27.9.2012

Mathematical theory of population genetics

Exercises 2.

1. (3 points) Show that Hardy-Weinberg equilibrium is also attained, though delayed by one generation, in a population with separate sexes and different initial genotypic frequencies (at an autosomal locus). Consider a two allele case.

2. (6 points) Generalize the Hardy-Weinberg Law to the case of k alleles in one locus (for monoecious populations, or, dioecious with initially identical genotype frequencies in both sexes).

3. In the mid-1960s, population geneticists began to use electrophoresis to describe genetic variation in proteins. For the first time, the genetic variation at a "typical" locus could be ascertained. Harry Harris's 1966 paper, "Enzyme polymorphism in man", was among the first of many electrophoretic survey papers. In it, he summarized the electrophoretic variation at 10 loci sampled from the English population. The protein produced by one of these loci is placental alkaline phosphatase. Harris found three phosphatase alleles that differed by state (migration speed) and called them S (slow), I (intermediate), and F (fast) for their rate of movement in the electrophoresis apparatus. Individuals carrying different genotypes were distributed as follows: 141 individuals (genotype SS), 111 individuals (genotype SF), 28 individuals (genotype FF), 32 individuals (genotype SI), 15 individuals (genotype FI), 5 individuals (genotype II).

   (a) (2 points) Calculate the genotype frequencies.

   (b) (4 points) If mating is random, what are the expected genotype frequencies?

4. (6 points) Consider a single locus and two alleles in a population that is in Hardy-Weinberg equilibrium. Derive and expression (by minimizing the mean squared deviation from the genotypic values) for the average effects of the two alleles (in terms of allele frequencies and genotypic values).

5. Consider two alleles A_1 and A_2 in a population that is in Hardy-Weinberg equilibrium. Calculate the mean genotypic value and the average excess of all the genotypes, and, the average effect of both alleles (and the breeding value of the individuals) when

   (a) (2 points) the frequency of allele A_1 is 0.5 and the genotypic values are 280 (for A_1A_1), 300 (for A_1A_2), 320 (for A_2A_2).

   (b) (2 points) the frequency of allele A_1 is 0.5 and the genotypic values are 280 (for A_1A_1), 310 (for A_1A_2), 320 (for A_2A_2).

   (c) (2 points) the frequency of allele A_1 is 0.1 and the genotypic values are 280 (for A_1A_1), 300 (for A_1A_2), 320 (for A_2A_2).