EEB 2245: Evolutionary Biology

Spring 2009

Problem Set 1

1. Prior to the publication of Darwin's major argument, *On the Origin of Species* (1859), Chevalier De Lamarck presented his own evolutionary account in *Philosophie Zoologique* (1809).
   a. How did Lamarck's account of the origin of life's diversity differ from Darwin's ideas?
   b. Both Lamarck and Darwin recognized the adaptive design apparent in organisms. How did Lamarck's account of the evolution of adaptation differ from Darwin's ideas?
   c. It has been two centuries since Lamarck published his thesis and the science of biology is firmly couched in a Darwinian framework. What evidence has convinced the scientific community that Darwinian mechanisms best explain life's diversity?
2. After learning about the human *MN* locus in class, you decide to replicate a previous study in order to confirm the published results, which suggested that the *M* and *N* alleles are in Hardy-Weinberg equilibrium. 1315 fellow UCONN students volunteer to have their blood type characterized for your study. You discover 30 students with the *MM* genotype, 335 students with the *MN* genotype, and 950 students with the *NN* genotype.

a.. What are the genotype frequencies for your sample population of UCONN students?

b. What are the allele frequencies?

c. Given the allele frequencies, what are the expected Hardy-Weinberg genotype frequencies?

d.)Is this population in Hardy-Weinberg equilibrium with respect to the MN locus?

3. 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 field mice 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 130 individuals from this population. You discover 25 individuals with genotype *AA*, 90 individuals with genotype *AB*, and 15 individuals with genotype *BB*.

   a. What are the genotype frequencies of your sample population of field mice?

   b. What are the allele frequencies?

   c. Given the allele frequencies, what are the expected Hardy-Weinberg genotype frequencies.

   d. Is the population in Hardy-Weinberg equilibrium with respect to the AB MHC locus?

   e. What will be the genotype frequencies of the next generation, assuming none of the assumptions of Hardy-Weinberg are broken?

4. Black color in horses is governed primarily by a recessive allele at the A locus. *AA* and *Aa* horses are nonblack 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)

5. In humans, the *COL1A1* locus codes for a certain collagen protein found in bone. The normal allele at this locus is denoted with *S.* A recessive allele *s* is associated with reduced bone mineral density and increased risk of fractures in both *Ss* and *ss* women. A recent study of 1, 778 women showed that 1,194 were *SS*, 526 were *Ss*, and 58 were *ss* (Uitterlinden et al. 1998). Are these two alleles in Hardy-Weinberg equilibrium? How do you know? What information would you need to determine whether the alleles will be in Hardy-Weinberg equilibrium in the next generation? (Modified from Freeman and Herron, 2007)