply in the transition from surviving adults to new eggs and H-W proportions arise after a single generation of random mating)

3.) What mode of selection would you predict is acting in the following cases?

(a)

GENOTYPE →	**AA**	**Aa**	**aa**
# of eggs	**33**	**100**	**45**
# of adults	10	70	18

(b)

GENOTYPE →	**AA**	**Aa**	**aa**
# of eggs	**55**	**100**	**60**
# of adults	49	80	18

(c)

GENOTYPE →	**AA**	**Aa**	**aa**
# of eggs	**50**	**75**	**45**
# of adults	30	35	25

Remember: if $w_{11} < w_{12} > w_{22}$, then stabilizing selection is the selective process.
If $w_{11} > w_{12} > w_{22}$ or $w_{11} < w_{12} < w_{22}$, then stabilizing selection is the selective process.
If $w_{11} > w_{12} < w_{22}$, then disruptive selective is the selective process.

(a) 10/30 = 0.33, 70/100 = 0.70, 18/45 = 0.4
0.33 < 0.70 > 0.4 so, this represents stabilizing selection.

(b) 49/55 = 0.89, 80/100 = 0.8, 18/60 = 0.3
0.89 > 0.8 > 0.3 so, this represents directional selection.
(c) 30/ 50 = 0.6, 35/ 75 = 0.467, 25/ 45 = 0.556
0.6 > 0.467 < 0.566 so, this represents disruptive selection.

4.) Under artificial selection for increased body weight, what will be the response to selection (R), after one generation, for the following values of phenotypic variance (V_P), additive genetic variance (V_A), environmental variance (V_E), and selection differential (S)? (a) V_P = 2.0 grams^2, V_A = 1.25 g^2, V_E = 0.75 g^2, S = 1.33 g; (b) V_P = 2.0 grams^2, V_A = 0.95 g^2, V_E = 1.05 g^2, S = 1.33 g; (c) V_P = 2.0 grams^2, V_A = 1.25 g^2, V_E = 0.75 g^2, S = 2.67 g. If the parameters remain the same for successive generations of selection, and the initial mean weight is 10 grams, what is the expected mean after two generations of selection in each case? (Futuyma 2005)

Important: We used the variable V_G to represent additive genetic variation in class, but Futumya uses V_A to represent the same thing. $V_G = V_A$. I'm only going to solve (a), the others are exactly the same, so I'll just give you the answers to those.

Remember: $R = h^2 S$; and $h^2 = V_A / V_P$

So, (a) h^2 = 1.25 g^2/ 2.0 $grams^2$ = 0.625

R = (0.625)(1.33g) = 0.83 g

If the initial mean is 10g and the response to selection is 0.83g, the mean in the next generation will be 10g + 0.83 = 10.83g and the mean after two generations will be 10.83g + 0.83 = 11.66g.

(b) R = 0.632g

After two generations of selection the expected mean is 11.264g.

(c) R = 1. 67g

After two generations of selection the expected mean is 11.669g.