Module 15: Evolution

Three conditions must be met:

1. Genetic variation (mutation)
2. Some stress that favors this variation (adaptation)
3. Survivors procreate, pass on the variation (reproduction)

Genotype: set of genes (dominant and recessive)

Phenotype: traits expressed in a living creature
Genetic drift-pretty much what it sounds like

Bottleneck effect-VERY important: when a species is almost extinct, there is little variation in the gene pool of the survivors, even if their population rebounds (e.g. whales hunted almost to extinction, the entire gene pool is limited to the diversity of the sole survivors)

The bottleneck effect is an evolutionary phenomenon where a significant reduction in a population's size, usually due to an environmental catastrophe, disease, or human activity, leads to a loss of genetic diversity. When only a small portion of the population survives, **the resulting gene pool is limited to the genetic traits of the survivors.** This effect can drastically alter a population's genetic makeup and impact its adaptability and survival ("robustness").

How the Bottleneck Effect Works

1. **Population Reduction**: A large, diverse population faces a sudden event, such as a natural disaster (e.g., a volcanic eruption or flood), disease outbreak, or habitat destruction. This reduces the population to a small number of individuals.
2. **Loss of Genetic Diversity**: Because only a subset of the original population survives, the gene pool is significantly reduced. The surviving individuals carry only a small portion of the genetic diversity present in the original population.
3. **Repopulation**: As the surviving population grows again, all future generations are based on the limited genetic diversity of the survivors. Certain alleles (gene variants) may become much more common or even fixed, while others may be lost entirely.

Consequences of the Bottleneck Effect

- **Reduced Genetic Diversity**: With fewer alleles in the gene pool, the population may lack traits that would allow it to adapt to new environmental pressures or changes, making it more vulnerable to extinction.
- **Increased Genetic Drift**: Genetic drift, the random fluctuation of allele frequencies, becomes more pronounced in smaller populations. Some alleles may disappear entirely from the population by chance, while others may become more common.
- **Higher Risk of Inbreeding**: In a population with reduced diversity, individuals are more likely to mate with close relatives, which increases the chances of inbreeding. Inbreeding can lead to an increase in harmful recessive traits and reduce overall fitness.

Founder effect: random selection of survivors, creating a new gene pool (birds, Gilligan)

The founder effect is an evolutionary phenomenon that occurs when a small group of individuals separates from a larger population to establish a new population. This small group carries only a limited amount of the genetic diversity from the original population, leading to unique genetic characteristics in the new population, which may differ significantly from the original group.

How the Founder Effect Works

1. **Small Group of Founders**: A small subset of a population moves to a new location, becomes isolated, or is otherwise separated from the main population. This can occur through events like migration to a new region, geographic separation, or the establishment of a colony by a few individuals.
2. **Limited Gene Pool**: Because the founders represent only a small fraction of the original population, they carry a limited set of genes. Certain alleles (gene variants) may be overrepresented, underrepresented, or entirely absent in the new population compared to the original population.
3. **Genetic Drift in Small Populations**: In the new, smaller population, genetic drift—random changes in allele frequencies—can have a larger impact. Some alleles may become fixed (present in every individual), while others may be lost. Over time, this can lead to distinct genetic characteristics and traits in the new population.

Consequences of the Founder Effect

- **Reduced Genetic Diversity**: Like the bottleneck effect, the founder effect often results in a population with less genetic diversity, which can limit the population's ability to adapt to environmental changes.
- **High Frequency of Certain Traits**: Some alleles may be more common in the new population than they were in the original population. This can lead to a higher prevalence of specific traits, including rare genetic conditions, within the new population.
- **Genetic Differences from the Original Population**: The founder effect can lead to distinct genetic and phenotypic differences between the new population and the original population over generations, even if both groups remain within the same species.

Examples of the Founder Effect

- **Amish Populations:** The Amish community in the United States originated from a small group of European settlers. Due to the founder effect, certain genetic disorders, like Ellis-van Creveld syndrome (a form of dwarfism), are more common in Amish populations than in the general population.
- **Darwin's Finches**: On the Galápagos Islands, isolated populations of finches, each founded by a small group, evolved into different species with unique beak shapes suited to their specific environments. The founder effect, combined with natural selection, contributed to the diversification of finch species.
- **Pitcairn Island**: The descendants of the Bounty mutineers, who settled on Pitcairn Island, have unique genetic characteristics that reflect the limited gene pool of the original settlers.

Key Takeaways

- **The founder effect** occurs when a new population is established by a small group, leading to reduced genetic diversity and potentially unique traits in the population.
- **Allele frequencies** in the new population can differ significantly from the original population, which can increase the prevalence of certain genetic traits, including rare disorders.
- **Environmental and social factors** can amplify or diminish the founder effect's impact, leading to either significant differentiation from or similarity to the original population over time.

Questions:

1. If the early atmosphere of our planet was thinner and less developed, it might have allowed more cosmic radiation to reach the surface. How would this impact the natural mutation/evolution rate?

2. What would be the impact on an ecosystem of rampant mutation rates?

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