EEB 2245/2245W- Evolutionary Biology
Problem Set 1
Jan 28, 2011

1- The major histocompatibility complex (MHC) consists of a suite of genes that play an important role in the immune system. While studying a particular MHC locus in a population of deer found in Connecticut, you discover ample genetic variation. There appears to be two common alleles residing at this particular MHC locus. You characterize the genotype of 150 individuals from this population. You discover 25 individuals with genotype *AA*, 75 individuals with genotype *AB*, and 50 individuals with genotype *BB*.

a. What are the genotype frequencies of your sample population of deer?
b. What are the allele frequencies?
c. Given the allele frequencies, what are the expected Hardy-Weinberg genotype frequencies?
d. Does the population appear to be in Hardy-Weinberg equilibrium with respect to the AB MHC locus?
e. If not, what factors are possibly responsible for the deviation from expected genotype frequencies?
f. What will be the genotype frequencies of the next generation, assuming none of the assumptions of Hardy-Weinberg are broken?

2- Black color in horses is governed primarily by a recessive allele at the A locus. *AA* and *Aa* horses are non-black colors, while *aa* horses are black all over. In the internet group "rec.equestrian", one person asked why there are relatively few black horses of the Arabian breed. One response was, "Black is a rare color because it is recessive. More Arabians are bay or gray because those colors are dominant." What is wrong with this explanation? (Assume that the *A* and *a* alleles are in Hardy-Weinberg equilibrium, which was probably true at the time of this discussion.) Generally, what does the Hardy-Weinberg model show us about the impact that an allele's dominance or recessiveness has on its frequency? (Modified from Freeman and Herron, 2007

3- In a population of carabid beetles, 65% of the beetles are bright red and the remainder are green. The color of the beetles is controlled by two alleles at a single locus, and red is dominant to green. Using R for the dominant (red) allele and g for the recessive (green) allele, answer the following questions.

a. List the possible genotypes and the colors corresponding to each.
b. What is the frequency of genotype gg?
c. Write down a formula for the expected frequency of the RR genotype, assuming that the population is in Hardy-Weinberg equilibrium.
d. Calculate the frequency of the alleles R and g.

4- Consider one locus with three alleles, C, D and E.

a. List all of the possible genotypes.
b. What is the expected frequency of the CC genotype, assuming the population is in

Hardy-Weinberg Equilibrium?
c. What is the expected frequency of the DE genotype, assuming the population is in Hardy Weinberg Equilibrium?

5- You studied tree frog and found an important gene for coloration, where BB and Bb individuals are brown and bb individuals are gray. You sampled a population in which you know that the percentage of the homozygous recessive genotype (bb) is 40% and produces gray frogs. Assuming that the populations has 100 frogs and is in Hardy-Weinberg equilibrium, calculate the following:

a. The frequency of the "aa" genotype
b. The frequency of the "a" allele
c. The frequency of the "A" allele
d. The frequency of the "AA" genotype
e. The frequency of the "Aa" genotype
f. How many brown frogs are in your population?

6- A population of 200 lions in Kenya are sampled for genetic variation. At one gene there are two alleles and 17 individuals are found to have a genotype of DD, 126 individuals have a genotype of Dd and 57 individuals have a genotype of dd.

a. What are the genotype frequencies?
b. What are the allele frequencies?
c. What are the genotype frequencies expected at Hardy-Weinberg equilibrium?
d. How many individuals with each of the genotypes would you expect?

7- A population of 125 lions in Tanzania (the country south of Kenya) is also sampled at the same gene as the lion population in Kenya and the same two alleles are found. 13 lions have a genotype of DD, 10 individuals have a genotype of Dd, and 102 individuals have a genotype of dd.

a. What are the genotype frequencies?
b. What are the allele frequencies?
c. What are the genotype frequencies expected at Hardy-Weinberg equilibrium?
d. Suppose you analyzed the data from Kenya and Tanzania together. Would you conclude that the combined population could be in Hardy-Weinberg equilibrium? Why or why not?

8- You suspect that the Adh^F allele in fruit flies is better at breaking down ethanol than the Adh^S allele. You set up four experimental lines of fruit flies. Two lines are fed food that has been spiked with ethanol. As expected the Adh^F allele increases in frequency over time in both these lines, suggesting that this allele provides a fitness advantage in certain environments. The other two lines are fed an ethanol free diet. You don't expect either allele to provide an advantage in this environment, but the frequencies of the alleles in the two control populations do change a little, moving up and down over time. Which assumption of the Hardy-Weinberg model is most probably being violated? If this experiment were repeated, what change in experimental design would reduce this deviation from Hardy-Weinberg equilibrium? (Modified from Freeman and Herron, 2007)