Lab 5-Genetics Labs

An understanding of inheritance is critical in order to understand how evolution by natural selection works. If you recall the three conditions for natural selection, one of those deals with the idea that a phenotypic trait provides some sort of selective advantage that must be passed down to the offspring—in other words, there has to be a genetic basis for that trait. Otherwise populations of organisms would not evolve in response to their environments (e.g., adaptation), interactions with other organisms (e.g., competition, predation), or even interactions among themselves (e.g., sexual selection.)

Much of the pre-lab and the first exercise in lab 5 dealt with ideas of basic genetics and inheritance. For example, eye color has a genetic basis. How are these traits passed to their offspring? We know this by looking at the genotypes of the offspring. This tells us something about the genotypes of the parents. You looked at this by looking at fruit fly paternity

This brings us to the idea of Mendel's Law of Independent Assortment. Again, this was important because it tells us that the segregation of alleles coding for eye color was independent of the segregation of alleles for body color during the formation of gametes. This meant that we had to consider the inheritance of eye color as a separate event relative to the inheritance of body color. We tried to model this by having you place beads in the cloth bag, and pull out a round-ended bead and a square-ended bead without looking. The fact you pulled out a particular round bead had no influence on the square bead you pulled out—this is Independent assortment, and this happens with eye color and body color.

The second part of the lab approached genetics from a different perspective—more on the level of a population rather than the individual. Why are populations important? When we look at evolution, we are interested in seeing what is happening to the population. The population is the sum of the individuals. We do measure the genetics of the individual, but in order to understand what is happening to a particular species, we need to focus at the level of the population. This leads us to questions such as how does one population of a species compare to another of the same species? If we notice changes in genetic frequencies in one population from generation to generation but not in another, what factors are driving this frequency change? Basically, is evolution occurring, and if so, why?

You made an attempt to measure evolution by looking at eye color (recall you looked at flies with white, red, and pink eyes.) These were the phenotypes you could identify, and each phenotype had a specific genotype. Because you knew the genotype of each phenotype (this was given to you), you could then calculate the frequency of each genotype, then from there, calculate the frequencies of the two alleles that made up the three genotypes. And then you could calculate expected frequencies using the relationship p^2, 2pq, and q^2.

In our lab, we had three populations that were being considered. Two were very large (S_0 and S_1). The third population (F_1) was started by a single female, and thus was very small. Our assumption was that our source populations were in a steady state. That is, no evolution was occurring because all conditions of Hardy-Weinberg had been met. However, our founder population was initially a small population, so you should see founder effects, which would become apparent as you compare allele and genotype frequencies. For example, at the level of the phenotype, you might see more red eyed flies and fewer white eyed flies than in the source population. Or you might see one group of flies completely drop out (such as the pink eyed flies.) The genetics of the founder population are determined by the genotype of the female that started the population and any male she had mated with. In any case, by comparing these frequencies, it allows you to see what changes are occurring. These changes are, by definition, evolution.

The other part of the lab was concerned with looking at a quantitative trait. You had nine genes identified for you on a chromosome map, and each gene had two alleles. Each allele contributed a different "dose" to body length of the fruit fly. Your task was to figure out contribution of each allele to body size.

Study questions:

1. Briefly define what a quantitative (continuous) trait is.

2. Why would there never be an unfertilized egg with the genotype EeSs?

3. Recall that in the pre-lab you looked at flies that had either: 1) red eyes (the dominant trait) or sepia eyes; or 2) brown bodies (the dominant trait) or ebony bodies. These traits were depicted using **S** or **s** for eye color and **E** or **e** for body color. Use this information to answer the following questions:

A. Why would you not be able to know the exact genotype of a fly with red eyes and a brown body just by looking at the phenotype?

B. A female fly that is **homozygous** for red eyes and **homozygous** for a brown body mates with a male with sepia eyes and an ebony body.

List all the possible genotypes that would be present in the **female's gametes**.

List all the possible genotypes that would be present in the **male's gametes**.

What will be the frequency of the flies with red eyes and brown bodies in their offspring?

4A. Recall in lab that you looked at a population of flies with red, white, and pink eyes. The alleles for eye color in these flies were co-dominant. In a population of 100 flies, you find 30 have red eyes and 60 have white eyes. What is the frequency of those with pink eyes?

Recall that the genotype of each fly phenotype was as follows:

Red eyes: C_1C_1
Pink Eyes: C_1C_2
White eyes: C_2C_2

4B. What is the frequency of each allele in the above population?

5. What are the expected genotypic frequencies for the next generation if there is no evolution occurring in the population?

Answers:

1. A trait where there is more than one gene affecting a single phenotype (think about the last exercise form the lab—9 genes were involved in fruit fly body length).

2. Unfertilized eggs are haploid cells. EeSs depicts a diploid cell.

3A. A fly could be homozygous or heterozygous for the dominant trait.

3B. ES for female, es for male. 100% of the flies in their offspring will have red eyes and brown bodies.

4A. 0.1

4B. $C_1 = 0.35$; $C_2 = 0.65$

5. $C_1C_1 = 0.12$; $C_2C_2 = 0.42$; $C_1C_2 = 0.46$