

Lesson 3: A Closer Look at Darwin

Introduction

Darwin's idea of natural selection has four specific factors. In this lesson, you will have a chance to consider whether the stickleback fish provide evidence of the four factors. This will help you determine if Darwin's ideas are accurate to describe how populations change over time.

Process and Procedure

1. Write the focus question for the lesson in the box below. Underneath the box, write your best ideas about the question. Leave space to revise your ideas as you learn more.

Taking a Closer Look at Darwin's Ideas

2. In the last lesson, you found that Darwin's idea of natural selection better explains the changes that occurred to the Loberg Lake stickleback population. There are four factors that make up natural selection. Read about the factors below. Discuss each with your group to make sure you know what each factor means.

Factor 1: *More individuals are born than can survive and reproduce.*

Factor 2: Individuals within a population inherit traits from their parents. These traits show variation.

Factor 3: *Individuals in a population compete for limited resources (e.g., food, habitat, or mates).*

Factor 4: *Some offspring inherit variations of traits that help them better survive and reproduce in their environment.*

3. Today, you will examine new information and data about the Loberg Lake stickleback population. As you examine the information and data, you may find evidence that supports one or more of the four factors listed in step 2. When you find evidence that supports one or more of the factors, fill in the appropriate box in the chart below related to the factor. *Do not write anything on this chart until you begin to examine the data.*

Four Factors of Natural Selection

Factor 1: More individuals are born than can survive and reproduce.

Factor 2: Individuals within a population inherit traits from their parents. These traits show variation.

Factor 3: Individuals in a population compete for limited resources (e.g., food, habitat, or mates).

Factor 4: Some offspring inherit variations of traits that help them better survive and reproduce in their environment.

4. One way to collect more information about whether the Loberg Lake stickleback fit with Darwin's ideas of natural selection is to learn more about the fish in general. Read the following field guide to find out more about stickleback. As you read, highlight any information that would help you complete the chart in STEP 3. Be sure to label each highlighted piece with 1, 2, 3, or 4 depending on the factor it supports.

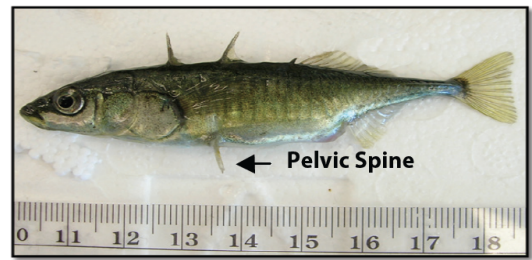


Photo by HHMI

Discuss ideas from the field guide and add them to the Four Factors of Natural Selection graphic organizer to in STEP 3.

Field Guide to Stickleback

Stickleback are small fish that can be found in freshwater and in the ocean. They are one of the most scientifically studied fish in the world.

Appearance: Stickleback fish are between 30 and 80 mm (1 and 3 inches) in length. They vary in color with gray, olive, brown, and black fish. Many stickleback have spines on their back, with some also having spines on their underside. They do not have scales. However, some stickleback have bony armor plates along their bodies. Spines and armor can protect stickleback from predators.

Habitat: Stickleback live in shallow water near shores where there is usually a lot of plant life. They can be found in the ocean and in freshwater. There are 16 different species of stickleback fish, and the ocean-dwelling fish tend to have full body armor. The freshwater fish are less likely to have full body armor. It is possible for ocean-dwelling fish to enter areas of freshwater during the time when females lay eggs.

Geography: Most species are found only in the Northern Hemisphere. There are a few species that can be found in the Southern Hemisphere. There are also species that travel into different areas at different times of the year, depending on the temperature.

Feeding: Stickleback eat worms, larvae of aquatic insects, small fishes, and occasionally their own eggs and fry (very young fish).

Predators: Stickleback have a number of predators. They are eaten by other fish (including other stickleback), birds, otters, and dragonfly nymphs.

Lifespan: Stickleback live 1–3 years. They can reproduce after one year.

Reproduction: Some species of stickleback spawn, or release eggs, during a time frame of about two months in the spring. Others have a longer spawning season of six or seven months. The males develop red bellies or red pelvic fins during the breeding season. The males build nests, and females deposit 75-100 eggs into the nest. The males then care for the eggs and fry, attacking other fish if necessary, until the young fish can take care of themselves.

