Category IV Notes for Natural Selection Examples

Representing Ideas Effectively

Material I, pp. 218-220st

Represents key idea that “Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase” (idea c).

Table 9.1

x	f
16–18	2
19–21	7
22–24	4
25–27	9
28–30	14
etc.	etc.

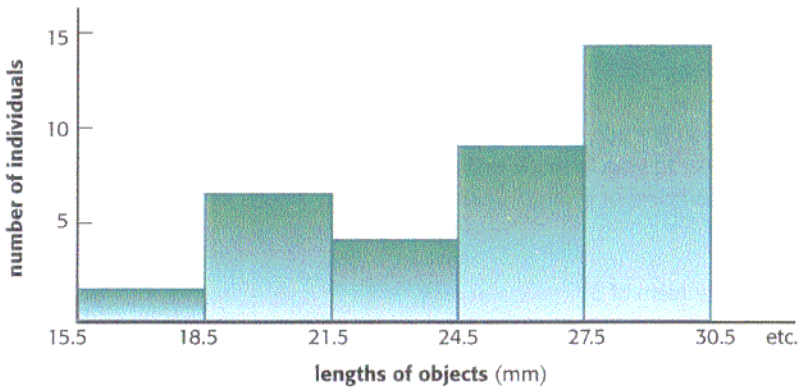

Figure 9.23 A histogram

largest, 39 mm), it could be divided into 8 intervals of 3 mm each, as follows: 16–18, 19–21, 22–24, 25–27, 28–30, 31–33, 34–36, and 37–39.

c. Assemble your data in a frequency distribution table with the intervals listed in the x column and the number of individuals falling into each interval (frequency) listed in the F column, as shown in Table 9.1.

7. Construct a histogram similar to Figure 9.23 from your frequency distribution table. A histogram is simply a bar graph with the intervals on the horizontal axis and the frequency on the vertical axis.
8. Calculate the mean, or average, of your data. The mean is the sum of all measurements divided by the number of individuals you measured.
9. What is the mode, or high point, on the histogram? The value of the mode usually is given as the midpoint of the interval having the highest bar. If the high point falls in the 16 to 18 range for example, choose 17 as the mode. In Figure 9. 23, the mode is 29.
10. Find the median, which is the value for the middle of the sample, when the values (lengths) are arranged in order. If a series of measurements is 2, 2, 3, 4, 7, 8, 9, 9, and 11, the median would be 7.

Discussion

1. Look at the data and your histogram. What is the difference in length between the longest and the shortest objects in your sample?
2. Given the overall size of the objects, do you think this difference is important? What might be the advantage or disadvantage of being smaller or larger than average?
3. Would you have noticed the differences if you had not measured the objects?
4. Do you think there would be any size difference if the objects were of different ages or from different plants?
5. When do you think a histogram is a better, or more accurate, way to present data than a line graph?

INVESTIGATION 9.2 Natural Selection—A Simulation

Biologists consider natural selection to be the chief mechanism of evolutionary change and the process responsible for the diversity of life on earth. This investigation illustrates one way in which natural selection operates.

Materials (per team of 6)

2 l-m × 2-m pieces of fabric with different colors and patterns
100 paper chips of assorted colors in plastic bag
small bowl
1 set of colored pencils with colors similar to chip colors
5 sheets of graph paper

PART B Procedure

8, 9, 10. The average probably will be slightly different for each group. Depending on the number of modes, the data may be unimodal, bimodal, or polymodal. For clarity, treat the data as unimodal. Mean, mode, and median are measures of central tendency—the tendency of data to congregate around a central point. The students should understand that these measures are used by biologists and provide different ways of using and interpreting data. Each is a valuable measure in demonstrating different points.

Discussion

1. **Answers will vary from group to group.**
2. **Although size differences may be only slight, they could make a profound difference in the life of an organism. For example, small seeds of many plant species tend to germinate faster than larger seeds. Small seeds will be dispersed farther from the parent plant than larger ones and will be harder to find by predators.**
3. **This is a subjective question. The difference in size may be more significant to some students than to others.**
4. **The size of many objects will vary with age. Also, objects from different individuals probably will show greater variation than objects from a single individual.**
5. **In this example, it will be easier for your students to make the histogram than the line graph. For data that are continuous, a line graph is most appropriate. For data that are discontinuous, a histogram is more appropriate.**

This investigation illustrates how natural selection operates and allows students to experience the interrelationship between coloration and habitat. It also emphasizes the relationship between predators and their prey. Teams of 6 are recommended.

