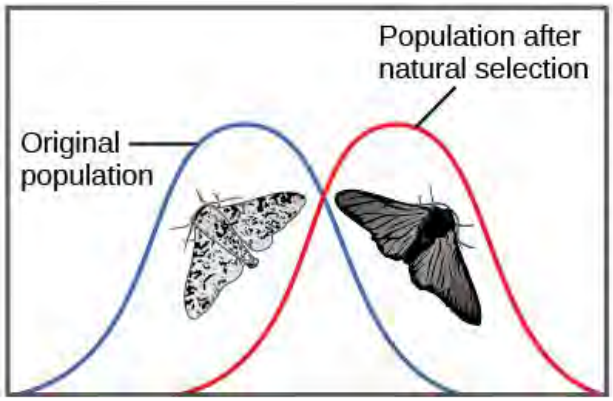

Light-colored peppered moths are better camouflaged against a pristine environment; likewise, dark-colored peppered moths are better camouflaged against a sooty environment. Thus, as the Industrial Revolution progressed in nineteenth-century England, the color of the moth population shifted from light to dark.

Figure 11.7 As the Industrial Revolution caused trees to darken from soot, darker colored peppered moths were better camouflaged than the lighter colored ones, which caused there to be more of the darker colored moths in the population. (credit: Fowler et al. / Concepts of Biology OpenStax)

In the early twentieth century, many questioned why a "dominant" allele, one that masks a recessive allele, would not increase in frequency in a population until it eliminated all the other alleles. English mathematician Godfrey Hardy and German physician Wilhelm Weinberg independently provided explanations for this somewhat counterintuitive concept. Hardy, who was not even a biologist, pointed out that if there are no factors that affect an allele frequency, those frequencies will remain constant from one generation to the next. This principle is now known as the Hardy-Weinberg equilibrium. The **Hardy-Weinberg equilibrium** states that a population's allele and genotype frequencies are inherently stable unless some kind of evolutionary force is acting on the population. In other words, the population would carry the same alleles in the same proportions generation after generation if evolution was not occurring. Individuals would look essentially the same and this would be unrelated to whether the alleles were dominant or recessive.

Populations are always evolving, and the Hardy-Weinberg equilibrium will never be exactly observed. However, the Hardy-Weinberg principle gives scientists a baseline expectation for allele frequencies in a non-evolving population. They can then compare evolving populations and infer what evolutionary forces might be at play. The population is evolving if the frequencies of alleles or genotypes deviate from the expected values calculated using the Hardy-Weinberg principle.

Footnotes

- 2 Charles Darwin, *Journal of Researches into the Natural History and Geology of the Countries Visited during the Voyage of H.M.S. Beagle Round the World, under the Command of Capt. Fitz Roy, R.N*, 2nd. ed. (London: John Murray, 1860), http://www.archive.org/details/journalofresea00darw.
- 3 Sahar S. Hanania, Dhia S. Hassawi, and Nidal M. Irshaid, "Allele Frequency and Molecular Genotypes of ABO Blood Group System in a Jordanian Population," *Journal of Medical Sciences* 7 (2007): 51-58, doi:10.3923/jms.2007.51.58

Section Summary

Evolution by natural selection arises from three conditions: individuals within a species vary, some of those variations are heritable, and organisms have more offspring than resources can support. The consequence is that individuals with relatively advantageous variations will be more likely to survive and have higher reproductive rates than those individuals with different traits. The advantageous traits will be passed on to offspring in greater proportion. Thus, the trait will have higher representation in the next and subsequent generations leading to genetic change in the population.

The modern synthesis of evolutionary theory grew out of the understanding of Darwin's, Wallace's, and Mendel's thoughts on evolution and heredity. Population genetics is a theoretical framework for describing evolutionary change in populations through the change in allele frequencies. Population genetics defines evolution as a change in allele frequency over generations. In the absence of evolutionary forces allele frequencies will not change in a population; this is known as Hardy-Weinberg equilibrium principle.

Exercises

1. Which scientific concept did Charles Darwin and Alfred Wallace independently discover?
    a. mutation
    b. overbreeding
    c. natural selection
    d. sexual reproduction
2. Which of the following situation is not an example of natural selection?
    a. One plant grows larger than another plant because its leaves contain more chlorophyll.
    b. Two types of fish eat the same kind of food, and one is better able to gather food than the other.
    c. One male lion earns the right to mate with the females because he is larger than all the other males.
    d. A hurricane wiping out half of a population.
3. Explain the Hardy-Weinberg principle of equilibrium.

Answers

1. (c)
2. (d)
3. The Hardy-Weinberg equilibrium states that a population's allele and genotype frequencies are inherently stable unless some kind of evolutionary force is acting on the population. In other words, the population would carry the same alleles in the same proportions' generation after generation. Individuals would look essentially the same and this would be unrelated to whether the alleles were dominant or recessive.

Glossary

adaptation: a heritable trait or behavior in an organism that aids in its survival in its present environment

allopatric speciation: a speciation that occurs via a geographic separation

analogous structure: a structure that is similar because of evolution in response to similar selection pressures resulting in convergent evolution, not similar because of descent from a common ancestor

convergent evolution: an evolution that results in similar forms on different species

divergent evolution: an evolution that results in different forms in two species with a common ancestor

gene pool: all of the alleles carried by all of the individuals in the population

Hardy-Weinberg equilibrium: a principle that states a population's allele and genotype frequencies are inherently stable unless some kind of evolutionary force is acting on the population

homologous structure: a structure that is similar because of descent from a common ancestor

inheritance of acquired characteristics: a phrase that describes the mechanism of evolution proposed by Lamarck in which traits acquired by individuals through use or disuse could be passed on to their offspring thus leading to evolutionary change in the population

macroevolution: a broader scale of evolutionary changes seen over paleontological time

microevolution: the changes in a population's genetic structure (i.e., allele frequency)

modern synthesis: the overarching evolutionary paradigm that took shape by the 1940s and is generally accepted today

mutation: a permanent variation in the nucleotide sequence of a genome

natural selection: the greater relative survival and reproduction of individuals in a population that have favorable heritable traits, leading to evolutionary change

population genetics: the study of how selective forces change the allele frequencies in a population over time

speciation: a formation of a new species

sympatric speciation: a speciation that occurs in the same geographic space

variation: the variety of alleles in a population