Flagstaff High School Pre-AP Biology Evolution Packet & Study Guide #1

Part I. Natural Selection

Peter and Rosemary Grant spent years researching the rate of evolutionary change in finch populations of the Galapagos. During their research, the islands suffered from an extreme drought from 1981 to 1987, during which there was a reduction in the number of plants producing thin-walled seeds. During this time, they also measured an increase in average beak size of the finches.

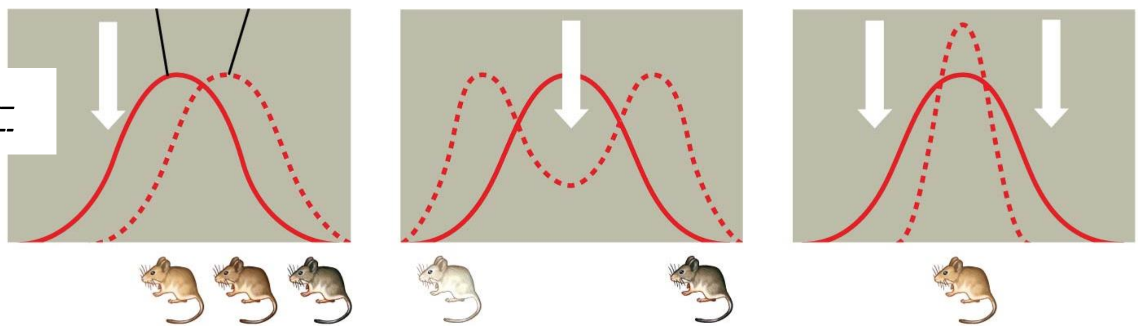
1. Which data-collection procedure likely allowed the Grant's to determine that there was an average change in beak size?
2. What was the main selective pressure behind the change in finch beak size? And describe how gene frequencies were affected as a result:
3. Why would finches with larger beaks have had a survival-advantage during the drought?
4. The Grants discovered that from 1988 to 1993, the average beak size declined to pre-1981 levels. What environmental change was likely related to the reversal of beak sizes?

Mosquitos resistant to the pesticide DDT first appeared in India in 1959 and are now found throughout the world. Use the data provided to justify each of the following claims:

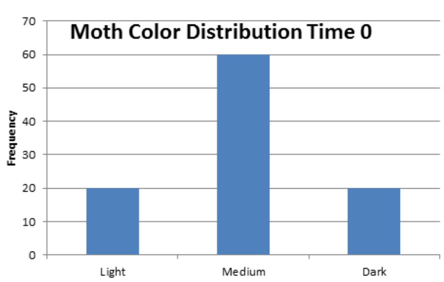
Month	0	8	12
Mosquitoes Resistant* to DDT	4%	45%	77%

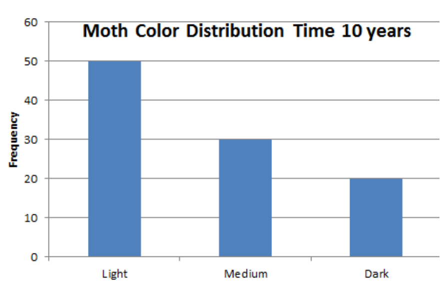
5. Some mosquitos in the population were already DDT resistant at the time when the population was first exposed to DDT.
6. Mosquitos that were DDT-resistant had a selective advantage, surviving and reproducing at a higher rate than nonresistant mosquitos.

Original Population ___
Evolved Population -----



7. Describe the distribution of mice fur-color in the original population (solid line):
8. Describe how the distribution of mice fur-color has changed in each of the three diagrams:
9. Explain the meaning of the large, white down-arrow(s) in the diagrams:
10. Propose a scenario/selective-pressure that would result in the shifts shown in each of the three diagrams:



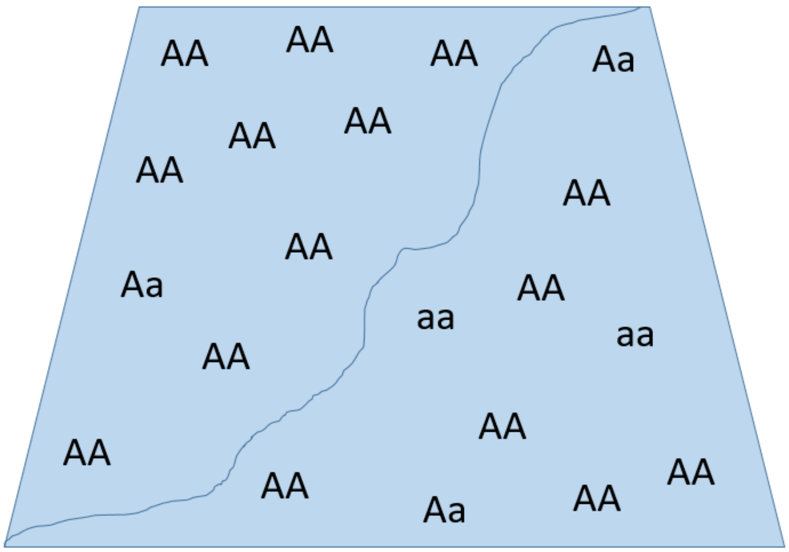


The moth species under investigation comes in three color-morphs. The distribution of moth color was measured at time zero, which represented when a nearby coal-burning power plant was shut down. Ten years later, the distribution of moth color was once again measured.

