**CHAPTER 1 INTRODUCTION: EVOLUTION AND THE FOUNDATIONS OF BIOLOGY**

**Scientific Skills Exercise**

**Teaching objective:** Students build scientific skills by interpreting data in a pair of bar graphs and relating the data to the biological system it came from.

**Teaching tips:** A version of this Scientific Skills Exercise can be assigned in MasteringBiology.

If this is the first exercise the students are doing related to interpreting graphs, then you will need to spend time reviewing independent and dependent variables. If the students are confused by having two independent variables on one graph, have them cover one set of data while they look at the other (for example, cover the "full moon" portion of graph A while analyzing the "no moon" portion of it).

In these graphs, there are no statistical significance values given for comparisons between treatments. In the original paper, there was a statistical difference between predation levels of light brown versus dark brown mice in light-colored soil enclosures with no moon and in dark-colored soil enclosures under a full moon. The other two combinations, light-colored soil under a full moon and dark-colored soil with no moon, had no statistically significant difference between light and dark mice.

**Answers:**

**1.** (a) The independent variables for each graph are the coat color of the mice (light or dark brown) and the presence or absence of moonlight (full moon or no moon). These are on the *x*-axis. Taking both graphs together, a third independent variable is the color of soil in the enclosure. (b) The dependent variable is the amount of predation, measured as the number of mice caught. The dependent variable is on the *y*-axis of the two graphs.

**2.** (a) About 19. (b) About 12. (c) Based on the data, the mouse would be more likely to escape on dark soil. This might be because in the moonlight, a dark mouse on light soil would be more noticeable than one on dark soil.

**3.** (a) Under a full moon (12 were caught vs. 20 under no moon). (b) Under no moon (11 were caught vs. 18 under a full moon).

**4.** (a) Dark soil field with a full moon. (b) Light soil with no moon.

**5.** (a) No moon plus dark brown coat had the highest predation level in the light soil enclosure (38 mice were caught). (b) Full moon plus light brown coat had the highest predation level in the dark soil enclosure.

**6.** Being on the contrasting soil is most deadly for both colors of mice.

**7.** The total number of mice caught on moonlit nights was about 77 and on nights with no moon was about 95, so the dark nights seem to be slightly better overall for hunting for owls.

**Interpret the Data**

**Figure 1.21** In the beach habitat, approximately 27 light models and 73 dark models were attacked. In the inland habitat, approximately 76 light models and 24 dark models were attacked.

**Suggested Answers for End-of-Chapter Essay Questions**

See the general information on grading short-answer essays and a suggested rubric at the beginning of this document.

**7. Scientific Inquiry**

Many legitimate hypotheses could be proposed to extend the investigation. Here is one example. If the camouflage color has arisen through the processes of natural selection due to visual predators, then you might wonder what would happen if a population of beach mice lived in an area where predators were absent. It might be possible to do a long-term study in an area where you excluded predators. Mice have fairly short generation times, so if predation is “naturally selecting” lighter colored mice, then in the absence of predation you might predict the coat color would not remain predominantly light in such an experimental population.

**8. Scientific Inquiry**

Students are asked to use a PubMed search to identify an abstract of an article authored or co-authored by Hopi Hoekstra from 2014 forward. It is therefore expected that the range of abstracts from which students might choose will grow as the Hoekstra lab generates additional publications.

**9. Focus on Evolution**

**Sample key points:**

* Darwin used reasoning based on observations to develop his theory of natural selection as a mechanism for evolution.
* His observations included:
  + Heritable variations exist in each population.
  + A population has more individuals than can be supported by the environment.
  + Each species seems suited for its particular environment.
* He proposed that the best-adapted individuals in a population would outcompete others for resources and disproportionately survive and produce more offspring, leading to an increase in the adaptations seen in the population.

**Sample top-scoring answer:**

Based on many observations of different species, Darwin proposed his theory that evolution by means of natural selection accounts for both the unity and diversity of life on Earth. He noticed that variations existed among the individuals in a population and that these variations seemed to be heritable. He also saw that populations could grow larger than could be supported by the resources around them. Finally, he observed that species (like the different species of finches) seemed to suit their environment. He proposed that the best-suited individuals in a population would survive and reproduce more successfully that those less adapted to their environment, and he called this “natural selection.” In Darwin’s view, this mechanism could account for both the unity and diversity of features among species. The descent of organisms from a common ancestor explains similar features, while the force of natural selection in different environments accounts for differences between organisms.

**10. Focus on Information**

Common ancestry explains this observation. The thousand-some-odd genes shared by humans and prokaryotes originated in early prokaryotes. They have been retained, with some modification, over the billions of years of eukaryotic evolution. These genes no doubt code for proteins and RNAs whose functions are essential for survival—for example, the genes that code for ribosomal RNA, which is important for protein synthesis in both prokaryotes and eukaryotes.

**11. Synthesize Your Knowledge**

It’s difficult to pick out this gecko against the background of the tree trunk, because the gecko itself looks like mossy bark. This coloration likely makes it harder for the gecko to be seen by predators, thus enhancing its survival. This cryptic coloration pattern probably evolved over generations. The members of a gecko population that more closely resembled their background would have been less visible to predators, thus more likely to survive, reproduce, and leave offspring. The offspring would inherit the genes that generated the mossy bark coloration, and the offspring that blended in better would survive better and reproduce more successfully. Over generations, the coloration would become a closer and closer match to the tree bark. (The mossy leaf-tailed gecko is endemic to Madagascar, meaning it is found only there and nowhere else in the world. Many endemic species live in Madagascar. This is because it is an island with land features and climatic factors that have allowed evolution of many species in isolation.)