***Time:* One class period.**

PART A Natural Selection

Procedure

1. Spread out the fabric "habitat" on a table top. Examine the paper chips and record the colors of the chips.
2. Appoint one team member as the keeper of the bag of paper chips. All other members are predators, whose prey are chips. The keeper will keep track of the number of turns each predator takes and the number of prey remaining.
3. Turn your backs to the table and allow the keeper to spread the chips uniformly over the fabric, making sure no chips stick together.
4. Imagine yourselves as predators, the paper chips as your prey, and the fabric background as your habitat. One at a time, turn around and select a paper chip using only your eyes to locate it. Do not use your hands to feel the chips. When you have selected a chip, place it in the bowl and turn around. Continue taking turns until only 25 paper chips remain on the fabric and the keeper signals you to stop.
5. Carefully shake the fabric to remove the survivors.
6. Group the survivors according to color by placing chips of the same color together. Arrange them in a row. Record the number of each color that survived.
7. Assume each survivor produces three offspring. Using your teacher's reserve supply, place three chips underneath each survivor.
8. Mix the survivors and their offspring thoroughly and distribute them as in Step 3. (Do not use the chips that were "eaten.")
9. Repeat the entire process of selection (Steps 3–7) four more times. Be sure to record the total number of chips of each color at the start of each round.

Discussion

1. Prepare a histogram for each generation (five histograms) using colored pencils that match as closely as possible the chip colors. Study the histograms of each generation. Was one color chip represented more than others in the first generation of survivors? Why do you think these chips "survived"? What, if any, change occurred between the first and second generation? The first and fifth generation?
2. Compare the original and the last survivor population. Which, if any, color from the original population is not represented in the survivor population? Why?
3. Examine the colors of chips in the fifth generation and the fabric habitat. How do the colors of the survivors relate to the colors of the habitat?
4. How are your results related to the process of natural selection?
5. Assuming no new individuals migrate into the habitat, how will the population change with time? How are your results related to evolution?

PART B Variation and Changes in the Environment

Procedure

10. Using a piece of fabric (habitat) with colors different from the first, begin a new series of predator-prey interactions with the 100 paper chips used in Part A.
11. Repeat Steps 3–8 five times.

Discussion

1. An organism is adapted to its environment if it can grow and reproduce in it. In Part A, which color of chip was "best adapted" to the habitat? Which color of chip was "least adapted"?
2. In Part B, which color of chip was "best adapted" to the new habitat? Which color was "least adapted"? How do these compare to the chips from Part A?
3. Changing colors of habitat is similar to a change in the environment. Name as many types of changes in the environment as you can.

Discussion

1. **The chip best blending into the background will have the most survivors. You can relate this to animals having camouflage. The change between the first and the fifth generations is much more dramatic than that between the first and the second.**
2. **Individuals that stand out from the habitat are easily seen by predators, captured, eaten, and their genes removed from the gene pool.**
3. **The colors of the survivors blend closely with the colors of the habitat.**
4. **These results mimic natural selection, where the best adapted individuals reproduce the most and pass their genes on to the next generation.**
5. **Eventually, the best adapted individuals will make up the majority within the population and the least adapted will become extinct.**

Discussion

1, 2. **This answer is similar to 1 above; however, students should relate adaptation to reproduction. Also, students should see that with a change in the habitat, a different color of chip is better adapted to the new environment, even if it survived poorly in the first habitat.**
3. **Seasonal changes and changes from one year to the next, such as dry or wet years. Changes through geological time, such as ice ages, also can affect the success of living things.**

