EVOLUTION BY NATURAL SELECTION

I. INTRODUCTION

On November 24, 1859 Charles Darwin published *The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, in which he proposed the following two hypotheses:

(1) The theory of common descent, which stated that all living organisms had descended from one or a few common ancestors. Darwin summarized this concept as "descent with modification."
(2) The theory of natural selection, which describes a mechanism that could produce evolutionary change.

The first hypothesis, that of common descent, did not begin with Charles Darwin, although it has been widely credited to him by the general public. In fact, it had already been kicking around a relatively radical element of the scientific community for several generations. You might be surprised to hear that his grandfather, Erasmus Darwin, had published his belief in the common ancestry of all life 65 years earlier in a book called *Zoonomia*! Jean-Baptiste de Lamarck was another who had also held this radical notion and had even proposed a mechanism based on a necessity-driven acquisition of traits, which was widely rejected. Even though we cannot credit Darwin with the idea, we can say that it was his book, with its exhaustive accumulation of evidence from many different areas of biology, that brought about acceptance of the fact of evolution.

It is really the second hypothesis that one could attribute to Darwin, although here again there were contemporaries with the same views although not remotely as well developed as his. Darwin based his hypothesis on two observations laided out in detail in *The Origin of Species*. The first observation is of phenotypic variation among individuals in domesticated animals (Chapter I) and in nature (Chapter II). The second observation is that more young of given species are born than will live to reproduce. Even among those that reproduce, some will leave more offspring than others (Chapter III).

Darwin combined the two observations and asserted that individuals of some phenotypes would consistently survive better and leave more offspring than individuals with other phenotypes. This is the working definition of natural selection and is what Darwin meant by "favored races" in the title of the book. But we are not done yet! As Darwin concluded, if a phenotype is not inheritable, then each generation will retain the same variation even under intense natural selection. Therefore, natural selection will only lead to evolution if the phenotype is heritable. We can now summarize the requirements of evolution by natural selection as follows:

1) Phenotypic variation

2) Consistent differences in the survival and reproduction of different phenotypes

3) Phenotypic variation is inherited by offspring.

II. SIMULATION OF EVOLUTION BY NATURAL SELECTION

To learn in a more concrete way how natural selection operates, we will examine the following scenario. Each person represents an individual randomly sampled from a large population of a scavanging species, let's say a crab for example. The crabs in this population have four different possible claw shapes (cupped, dissected, flat, and tubed) represented in our simulation by spoons, forks, knives, and straws respectively. The crab's favorite (and only) food item is a bean. Crabs that collect more beans than the median crab will produce two offspring, then die. Crabs that collect fewer beans than the median crab will just die. We will begin the simulation with equal proportion of the four crab phenotypes. Each generation will last 1 minute or until the beans are all collected. When time is called, you will count your beans collected and segregate around the room to a number that corresponds to that value. Your TA will count off to tell you whether you were a reproductive crab or not. If you were reproductive, hang on to your feeding appendage and become your offspring for the next generation. If you were not reproductive, then place your old appendage with the supplies and choose the correct equipment for being some other crab's offspring for the next generation. Your TA will keep track of the data from each generation on the board. At the end of the simulation, you will need to copy the data into the table below (Table 1) .

Table 1. Raw Data

	Number of Individuals of Each Phenotype				
Generation	Cupped	Dissected	Flat	Tubed	Total
0					
1					
2					
3					
4					
5					
6					

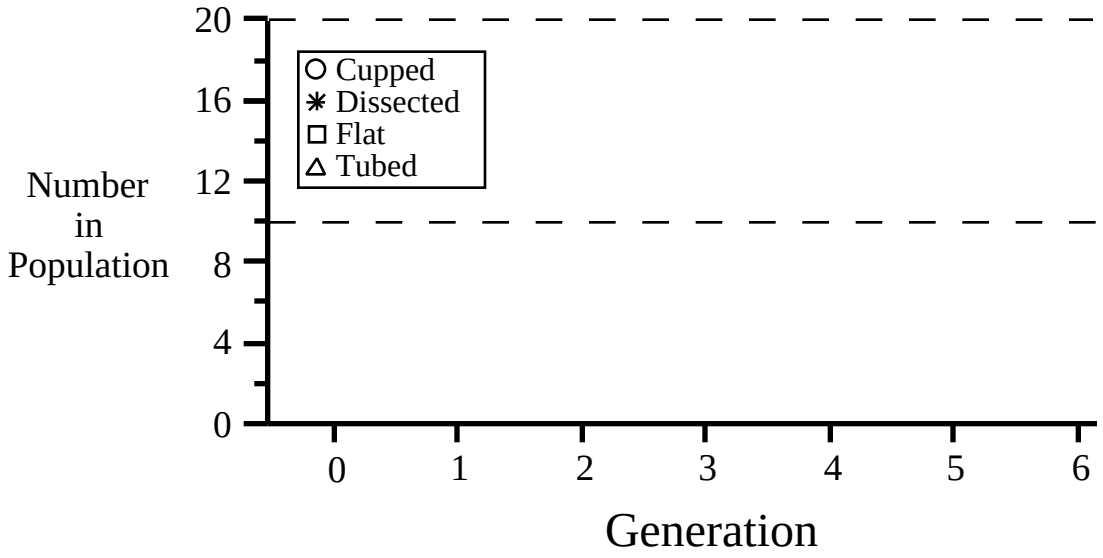
III. ASSIGNMENT

Graph your results on the following page and answer the questions, then detach that sheet and turn it in next Thursday, Sept. 16, in section.

NATURAL SELECTION WORKSHEET
Due Sept. 16 in section

Your Name: _____

Figure 1. Number of individuals of each phenotype present per generation.



Questions

1. Does this simulation include the three conditions necessary for evolution by natural selection to occur?

2. Examine the graph. Have the frequencies of the variants changed across generations? If yes, describe the changes.

3. Has evolution occured in this population? Explain your answer and include your definition of evolution.

4. What do you predict would happen in this population if we continued the simulation for another 50 generations?