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March 2, 2019 2:23 PM

Natural Selection, Genetic Drift, and Gene Flow Can Alter Allele Frequencies in a Population

- New mutations can altera allele frequencies, but because mutations are rare, the change from one generation to the next is likely to be very small
- Non-random mating can affect the frequencies of homozygous and heterozygous genotypes but by itself usually has no effect on allele frequencies in the gene pool

Natural Selection

- Individuals in a population exhibit variations in their heritable traits, and those with traits better suited to their environment tend to produce more offspring
- Ex. Fruit flies adapting to not be affected by insecticides (Ex. DDT)
- Natural selection can cause adaptive evolution (evolution that results in better match between organisms and their environment)

Genetic Drift

- Chance events can also cause allele frequencies to fluctuate unpredictably from one generation to the next, especially in small populations, a process called genetic drift
- Allele frequencies can also be caused by chance events associated with survival and reproduction

The Founder Effect

- When a few individuals become isolated from a larger population, this smaller group may establish a new population whose gene pool differs from the source population; this is called the founder effect
- Genetic drift, in which chance events alter allele frequencies, will occur in such a case if the storm indiscriminately transports some individuals (and their alleles) but not others, from a source population

The Bottleneck Effect

- A sudden change in the environment, such as a fire or flood, may drastically reduce the size of a population
- A severe drop in population size can cause the bottleneck effect so named because the population has passed through a bottle neck that reduces its size
- Ongoing genetic drift is likely to have substantial effects on the gene pool until the population becomes large enough that chance events have less impact

Field Study: Impact of Genetic Drift on the Greater Prairie Chicken

- Prairies being populated
- Birds did not survive as well
- Low genetic variation
- Genetic drift may have increased the variation of harmful alleles
- When new genes entered the population, it started to stabilize and increase

Effects of Genetic Drift: A Summary

1. Genetic drift is significant in small populations
2. Genetic drift can cause allele frequencies to change at random
    a. May increase one year and decrease the next
3. Genetic drift can lead to a loss of genetic variation within populations
    a. Can eliminate alleles from a population
4. Genetic drfit can cause harmful alleles to become fixed

Gene Flow

- Gene flow: the transfer of alleles into or out of a population due to the movement of fertile individuals or their gametes
- Gene flow tends to reduce the genetic differences between populations
- Allele transferred by gene flow can also affect how well populations are adapted to local environmental conditions
- It can also transfer alleles that improve the ability of populations to adapt to local conditions
- It has become increasingly important agent of evolutionary change in human populations

Natural Selection is the Only Mechanism that Consistently Causes Adaptive Evolution

Natural Selection: A Closer Look

- Relative Fitness
    - The contribution of an individual makes to the gene pool of the next generation relative to the contributions of other individuals
    - Selection acts more directly on the phenotype than on the genotype

- Directional, Disruptive, and Stabilizing Selection
    - Directional selection occurs when conditions favor individuals exhibiting one extreme of a phenotypic range, thereby shifting a population's frequency curve for the phenotypic character in one direction or the other
        - Common when environment changes
    - Disruptive selection occurs when conditions favour individuals at both extremes of a phenotypic range over individuals with intermediate phenotypes
    - Stabilizing selection acts against both extreme phenotypes and favors intermediate variants

The Key Role of Natura Selection in Adaptive Evolution

- Adaptions can arise gradually over time as natural selection increases the frequencies of alleles that enhance survival and reproduction
- As the proportion of individuals that have favourable traits increases, the match between a species and its environment improves; that is, adaptive evolution occurs
- Genetic drift can cause the frequency of slightly beneficial allele to increase, but it also can cause the frequency of such an allele to decrease
- Gene flow may introduce new advantageous alleles

Sexual Selection

- Sexual selection a form of selection in which individuals with certain inherited characteristics are more likely than other individuals to obtain mates
- Sexual dimorphism a difference between the two sexes in secondary sexual characteristics
- Intrasexual selection meaning selection within the same sex, individuals of one sex compete directly for mates of the opposite sex
- Intersexual selection also called mate choice, individuals of one sex (usually females) are choosy in selecting their mates from the other sex

Balancing Selection

- Genetic variation is often found at loci affected by selection
- Balancing Selection: this type of selection includes heterozygote advantage and frequency-dependent selection

Heterozygote Advantage

- Individuals who are heterozygous at a particular locus have greater fitness than do both kinds of homozygotes, they exhibit heterozygote advantage
- Natural selection tends to maintain two or more alleles at that locus
- Heterozygote advantage is defined in terms of genotype, not phenotype

Frequency-Dependent Selection

- Frequency-dependent selection: the fitness of a phenotype depends on how common it is in the population
- Ex. Scale eating fish

Why Natural Selection Cannot Fashion Perfect Organisms

1. Selection can act only on existing variations
    a. New advantageous alleles do not arise on demand
2. Evolution is limited by historical constraints
    a. Each species has a legacy of decent with modification from ancestral forms
    b. Evolution works on traits an organism already has
3. Adaptations are often compromises
    a. Each organism must do many different things
4. Chance, natural selection, and the environment interact
    a. Not all alleles present in the founding population's gene pool are best suited to the new environment

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