Aquarium Study

5. Imagine you had a population of 10 stickleback living in a 10-gallon aquarium. Five of them are female. Each year, half of the fish in the population are female and each of those females can lay 100 eggs.
- If all the fish survived, approximately how many fish would be in the aquarium at the end of 3 years?
 - Do you think the aquarium could reasonably hold this many fish? Why or why not?
 - Just as in an aquarium, the stickleback fish in Loberg Lake are contained in a specific amount of water. Remember that Loberg Lake contains approximately 62 million gallons of water as compared to a 10-gallon aquarium. Do you think all 75–100 eggs that each female stickleback can lay each year could reasonably survive in the lake? Why or why not?

6. Look back at the chart in STEP 3. If you have evidence related to any of the natural selection factors, add that evidence to the appropriate boxes. Use a different-colored pen or pencil to add any new ideas.

7. Another way to learn about the population of stickleback is by observing individual fish. Use the Stickleback Cards and the data table below to record information about 10 fish from the population. Be sure to record information about all three traits for each fish. All of these fish were found in freshwater.

STICKLEBACK MEASUREMENTS

Fish number	Length of fish (mm)	Pelvic spines* present? (Yes or No)	Length of pelvic spines (mm)

*Pelvic spines are located on the bottom, near the middle of the fish and are pointing backward toward the tail. The spines have been stained red so you can see them better.

8. Look back at the chart in STEP 3. Consider which factor(s) the data you analyzed in the previous step might support. Based on your analysis of a sample of fish from a population, add any new evidence to the chart in the appropriate box.
9. So far, you have seen data collected from lakes. These types of data are good to see what happens in the natural world. At the same time, there are often complex factors that can affect results. In the next set of data, you will look at a study that happened in a laboratory. Because the experiments were carefully controlled in the lab, these data can give information that scientists might only infer in nature.

Read the information below to learn about the details of the investigation.