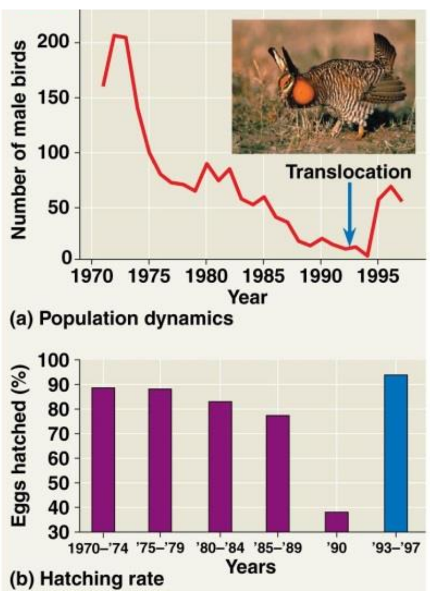
11. Describe the observed change in frequency distribution for moth color in the population under investigation:
12. Propose an evolutionary explanation for this change:
13. Predict what a graph of the frequency of the dark allele would look like from time zero to 10 years.

Part II. Population Genetics and Genetic Drift

Consider a population of endangered lizards, whose genotype for one trait related to genetic resistance to a disease, is shown in the diagram below. The lizards are randomly distributed across their habitat in respect to the genotype shown, when a flashflood suddenly wipes away and kills those lizards shown to the right of the line that intersects the lizard's habitat.



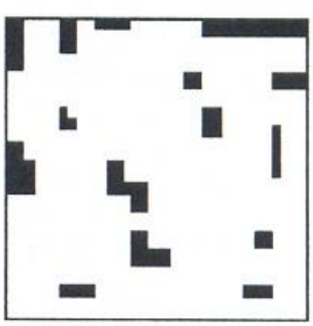
1. What is the population size before and after flooding kills individuals on the right?
2. Calculate the frequency of the dominant allele before & after.
3. Calculate the frequency of the recessive allele before & after.
4. Make a claim with justification for whether microevolution occurred:
5. Make a claim with justification or whether the new population has increased fitness:
6. Discuss what the outcome would likely be if a new disease was introduced, to which AA had no genetic resistance, Aa had partial, and aa had complete resistance.
7. What are two ways that the population (after the flooding) could regain genetic diversity?



(a) Population dynamics

(b) Hatching rate

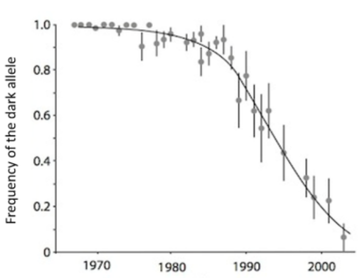
8. What effect did conversion of native-prairie to farming (habitat loss and fragmentation) in the late 1900s have on the population size of prairie chicken?
9. Would you expect the allelic frequencies of the population in 1990 to be the same or different than that of the 1972 population? Justify your response:
10. What is your prediction concerning the population's genetic diversity between 1972 and 1990?
11. How does the % egg hatched data justify your prediction?
12. In 1992, prairie chickens from a number of different populations were translocated into the study location. How did the translocation change the % hatching rate?
13. What is the likely reason for the change following translocation?
14. How and why did the overall population of prairie chickens change in the years following the translocation?



An area that once was a large wetland has been largely drained and as a result the remaining wetland areas are fragmented (separated from one other by dryer areas). As a result, there is limited gene-flow between the frogs found in the isolated populations.

15. What affect would continued isolation have on genetic diversity of each frog population and why?
16. What is the risk of the populations continuing to be isolated?
17. What land-management strategy could improve the long-term survival of the frogs?