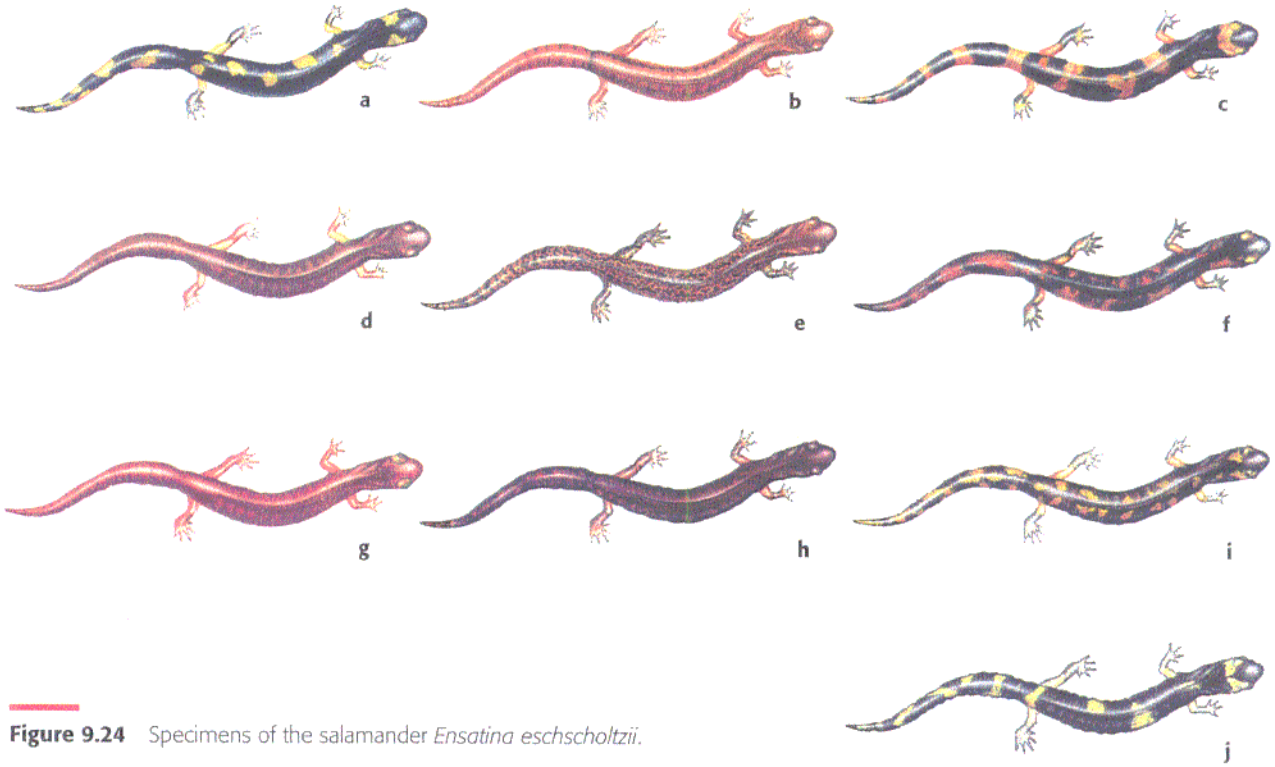

Figure 9.24 Specimens of the salamander *Ensatina eschscholtzii*.

4, 5. Variation increases the likelihood that at least a few members of a population will be able to survive even if the environment changes. If all the offspring were identical, then most would survive in a constant environment, but would die when they could no longer tolerate part of their environment.

4. How are species with genetic variation in their offspring able to survive in environments that change through time?
5. What do you think would happen to a population if it produced only offspring that were all alike?

For Further Investigation

If new individuals of different colors immigrate into your population, what will be the effect on the population, assuming that habitat and predators remain the same?

This investigation demonstrates how speciation occurs and should emphasize for students that a scientist's real work begins when she or he starts to organize and analyze data. Dr. Stebbins's research was published in *University of California Publications in Zoology* 48 (1949): 377-526. Students should plot data individually but use small groups to consider the discussion question
***Time:* One class period.**

INVESTIGATION 9.3 A Step in Speciation

The small salamanders of the genus *Ensatina* are strictly terrestrial. They even lay their eggs on land. Nevertheless, these salamanders need a moist environment and do not thrive in arid regions. In California, *Ensatina eschscholtzii* has been studied by R. C. Stebbins at the University of California (Berkeley). This investigation is based on his work.

Materials (per team of 1)

outline map of California
8 different colored pencils

PART A COLLECTION AREAS

Procedure

1. Imagine that you are working with Stebbins's salamander specimens, some of which are pictured in Figure 9.24. In the following list, salamanders are identified by subspecies. (A subspecies is a geographically restricted population that differs consistently from other populations of the same species.) The parentheses after each subspecies contain a number and a color. The number is the total of individuals Stebbins had available for his study. The color is for you to use in designating the subspecies. Following this is a list of collection areas. They are indicated by a code that fits the map of California in Figure 9.25. For example, 32/R means that one or more *E. e. croceator* specimens were collected near the intersection of Line 32 and Line R.