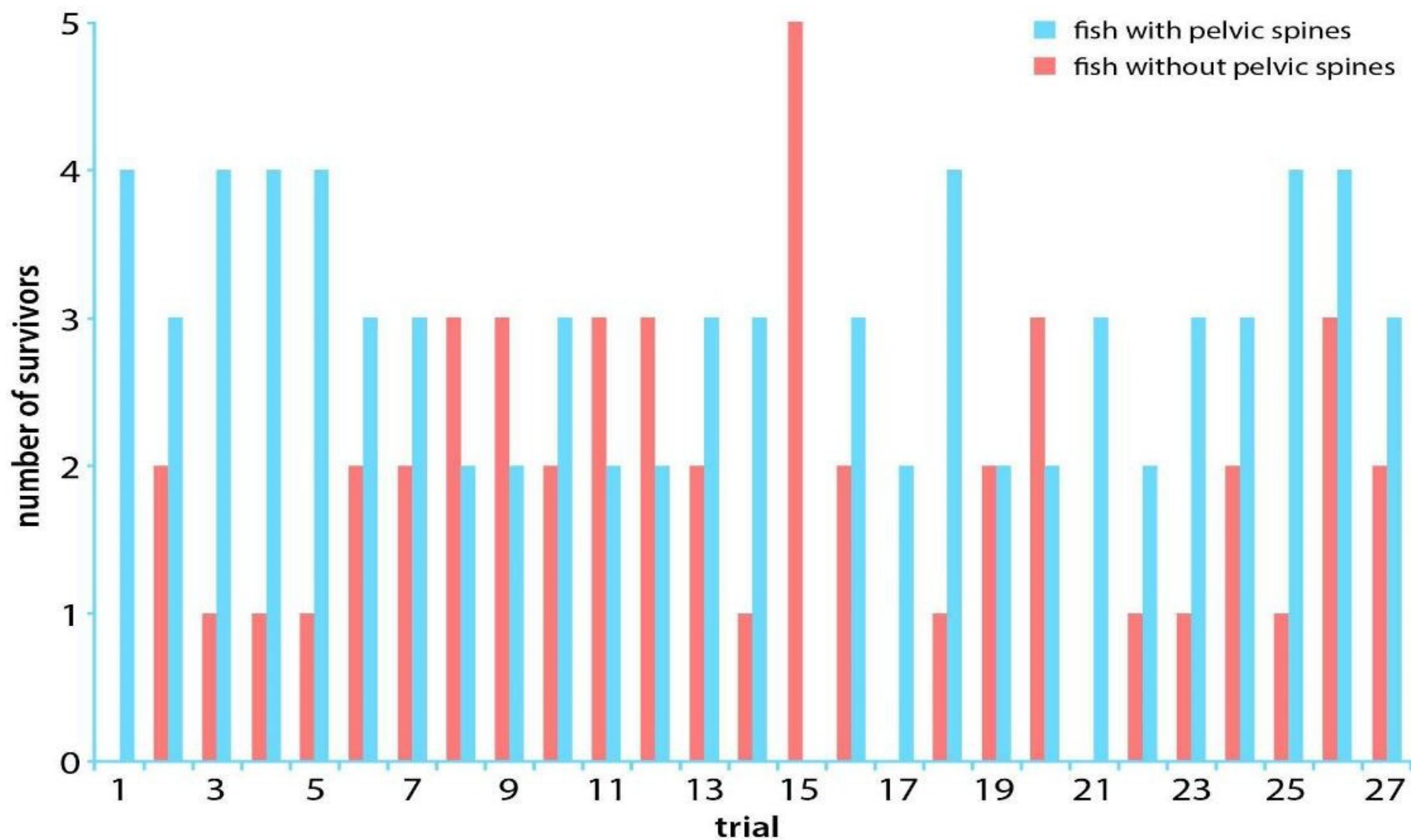
The Study

- One trout was put into a tank with 10 adult stickleback. Five of the stickleback had pelvic spines, and five of the stickleback had no pelvic spines. Trout are a predator of stickleback.
- The trout was not fed for three days before the experiment.
- The scientists left the fish together with a goal of ending each trial when about half (five) stickleback had been eaten, usually after about 11 days.
- Sometimes the trout ate more than five stickleback before the scientists had a chance to stop the trial. In eight trials, the trout ate between six and eight stickleback.
- The scientists did a total of 27 trials.

Draw a diagram below to show the setup of one trial at the start and at the finish of the trial. Explain your diagram to a partner to make sure you both understand what the scientists did.

10. The graph on the next page shows the number of survivors after each trial. The blue bars show the number of stickleback with long pelvic spines that survived. The red bars show the number of stickleback with short pelvic spines that survived. Use the graph to respond to the questions below.
- In how many trials did more fish with long pelvic spines survive?
 - In how many trials did more fish with short pelvic spines survive?
 - Why do you think that not all trials had the same results?
 - Which natural environment does this graph simulate, saltwater or Loberg Lake? Why?
 - What do the results of the scientists' study mean? Include ideas about which fish could survive long enough to reproduce.
11. Return to the Four Factors of Natural Selection Chart. Consider which factor(s) the Effect of Pelvic Spines Study supports. Add any additional evidence to the appropriate box(es).

The Effect of Pelvic Spines on the Survivability of Stickleback in Presence of Trout



12. Imagine that the scientists had been testing the effect of having limited food on the stickleback. Rather than a trout being placed in the tank, the scientists put five stickleback with long spines and five stickleback with short spines in a tank with an amount of food for only five fish. In this experiment, do you think the fish that survived were more likely to have long spines, have short spines, or to have either characteristic? Give reasons for your answer, including why you think the results would be the same or different from the study with the trout.
13. Return to the Four Factors of Natural Selection Chart. Consider which factor(s) the data you analyzed in the previous step might support. Add any additional evidence to the appropriate box(es).

14. When your teacher directs you to do so, find a partner with whom to share your completed chart with from step 3. Your teacher will also provide additional directions concerning how you will share your evidence from the chart. After your conversation, draw a star next to each factor that has strong evidence to suggest it (the factor) may have helped contribute to the changes that occurred to the stickleback population in Loberg Lake

Summarize and Link

15. In this lesson, you have considered whether the four factors of natural selection caused the change in the stickleback population. Use the cause/effect card set to match the effect of each factor to the appropriate cause. Add a “star” to any factor that can help explain the changes in *any* population over time.

Cause and Effect Chart

Cause	Effect
Factor 1: More individuals are born than can survive and reproduce.	
Factor 2: Individuals within a population inherit traits from their parents. These traits show variation.	
Factor 3: Individuals in a population compete for limited resources (e.g., food, habitat, or mates).	
Factor 4: Some offspring inherit variations of traits that help them better survive and reproduce in their environment.	

16. The focus question for this lesson is *What evidence supports Darwin’s (Scientist 2’s) ideas of how populations change over time?* Write a response to this question based on what you learned in the lesson. Include your ideas about each of the four factors of natural selection. You may include diagrams with labels if they help you explain your ideas.