Flagstaff High School Pre-AP Biology Evolution Unit Study Guide #1 KEY

1. The Grant's most likely trapped large number of finches, measured their beak depth, and calculated the mean and standard error of the mean. They repeated this processes each year over the course of their study.
2. The main selective pressure that selected for larger beaks was the ability to use the beak as a tool to access food that had become scarce (limited).
3. Large beaks were required to crack the large tough seeds that were the only remaining food-supply as the drought continued. Only birds with beaks large enough to crack the seed-coats could access food, and thus survive to reproduce (and by doing so pass on the genes for large beaks).
4. The decline in beak-size as the study continued could have resulted from the end of the drought. If the drought ended, smaller seeds could have once again become abundant, allowing for survival and reproductive success for birds with smaller beaks.
5. At the time that DDT was first used (it was a brand new selective pressure) 4% of mosquitos were already had genetic resistance. Due to the genetic variability in the population, even though they had never been exposed to the chemical before, some had by chance the genes for resistance.
6. The data table shows that within 12 years of the chemical's first use, 77% of mosquitos were resistant. This is the result of natural selection: the mosquitos that possessed a genetic resistance to DDT were able to survive and reproduce, passing the resistance genes on to their offspring.
7. The original mice color-distribution was a bell-curve, with the majority of mice being in the medium-color range with fewer in either the extreme light or dark.
8. In the first diagram we see directional selection; the original bell-curve is shifted to the right such that the majority of mice are a darker color than in the original population. In the second graph we see disruptive selection such that the medium-colored mice are selected against (eliminated) and there is a bimodal distribution of both extreme colors: light and dark mice. In the final graph, we see stabilizing selection such that the extreme light and dark-colored mice are selected against (eliminated) and a higher proportion of the population is in the medium color-range than in the original population.
9. The large, white down-arrows in the diagram indicate the phenotype that the selective-pressure was eliminating from the population.
10. A scenario that could explain the first situation would be if the habitat was originally a medium sandy brown color and then a lava flow covered the region, changing the color background to a darker color and mice used color as camouflage to escape predation. In the second graph, a habitat that was once medium brown in color could change such that there were patches of darker and patches of lighter habitat and again the mice use color as camouflage. In the third scenario, a habitat that had a range of color backgrounds could have changed to be more uniform in the medium color-range.
11. Ten years after the coal-burning power plant was shut down, the frequency of the light moth color-morph was much higher. Overall, there appeared to be directional selection towards lighter color.
12. If moths use their color as camouflage, darker moths could have had a selective advantage on darker, soot-covered bark of trees at time zero, thus escaping detection by birds. However, after the coal-burning plant was shut down, the tree bark could have returned to its original lighter color, where lighter colored moths now had a selective advantage with camouflage.
13. 

Side #2

1. The population before the flooding was 20 and after the flooding it was only 10 - a population bottleneck occurred.
2. The frequency of the dominant allele before the flood was 33/40 = 0.83 and after it was 19/20=0.95
3. The frequency of the recessive allele before the flood was 7/40 = 0.18 and after it was 1/20 = 0.05
4. Microevolution did occur in this population because there was a change in allele frequency that occurred.
5. The new population does not necessarily have increased fitness, because the allele frequency did not occur due to natural selection, but due to genetic drift. In this case the allele frequency changed due to chance (sampling error in small populations). In fact, this process can result in a loss of genetic diversity that would be adversely affect this population's long-term survival.
6. If a new disease arrived in which the recessive allele resulted in a survival advantage, the population after the genetic bottleneck would be less likely to survive than the population before the bottleneck because the frequency of the now beneficial allele dropped from 0.18 to 0.05. In fact, since none of the surviving lizards are homozygous recessive, it is likely that they will be entirely wiped out by this new disease.
7. Two ways that a population could regain genetic diversity once it has been lost is either through new mutation (which is a slow process because it is random and rare) or by introducing in individuals from a different population that still has high genetic diversity.
8. The loss of most of the American prairie habitat resulted in a large decrease in the population size of native prairie chickens (population bottleneck).
9. Genetic drift (random changes in allele frequencies due to sampling error) has a greater affect as population size decreases. Thus the smaller 1990 population will likely have allele frequencies that differ from the original population.
10. The population size decreased dramatically from 1972 to 1990 and since population bottlenecks are associated with genetic bottlenecks, there is usually a loss of genetic diversity involved. Therefore, I would predict a decrease in genetic diversity occurred from 1972 to 1990.
11. The percent eggs hatching started out at nearly 90% and dropped to about only a third hatching by 1990. A decrease in fertility or viability of offspring is a common indicator of a lack of genetic diversity within a population.
12. The translocation increased the hatching rate from only about a third to higher than 90%.
13. The likely reason for the increase in hatching rate following translocation is that the translocation resulted in an increase in genetic diversity within the recipient population.
14. The overall population size increased following translocation because a higher percentage of eggs were hatching and thus adding to the overall population size over time. This was due to an increase in genetic diversity within the population as a result of translocation.
15. Continued isolation would likely result in a decrease in frog population because the action of genetic drift (random changes in allele frequencies) increases as population size decreases. And genetic drift can result in the loss of alleles, and thus genetic diversity. Each habitat island represents one small frog population
16. The risk of the frog populations continuing to stay isolated is that each population could experience a loss of genetic diversity, inbreeding, and continued decline in population numbers as a result.
17. Creating habitat corridors that connect the habitat islands so that frogs could cross and share genes (gene-flow) could help to maintain genetic diversity and thereby increase each population's chance of survival.