

PROBLEM SET 1 - EVOLUTIONARY BIOLOGY - FALL 2017

Hardy-Weinberg-Castle (20 pts total)

1. A population of Ladybird Beetles from North Carolina was genotyped at a single autosomal allozyme locus with two alleles (*F* and *S*) as follows:

Genotype	<i>FF</i>	<i>FS</i>	<i>SS</i>	Total
Number	375	140	18	533 (corrected 09/05/17)

- Characterize this population by its genotype frequencies. (1 pt)
 - Characterize the gene pool by the allele frequencies for *F* and *S*. (1 pt)
 - Using the Hardy-Weinberg-Castle Law, predict the genotype frequencies based on the allele frequencies. (1 pt)
2. The presence of spots in this Ladybird Beetle species is controlled by a single locus. The allele **S** confers spots while the allele **s** confers no spots. A breeding study shows that the **S** allele is completely dominant over the **s** allele. In a random sample of 758 individuals 28 completely lack spots.
- What are the expected frequencies of the three genotypes in this population? What assumption(s) did you make to solve this problem? (2 pts)
3. Tay-Sachs disease is an autosomal-recessive degenerative disorder of the brain that usually leads to death in infancy or early childhood. Among Ashkenazi Jews the incidence of the condition is about 1 in 6000 births, but among non-Jews the incidence is about 1 in 500,000 births.
- What incidence of the disease would be expected among the offspring of matings between Ashkenazi Jews and non-Jews? (2 pts)
 - If these offspring were to mate among themselves, what incidence of the disease would be expected among their offspring? (2 pts)
 - Among the Ashkenazi Jews what is the expected HWC ratio of Tay-Sachs carriers (heterozygotes) to affected individuals (Tay-Sachs homozygotes)? (2 pts)
 - Selection tends to reduce the frequency of deleterious alleles in a population. As the frequency of the Tay-Sachs allele goes down, what is the limit to the ratio of carriers to affected individuals? (1 pt)
 - How can we explain the high incidence of Tay-sachs in the Ashkenazi Jews? (1 pt)
4. One common feature of hybridization is that there is often an asymmetry such that females of one species will mate with males from another species but the opposite is not the case. Consider a hybrid population formed from females of Species 1 and males of Species 2.
- If the allele frequencies in the two species are not equal to begin with, after a single round of cross-species matings will the hybrid population be in HWC proportions? Support your conclusion with an algebraic solution. (2 pts)
 - If hybrid individuals can only mate amongst themselves, how long will it take for the hybrid population to achieve HWC proportions? (1 pt)
5. In some species of Sheep the presence of horns is controlled by a single locus and determined by an allele that is dominant in males and recessive in females. If 96% of males have horns, what proportion of females have horns? (2 pts)
6. Why is it difficult for selection to eliminate a completely recessive deleterious allele from a population? Why does it take so long for a new recessive beneficial allele to go to fixation in a population? (2 pts)