

## Variation in Natural Populations

Know Mendel's laws and understand the causes of deviation from Mendelian ratios in individual crosses.

Define polymorphic and give three examples of polymorphic traits in nature.

Define ecotype. How could ecotypic variation be distinguished from phenotypic plasticity?

What is a "common garden" experiment used for?

$$V_{\text{total}} = V_{\text{genetic}} + V_{\text{environment}}$$

Can natural selection modify variation due to the environment?

Define "genetic assimilation" and explain how it could be important in evolution.

How does methylation of DNA sequences modify epigenetic inheritance? Where does it act in a DNA sequence (gene body, promoter, transposons. Are there any organisms where methylation has not been found?

What does the Hardy Weinberg equation allow us to predict?

What two important points are made by the Hardy-Weinberg theorem? (Hint: How would a population biologist make use of the equation?)

If a population is perturbed by natural selection or migration and then that perturbation is removed, how long will it take the population to return to equilibrium?

What are the assumptions of the Hardy Weinberg equation?

You are a population biologist and you sample two populations, thinking that you are sampling one you calculate the observed and expected Hardy Weinberg genotype proportions and you end up with a heterozygote deficiency. Which of the HW assumptions has been violated as a result of your composite population?

Why do we care about the Hardy Weinberg equation?

Why do we care about violations of the Hardy-Weinberg assumptions?

Why do we care about genetic variability?

Fill in the blank: Early geneticists working with visible mutants believed that variation in natural populations was (circle one) : common, rare, intermediate between common and rare.

When was protein electrophoresis introduced into population biology and by whom?

What is allozyme protein electrophoresis and how is it able to detect mutations? What mutations does it miss?

What did Lewontin and Hubby demonstrate? How did their results change earlier views?

If the frequency of the common allele in a population was .7 and there were only two alleles at that locus, what would be the expected proportions of each genotype in the next generation, assuming that the population was in Hardy-Weinberg equilibrium?

Discuss the statement, "without genetic variation, there can be no evolution."

Of all the processes that can disrupt the HW equilibrium, which of them create variation and which of them destroy variation and if they can do both, explain how.

Why does migration sometimes not equal gene flow?

Regarding "Coalescence":

- A. Why does the average degree of relationship of individuals increase with the passage of time?
- B. True or False: If we look backward in time, all gene copies in a population ultimately are descended from a single ancestral gene copy.
- C. Know that the average time back to common ancestry (coalescence) of a random pair of gene copies in the population is  $2N$  generations, where  $N$  = population size.

Define: inbreeding; genetic drift; inbreeding coefficient, random walk, fixation.

How are inbreeding and genetic drift similar?

How are they different?

Can inbreeding occur and have a strong effect in large populations? Can drift have a strong effect in large populations? Explain both.

What is "inbreeding depression" and what causes it?

Why did theoretical ecologists argue that the genetics of a population might be irrelevant to endangered species in nature?

What did the Glanville Fritillary butterfly study illustrate and what were the consequences in terms of life history costs? Do the results of this study agree with studies of other threatened species living in small populations.

What is purging and why might it be dangerous?

Is inbreeding guaranteed to purge most lethal alleles from a population? What does experimental evidence from botanical studies suggest?

How did Alan Templeton save the Speaks gazelle?

Fill in the blank: In a finite population inbreeding causes the proportion of heterozygotes in the population to decline because \_\_\_\_\_.

Fill in the blank: In a finite population drift causes the proportion of heterozygotes in the population to decline because \_\_\_\_\_.

Can random genetic drift result in non-adaptive evolution?

Define effective population size.

Why is the effective population size often much lower than the actual population size?

Which of the following is *not* a reason that effective population size can be smaller than the actual population size?

- a. Not all males or females participate in breeding.
- b. Natural selection occurs (some individuals leave fewer progeny).
- c. Overlapping generations exist and can mate with each other.
- d. Every individual passes on only one of its two alleles at each locus
- e. Fluctuations in population size occur.

You are a conservation biologist who is asked to assess the chances for survival of a wide spread, formerly common, species that exists presently only as a series of small isolated populations. If these populations have been small and isolated for some time, would you expect the level of genetic variability in each population to be high or low? Would you expect the level of genetic variation in the total species to be high or low? If you were told that most of the current habitat of this species must be sacrificed to make way for "progress," what would you recommend as the best strategy to try to preserve the species given your limited budget?

Fill in the following blanks to indicate which statement is true of genetic drift (GD), which is true of inbreeding (IN) and which is true of both (B). Use the letter abbreviations or word in parentheses to shorten your response.

- 1) \_\_\_\_\_ The smaller the population, the more likely this is to occur
- 2) \_\_\_\_\_ Decreases genetic variability in most circumstances.
- 3) \_\_\_\_\_ This could happen in a large population if strong positive assortative mating was happening.

- 4) \_\_\_\_\_ Causes heterozygosity to decrease at a locus simply because one allele becomes rare.
- 5) \_\_\_\_\_ Causes heterozygosity to decrease at one locus because alleles that are identical by descent are more likely to be present in a single individual.
- 6) \_\_\_\_\_ Could have a positive effect on preserving variability if many populations of a single species are small and isolated.
- 7) \_\_\_\_\_ Which of the two, genetic drift or inbreeding, is most likely to result in combinations of rare deleterious alleles in homozygotes?

Define: Founder effect.

How many colonists do you need to preserve 75% of the variability in the original source population?

How will a short population bottle neck affect heterozygosity?

How will an extended bottle neck affect heterozygosity?

How will a short bottle neck affect the number of alleles in a population?

Give one example of a population or species that was used as an example of a genetic bottleneck.

Is mutation alone a strong force in evolution?

Diagram each of the following models of gene flow: a) "continent-island", b) "island", c) "stepping-stone", and d) "isolation-by-distance."

True or false: In the absence of strong selection, even a low amount of gene flow greatly reduces the divergence among populations.

True or false: the tendency of genetic drift to augment the total genetic diversity of a species by fixing different alleles in different populations can be counteracted by gene flow.

Monarch butterflies and winged versus wingless water strider and stonefly species have been used to demonstrate what?

Explain how gene flow and selection work together to affect the pattern of banded water snakes in the vicinity of Lake Erie.

Pocket gophers have strong among-population differences in allozyme frequency. Chromosomal translocations differ among populations and contribute to lack to gene exchange and suggest speciation in progress. Why is it suspected that natural selection has not led to differences among populations in chromosomal translocation type?

How does Godfrey Hewitt explain his many examples of "Northern purity, Southern richness"? In your answer explain what we mean by purity vs richness.

What causes some populations to be highly structured in genetic variation across a landscape? How has the climatic history of the last 2.6 million years (and especially the last 20,000 years) affected organisms and their genetic variation. Can ecological differences among species affect their genetic structure? Explain.

What determines the probability of fixation of an allele if only genetic drift is acting?

Kimura (1968) argued that most variation in natural populations was due to

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