Forces of Evolution

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CHAPTER 1 Forces of Evolution

- List processes that change gene frequencies of a population.
- Describe how mutations alter allele frequencies.
- Define gene flow.
- Explain genetic drift.
- Compare the bottleneck effect to the founder effect.

How do a population's genes change?

Remember, without change, there cannot be evolution. Together, the forces that change a population's gene frequencies are the driving mechanisms behind evolution.

Forces of Evolution

The conditions for Hardy-Weinberg equilibrium are unlikely to be met in real populations. The Hardy-Weinberg theorem also describes populations in which allele frequencies are not changing. By definition, such populations are not evolving. How does the theorem help us understand evolution in the real world?

From the theorem, we can infer factors that cause allele frequencies to change. These factors are the "forces of evolution." There are four such forces: mutation, gene flow, genetic drift, and natural selection. Natural selection will be discussed in the "Natural Selection" concept.

Mutation

Mutation creates new genetic variation in a gene pool. It is how all new alleles first arise. In sexually reproducing species, the mutations that matter for evolution are those that occur in gametes. Only these mutations can be passed to offspring. For any given gene, the chance of a mutation occurring in a given gamete is very low. Thus, mutations alone do not have much effect on allele frequencies. However, mutations provide the genetic variation needed for other forces of evolution to act.

Gene Flow

Gene flow occurs when individuals move into or out of a population. If the rate of migration is high, this can have a significant effect on allele frequencies. The allele frequencies of both the population they leave and the population they enter may change.

During the Vietnam War in the 1960s and 1970s, many American servicemen had children with Vietnamese women. Most of the servicemen returned to the United States after the war. However, they left copies of their genes behind in their offspring. In this way, they changed the allele frequencies in the Vietnamese gene pool. Was the gene pool of the American population also affected? Why or why not?

Genetic Drift

Genetic drift is a random change in allele frequencies that occurs in a small population. When a small number of parents produce just a few offspring, allele frequencies in the offspring may differ, by chance, from allele frequencies in the parents.

This is like tossing a coin. If you toss a coin just a few times, you may, by chance, get more or less than the expected 50 percent heads or tails. In a small population, you may also, by chance, get different allele frequencies than expected in the next generation. In this way, allele frequencies may drift over time.

There are two special conditions under which genetic drift occurs. They are called bottleneck effect and founder effect.

1. **Bottleneck effect** occurs when a population suddenly gets much smaller. This might happen because of a natural disaster such as a forest fire. By chance, allele frequencies of the survivors may be different from those of the original population.
2. **Founder effect** occurs when a few individuals start, or found, a new population. By chance, allele frequencies of the founders may be different from allele frequencies of the population they left. An example is described in the **Figure** 1.1.

Video

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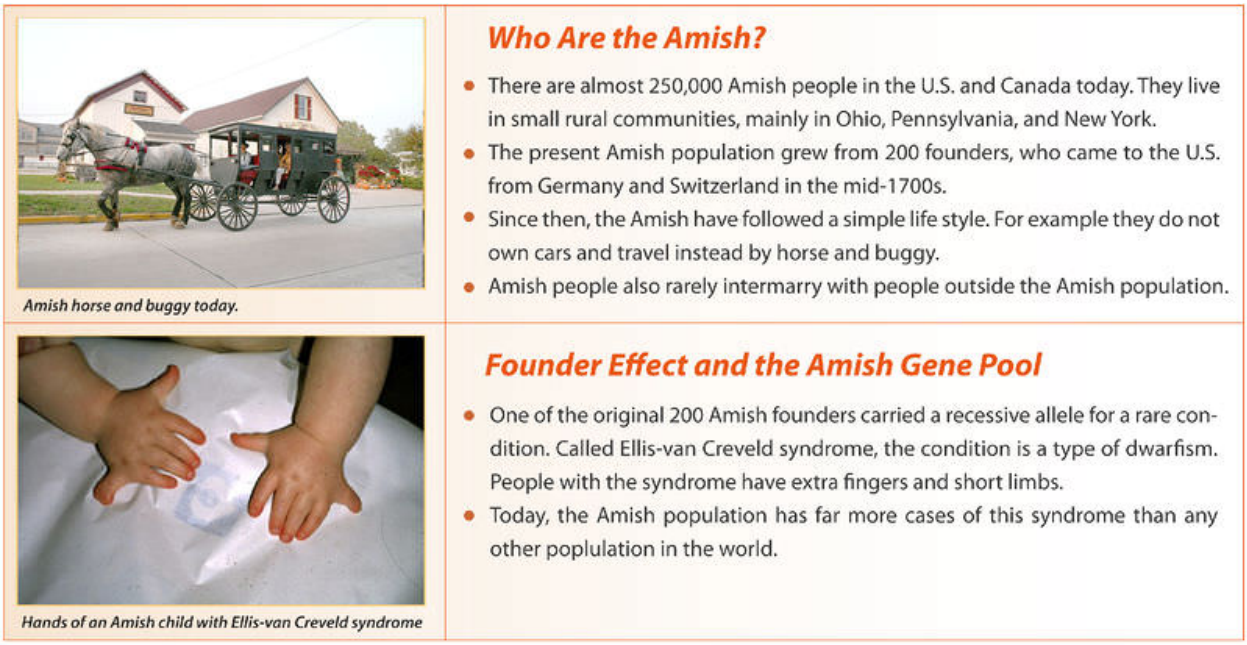

FIGURE 1.1

Founder Effect in the Amish Population. The Amish population in the U.S. and Canada had a small number of founders. How has this affected the Amish gene pool?

Summary

- There are four forces of evolution: mutation, gene flow, genetic drift, and natural selection.
- Mutation creates new genetic variation in a gene pool.
- Gene flow and genetic drift alter allele frequencies in a gene pool.

Review

1. Identify the four forces of evolution.
2. Why is mutation needed for evolution to occur, even though it usually has little effect on allele frequencies?
3. What is founder effect? Give an example.
4. Explain why genetic drift is most likely to occur in a small population.

References

1. Horse and Buggy: Derek Jensen; Hands: G Baujat and M Le Merrer; Composite created by CK-12 Foundation. Horse and Buggy: http://commons.wikimedia.org/wiki/File:Shipshewana-indiana-amish-buggy.jpg; Hands: http://commons.wikimedia.org/wiki/File:Polydactyly_ECS.jpg . Horse and Buggy: Public Domain; Hands: CC BY 2.0