Evolutionary Biology EEB 2245/2245W
Spring 2011
Problem Set 3

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GENOTYPE →	**AA**	**Aa**	**aa**
# of eggs	**40**	**100**	**60**
Viability	**0.25**	**0.6**	**0.5**
# of adults			

a. Calculate the number of adults that will be observed.
b. Using the data in the table, calculate the genotype frequency of AA before and after selection.
c. Calculate the allele frequency of A before and after selection.
d. 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 genotype frequencies of eggs in the next generation?

2- a. Given the following relative fitnesses, what will be the frequency of the A allele at equilibrium: Fitness AA < Fitness Aa < Fitness aa?

b. What can you conclude about the shape of the fitness landscape? (Don't forget to label the axes.)

3- Imagine that the frequency of allele D is 0.2 in a set of zygotes that you sample. All DD and Dd individuals survive to reproduce, but only 22% of dd individuals survive to reproduce.

a What is the average fitness of the population in this generation?
b What will be the frequencies of D and d alleles in the zygotes of the next generation (assuming mating is random and drift has no effect)

a. What will the frequencies of the D and d alleles be in the adults of the next generation?
b. What is the average fitness of the population in this next generation?

4- You find a recessive lethal allele (L) occurring at a frequency of 0.1. Use the following to explain why selection is slow to eliminate such alleles.

a. In a population of 1,000 individuals, how many individuals do you expect of each of the following genotypes BEFORE selection (assuming HWE)?

VV VL LL

b. What will the frequency of L be AFTER selection? (Hint: The LL genotype is lethal. Don't forget to account for the fact your population size decreases.)
c. What effect does being recessive have on the rate at which the L allele is lost? Explain.

5- You are studying a population of leatherback turtles and observed that at one locus 90 individuals have a genotype BB, 60 individuals have a genotype BT and 150 turtles have a genotype of TT.

a. Calculate the genotype frequencies and allele frequencies for this population.

b. Which genotype(s) are overrepresented? Which are underrepresented?

c. Which evolutionary process(es) could produce this pattern (Hint: Think about all the HWE assumption violations)

d. Predict what other information you would need to test which process could explain the pattern you see.

6- Swedish adders are a type of snake found in small populations in Sweden. They were once widespread, but due to recent agriculture they are now divided into smaller populations. A population of 40 adders was studied and shown to have a higher proportion of stillborn and deformed offspring. The environment in this populations is not different from other populations of adders.

a. What patterns of evolution could explain this and why?

b. What could the researchers do to reduce this effect so that the population had normal offspring?

7- The Siberian Husky is a dog bred for working in the snow. It is a medium sized dog that is very strong with a thick fur coat. Heavier dogs sink deeper into the snow and move slower, while lighter dogs are not strong enough to pull sleds and equipment.

a. What type of selection is this?

b. What does the fitness landscape look like? (label axes)

c. Give a scenario where the average weight of the dogs was beneficial. If this trait is heritable and only heavier dogs were bred, what type of selection would this be?

8- You are interested in studying wild Petunia plants. You observe that in some populations there are more flowers that are pink and purple and in other populations there are mostly light pink flowers. You observe that in populations with pink and purple flowers the main pollinator is bees, while in the light pink flower population the main pollinator is moths.

a. Is the change in flower colors an evolutionary change? How would you test this?

b. Assume that flower color is a heritable trait. You believe that flower color is an adaptation to the pollinator, either bumble bees or honey bees. How would you design an experiment to test your hypothesis?

c. What would you predict would be the outcomes to your experiment?

9- You are studying the White-Tailed Tropicbird in the Caribbean islands. The average male tail length in one population you study is 40 cm which is as long as its body. A small predator is introduced to the island and after one generation you notice that the average male tail length is 30 cm. You have already determined that h^2 = 0.8 in this population.

a. What are S and R for this population?

b. What will be the average male tail length in the third generation?

10- Under artificial selection for increased body weight, what will be the response to selection (R), after one generation, for the following values of genetic variance (V_G), environmental variance (V_E), and selection differential (S)?

a. $V_G = 1.5\ g^2$, $V_E = 0.5\ g^2$, $S = 3\ g$

b. $V_G = 1\ g^2$, $V_E = 1\ g^2$, $S = 5$ g

c. $V_G = 2\ g^2$, $V_E = 8\ g^2$, $S = 5$ g.

d. 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)

11-The slope of the regression line describing the relationship between the birth weight of offspring and the birth weight of their parents was estimated as 0.3 in a population of buffalo.

a. What is the heritability of birth weight in this population?

b. Suppose that the mean birth weight in this population is 13 kg and suppose that a buffalo rancher imposes selection on birth weight so that the mean birth weight among of those allowed to reproduce is 14.5 kg. What will the mean birth weight of the offspring be?

12- A researcher is studying long-horned beetle antennal length in New England. 550 individuals have an average antenna length of 10 cm. The average antenna length of beetles that were eaten by birds in the spring was estimated to be 12 cm.

a. What is the selection differential due to the birds?

b. What sort of selection did the birds cause?

c. Suppose that the researchers observes no more predation by birds and observe the average antenna length of the beetles' offspring to be 11 cm. What is the estimated heritability of antenna length?

13- Suppose that coat color in mice is determined primarily by the alleles present at three different loci (A-C). Each locus has two alleles, and one of the alleles (called A1, B1, and C1) makes hair whiter while the other allele (called A2, B2 and C2) makes it darker. As a result, mice that have six '2' alleles are jet black while those that have six '1' alleles are white.

a. How many different coat color phenotypes are there (ignoring environmental effects)?
b. How many different genotypes are there?
c. How many different genotypes produce the phenotype that is one shade lighter than jet black? (Hint: think about how many different places a '1' allele could occur)
d. A population of mice living in the Sand Dunes of White Sands, New Mexico, has (not surprisingly) been selected for light color. You estimate that the frequency of each '1' allele is 0.9 in this population. How frequent do you expect jet black individuals to be? (Hint: You can calculate the genotype frequencies at each locus using what we've learned about population genetics. The alleles present at different loci are independent of each other; to find the probability of independent events, you multiple the probability that each one occurs; e.g. when tossing a coin twice, the probability of getting two heads (0.25) is the probability of getting a head in the first toss (0.5) multiplied by the probability of getting a head in the second toss (0.5)).
e. What is the estimated frequency of white individuals in this population?

f. A related population of mice lives on nearby lava fields, which select for black coats. In this population, the frequency of each '2' allele is estimated to be 0.9. What is the estimated frequency of jet black individuals in this population?
g. Assuming that the lava population originated by migration from the sand population, how do you explain the changes in allele frequency?
h. Use this example to explain how new phenotypes can arise in a population *without* the introduction of new alleles.
i. If selection were to continue in the lava fields, what do you expect that the genetic composition of the population would ultimately be (assuming that there is no additional migration from the White Sands population)?