Category II Notes for Natural Selection Examples

Alerting Teacher to Commonly Held Student Ideas

Material A, p. 261t
States but does not explain commonly held student ideas

Industrial Melanism Is Natural Selection at Work

A particularly well studied example of natural selection in action is **industrial melanism,** the darkening of populations of organisms over time in response to industrial pollution. Although it occurs in many insect species, the best-known case of industrial melanism involves the European peppered moth, *Biston betularia.* Among the members of this species, there are two color variations, shown in Figure 12-17. The darker moths have genes for increased production of melanin (a black pigment). Once treasured by butterfly collectors, the dark variety of *Biston betularia* was extremely rare until the 1850s. Starting around 1850, however, dark peppered moths began to appear more often, usually in heavily industrialized areas. Every year, more dark moths were seen. After 100 years, almost all of the peppered-moth populations near industrial centers were composed of dark individuals.

The Concealment Hypothesis

Using Darwin's theory of evolution by natural selection, a hypothesis explaining the replacement of light moths by dark moths can be formed. Dark peppered moths are common in industrial regions where tree trunks are darkened by the soot of pollution. Perhaps dark moths are camouflaged against a background of soot-darkened bark and thereby escape being eaten by birds. Light moths, on the other hand, would stand out against a dark background and would be easy prey for hungry birds. A prediction can be made that the dark peppered moths would be favored in industrial areas because their dark color conceals them from birds that eat moths. This hypothesis is known as the concealment hypothesis.

Testing the Hypothesis

To see if natural selection could have caused the color change in the peppered-moth populations, the British ecologist H.B.D. Kettlewell performed an experiment during the late 1950s. Kettlewell raised populations of light and dark peppered moths in a laboratory. He then marked the underside of their wings with a dot of paint so they could be recognized later. Next, he released equal numbers of light and dark moths in two separate wooded areas of England. One of the wooded areas, near the city of Birmingham, was heavily polluted. The other wooded area, in the rural county of Dorset, was unpolluted. Finally, Kettlewell set rings of traps around the woods to recapture the moths and see which ones survived. As the graph in Figure 12-17 indicates, more of the moths matching the color of the tree trunks in each location survived. Many subsequent experiments confirmed these results. Hidden observers even saw birds passing by dark moths on polluted tree trunks and attacking the more conspicuous light moths. Kettlewell concluded that natural selection indeed causes industrial melanism in peppered-moth populations.

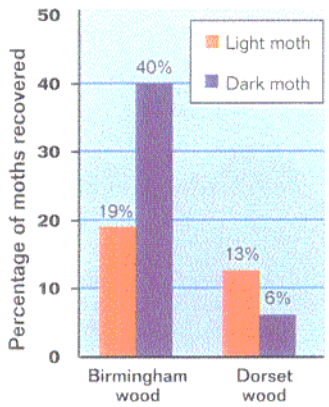

Figure 12-17 Two color variations, *top,* occur among European peppered moths, *Biston betularia.* A graph shows the results of Kettlewell's experiments, *bottom.* In the polluted woods near Birmingham, two-thirds of the surviving moths were dark. In rural Dorset, two-thirds of the surviving moths were light.

CAPSULE SUMMARY

Experiments show that microevolution has occurred within populations of the European peppered moth.

Overcoming Misconceptions

Environment Does Not Cause New Variations

The story of the peppered moth illustrates an important idea in the study of evolution that is frequently misunderstood: Individuals do not evolve, populations do. The darkened trees didn't cause the darker variant of moth to appear. That characteristic was already present in the natural genetic variation of the moth population. The "new" environment merely favored the survival of the darker moths.

SECTION 12-3

VISUAL STRATEGY

Figure 12-17

Instruct students to examine the photograph of the two color variations of peppered moths. Ask: For which of these moths is color an advantage? *(The color of the light-colored moth is an advantage here because the moth blends in with the light-colored bark on which it is resting and is less likely to be detected by a predator.)* Under what circumstances would the dark-colored moth's color be an advantage? *(Dark color would be an advantage if the moths were resting on a dark-colored tree trunk.)*

Teaching Tip

What If there were no dark peppered moths?

When the Industrial Revolution began, air pollution upset the homeostasis of the peppered moth population of Great Britain. Ask: What would likely have happened to the peppered moth population during the Industrial Revolution if a dark variety had not existed in the gene pool of the moths? *(They likely would have become extinct in industrial areas.)*

Application

Agriculture Natural selection has worked to make insect pests harder to fight. When DDT was first introduced, for example, it was a highly effective insecticide. Over time, DDT became less and less effective; individuals that were resistant to the insecticide survived and produced the next generation. In fact, many populations of insects are now resistant to DDT. Although DDT is now banned in this country because of its persistent toxicity, farmers have repeatedly had to deal with insect populations that develop resistance to insecticides.